AGREENACARBON PROJECT

Document Prepared by Agreena ApS

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1 PROJECT DETAILS

1.1 Summary Description of the Project

Audit Type	Period	Program	VVB Name	Number of years
Validation	20-01-2023 – 12-03-2024	Verified Carbon Standard	Earthood Services Private Limited	N/A
Total	1 year, 1 month, 21 days			N/A

While agriculture is critical in ensuring food security around the globe, the Intergovernmental Panel on Climate Change (IPCC) has also determined that agricultural soils have the capacity to sequester carbon in much greater amounts than the sector emits in Greenhouse Gases (GHGs). The agricultural sector is receiving increased attention from policymakers, not only due to challenges related to food security, but also because the sector is becoming a critical player in climate change policy. The sector accounts for nearly 10% of all GHG emissions across the European Union (EU),[1] and holds a significant potential to mitigate these emissions. The answer to unlocking the potential of the sector lies in regenerative agriculture practices, which can enrich the globe's life-sustaining soils while also meeting the demands of a growing human population. Serving as natural carbon sinks, soils hold immense potential to sequester carbon and mitigate the effects of climate change. More than 55% of the climate mitigation potential in the EU-27 agricultural sector lies in agricultural soil and manure management.[2]

The AgreenaCarbon Project (hereafter the "Project" or "AgreenaCarbon") reduces agricultural GHG emissions and increases removals through the implementation of Project Activities rooted in central principles of regenerative agriculture. The Project intends to help farmers (i.e., Project participants) transition to regenerative agriculture and start applying sustainable management practices that can maintain yields while ensuring long-term viability of their land. Regenerative agriculture encompasses holistic farming practices that improve soil fertility and enhance the storage of soil organic carbon (SOC), and it 'focuses on the regeneration of living soil, improved micro hydrology, and conserving biodiversity at all levels while enhancing inputs use-efficiency and ecosystem system services'.[3] The technologies and activities expected to be implemented

[1] EEA. 2021. https://www.eea.europa.eu/publications/data-and-maps/data/data-viewers/greenhouse-gases-viewer
[2] European Parliament. 2022. Agricultural Potential in Carbon Sequestration. https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/699656/IPOL_ATA(2022)699656_EN.pdf
[3] FAO, 2021. Regenerative Agriculture: good practices for small-scale producers. https://www.fao.org/publications/card/en/c/CB6018EN/

by Project participants throughout the Project's geographical scope, either individually or as a combined suite of practices, are outlined in the table below.

Table 1-1. Technologies used in the Project Activities promoted by AgreenaCarbon.

Project Activities	Technologies
Reducing tillage to lower soil disturbance and increase residue retention and carbon inputs[4]	Tine Drill, Disc Drill, Harrow, Cultivator Drill
Leaving crop residues on top of the soil to improve nutrient cycling and soil quality	Straw Harrow
Planting a cover crop through the winter or all the way through to the next harvest to increase organic matter carbon inputs	Tine Drill, Disc Drill, Harrow, Cultivator Drill
Planting catch crops in between spring and winter crops	Tine Drill, Disc Drill, Harrow, Cultivator Drill
Reducing the rate of synthetic nitrogen fertiliser applied and switching to organic fertiliser (manure)	Disc Incorporations (Harrow and Tine)

1.1.1 Project Location

The Project is based in temperate climates across the European continent, its geographic scope spans ten countries; hence all the Project Activity Instances (PAIs) included in this first validation are located across ten nations as per Figure 1-1, and Table 1-2.

[4] Supplemented by the internal Tillage Manual that is distributed to farmers who are participating in the Project to provide technical input.

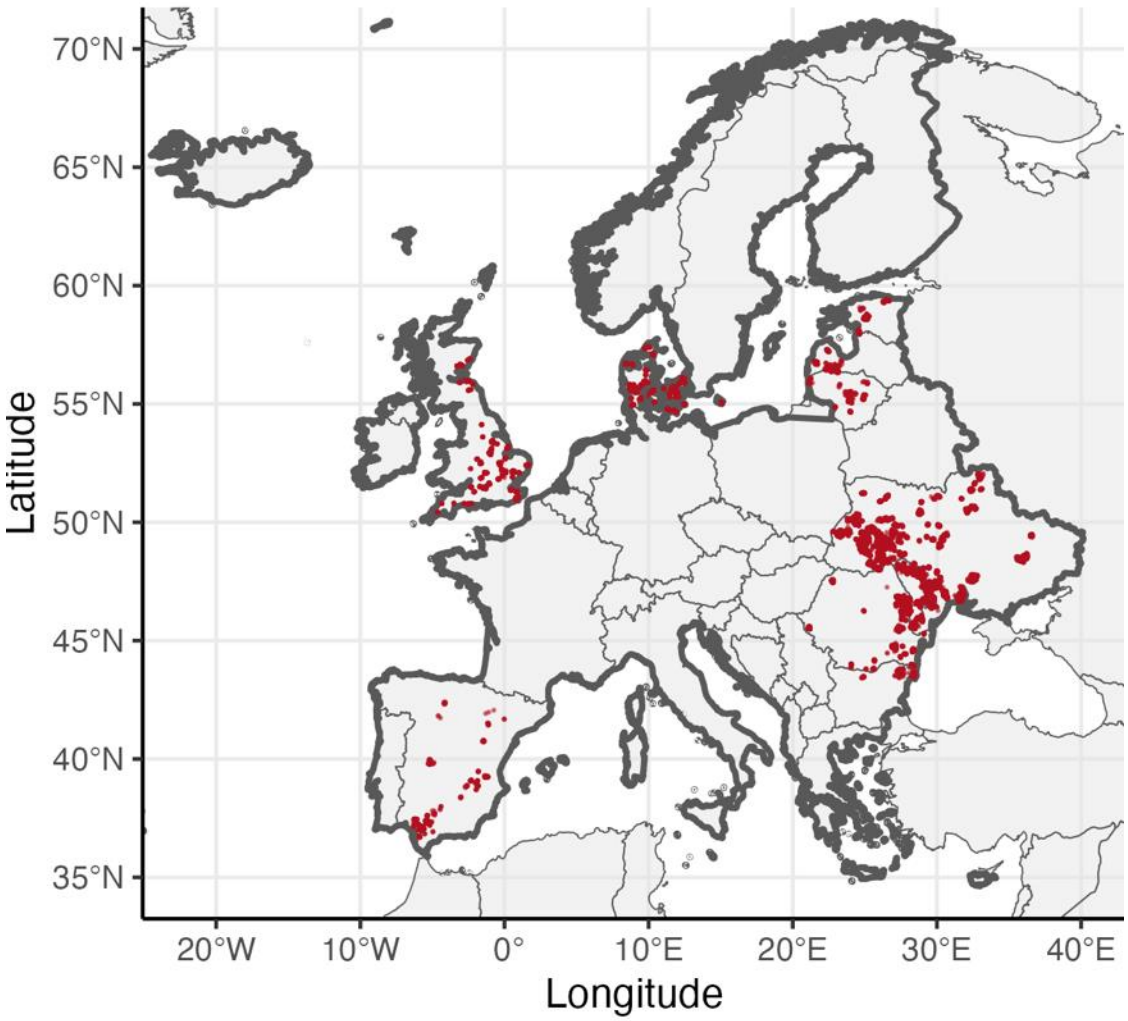


Figure 1-1. Geographical spread of the AgreenaCarbon Project for vintages 2021 and 2022. The European project area is encompassed by the black border, with individual Project Area Instances (PAIs) depicted using red (•) symbols.

Table 1-2. List of countries (Geographic Areas[5]), number of PAIs, hectares and farmers included in the AgreenaCarbon Project for vintages 2021 and 2022.[6]

Country / Geographic Area	No. of-PAIs	No. of Hectares	No. of Farmers
Bulgaria	168	3,573.05	6
Denmark	854	12,409.62	46
Estonia	206	3,739.82	5
Latvia	359	9,255.24	6
Lithuania	286	5,658.92	14
Moldova	1,523	81,255.43	20
Romania	1,531	42,989.66	27
Spain	492	9,554.65	58
Ukraine	6,003	296,763.81	36
United Kingdom	1,194	14,633.91	68
Total	12,616	479,834.11	286

1.1.2 GHG Reductions and Removals

The Project is designed to promote the adoption of sustainable Agricultural Land Management (ALM) practices that lead to reduced GHG emissions on croplands. To join the AgreenaCarbon Project as a new Project Activity Instance (PAI), a new farmer must implement at least one of the Project Activities listed in Table 1-1 (detailed in Table 1-9) within a defined field area and demonstrate that all VCS methodology requirements are met (for example, that the practice change is not already common practice in the region where the PAI is located).

The Project is expected to generate GHG emission reductions and removals (ERRs) through field-level adoption of Project Activities (Table 1-1; Table 1-9). There is strong evidence the latter can enhance SOC storage and/or reduce net GHG emissions. For example: an increase in organic

[5] Geographic Area is formally defined in Section 1.4.

[6] AgreenaCarbon does not use QGIS to calculate the area of field boundaries in the KML file provided with the documentation because QGIS uses a single projection for the entire file (native projection system). This makes the calculation fast but reduces accuracy. Instead, in-house Python code was used, which determines the Universal Transverse Mercator (UTM) zone for each field boundary individually, and reprojects each boundary based on that UTM projection to have a more accurate and localised boundary and hectare count (area). To reproduce the area, the UTM projection must be used.

inputs into the soil subsequently leads to an increase in carbon removal capabilities.[7] Reducing tillage lowers soil disturbance – a stressor that prevents the microbial metabolism of SOC; reduced tillage also reduces the fossil fuel use on-farm, as motorised agricultural machinery would not need to be operated as much. Keeping the soil covered year-round via cover-cropping and residue management improves the soil carbon storage.[8]

The expected reductions and removals are estimated over a 20-year period and are based on data that has already been collected from PAIs as described in Sections 5.1 and 5.2. Within the Project, the AgreenaCarbon platform is used to collect data from farmers. The monitored information includes land ownership, field boundaries, historic farming practices (5-year lookback), soil type (sand, silt, clay), crop-types, and fertiliser inputs (N, K, pig slurry, etc.). The platform gathers and monitors data during farmer outreach, data collection, field inspections, soil sampling, internal data QA/QC, and remote sensing inspections, thus ensuring all data are accurate and correct before they are used in modelling and ERRs quantification. Triangulating various data sources supports high quality and consistency of measurement for the Project (see Section 5.3 Monitoring Plan).

Table 1-3. Estimated annual emission reductions and removals (ERRs) and hectares included in the Project.

Year	Estimated GHG emission reductions and removals (tCO_2e)	Hectares in the Project
15th September 2021- 31st December 2021[9]	21,231.79	19,174.91
1st January 2022- 31st December 2022	547,456.91	479,834.11
1st January 2023- 31st December 2023	543,554.32	479,834.11
1st January 2024- 31st December 2024	542,106.78	479,834.11
1st January 2025- 31st December 2025	541,894.34	479,834.11
1st January 2026- 31st December 2026	541,985.70	479,834.11
1st January 2027- 31st December 2027	547,456.91	479,834.11

[7] https://easac.eu/fileadmin/PDF_s/reports_statements/Regenerative_Agriculture/EASAC_RegAgri_Web_290422.pdf
[8] ibid
[9] The Project start date is the 15th of September. In order to separate the vintages by calendar year, the first calendar year (1st of September to 31st Dec 2021) includes all the initial PAIs that have adopted improved ALM practices within that time period (e.g., Residue mulching or Cover crops until December). All other initial PAIs (and respective hectares) that have adopted improved ALM practices throughout the entire harvest year are included in the next vintage year (2022), though still within the first harvest cycle as depicted in Figure 1-3.

1st January 2028- 31st December 2028	543,554.32	479,834.11
1st January 2029- 31st December 2029	542,106.78	479,834.11
1st January 2030- 31st December 2030	541,894.34	479,834.11
1st January 2031- 31st December 2031	541,985.70	479,834.11
1st January 2032- 31st December 2032	547,456.91	479,834.11
1st January 2033- 31st December 2033	543,554.32	479,834.11
1st January 2034- 31st December 2034	542,106.78	479,834.11
1st January 2035- 31st December 2035	541,894.34	479,834.11
1st January 2036- 31st December 2036	541,985.70	479,834.11
1st January 2037- 31st December 2037	547,456.91	479,834.11
1st January 2038- 31st December 2038	543,554.32	479,834.11
1st January 2039- 31st December 2039	542,106.78	479,834.11
1st January 2040- 31st December 2040	541,894.34	479,834.11
1st January 2041- 14th September 2041	520,160.62	479,834.11
Total estimated ERRs	10,867,398.91	
Total number of years in crediting period	20 years	
Average annual ERRs	543,369.95	

In-house remote sensing expertise and capabilities are used to track soil type, production, cover cropping, historical practices and more, using spatial pattern analysis and remote sensing-based detection as described in Section 5.3.

The platform is used to collect data and facilitate the generation of credits under the VCS Methodology for Improved Agricultural Land Management, v2.0 (VM0042 v2.0). This is a grouped project, so there is a continuous onboarding of new farmers and the enrolment of specifically selected PAIs into the Project once they are confirmed as eligible to generate carbon credits.

Project participants register and submit information on individual PAIs onto the platform, receiving support either from an AgreenaCarbon representative or the self-service system in place as described in the Section 3.5 Application of Methodology, with the baseline scenario and potential change in the SOC storage or decrease in GHG emissions.

The AgreenaCarbon Project defines a PAI as a demarcated field area that is defined by the farmer that may or may not have different crops, practices, or area sizes than other field areas demarcated for other PAIs on the same farm. To be more specific on collecting data and monitoring carbon fluxes, the Project does not stratify at a whole-farm level. The input data from each individual PAI are used to calculate potential ERRs and for monitoring for the duration of the Project.

1.2 Sectoral Scope and Project Type

Sectoral Scope: The project activity falls under the VCS Sectoral Scope 14 of Agriculture Forestry and Other Land Use (AFOLU).

AFOLU Project Category: Agricultural Land Management (ALM).

Eligible ALM Activity: The project falls under ALM activity 1) Improved Agricultural Cropland Management (ICM), as it included reducing net GHG emissions of cropland systems through increasing soil carbon stocks, reducing N_2O emissions and/or reducing CH_4 emissions.

Project Type: The project is a large project (greater than 300,000 tonnes of CO_2e per year reduced or removed) and a grouped project.

The project activity builds upon the VCS methodology VM0042 METHODOLOGY FOR IMPROVED AGRICULTURAL LAND MANAGEMENT, Version 2.0 (30 May 2023).

1.3 Project Eligibility

The Project is eligible under the scope of the VCS Program under ICM[10] because it facilitates the transition of farmers to regenerative agriculture via improved ALM practices, which will result in a reduction in GHG emissions on croplands and sequestration of carbon as SOC. Table 1-4 describes the ways in which the Project fulfils the eligibility requirements laid out in the VCS Standard v4.5, in the sections covering scope, general requirements, and the AFOLU-specific requirements. Eligibility for the project covers the PAIs within the Project, as the AgreenaCarbon Project adheres to the VCS 4.5 Standard.

Table 1-4. Fulfilment of the VCS Standard eligibility requirements for the AgreenaCarbon Project.

VCS Standard	Criterion/Requirement	Justification

[10] This category includes practices that demonstrably reduce net GHG emissions of cropland systems by increasing soil carbon stocks, reducing soil N2O emissions, and/or reducing CH4 emissions (VCS Standard, v4.5, 4 October 2023).

VCS Standard, Scope of the VCS Program	The scope of the Project follows Section 2.1.1 point 1) scope includes the seven Kyoto Protocol GHGs; 3) scope requires that the VCS Program includes 'Project activities supported by a methodology approved under the VCS Program through the development and review process.	The Project is using an approved Verra methodology, VM0042 v2.0 Improved Agricultural Land Management v2.0, and therefore fulfils the scope of the VCS Standard.
VCS General Requirements	3.1.1 Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1.	The Project results in GHG emissions reductions through adoption of regenerative agriculture. Conventional farmers are implementing at least one Project Activity that meets the Applicability Conditions of VM0042 v2.0.
	3.1.2 Projects shall apply methodologies eligible under the VCS Program.	The Project is using an approved Verra methodology, VM0042 v2.0 Improved Agricultural Land Management and therefore fulfils the scope of the VCS Standard.
	3.1.3 Projects shall apply the latest version of the applicable methodology in all cases unless a grace period applies to the project as set out in 3.21 below.	The Project follows v2.0 of the methodology (VM0042) and is therefore in line with the most up to date version.
	3.1.4 Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	Project participants are required to certify during their onboarding that they are following local regulations or law. It is also stated in the Benefits Contract.
	3.1.5 The model selected by the project must meet the requirements set out in the VCS Methodology Requirements	The model used by the Project, Roth-C is one of the accepted models under VCS Requirements and the Project is following the rules outlined on model validation and calibration. The model Validation Report has been submitted to an Independent Modelling Expert (IME) and approved as per VMD0053 requirements.

	3.1.6 Default factors used in the project must meet the requirements set out in the VCS Methodology Requirements	The Project follows the accepted IPCC default factors specified in the VM0042 v2.0 methodology.
	3.1.7 The rules of the VCS Program shall take precedence over other GHG programs	The Project adheres to the rules of VCS taking precedence over other GHG Programs. More details are available in Section 1.15.
	3.1.8 If projects apply methodologies from approved GHG programs they shall conform with VCS Program capacity limits	Not relevant as the Project is not registered to another GHG program. More details are available in Sections 1.14-1.15.
	3.1.9 Project must adhere to new VCS Program rules and the effective dates	In Section 3.1 Title and Referenced Methodology, all relevant documents are listed and are the most recent documents of the VCS Program.
VCS AFOLU Specific Matters	General requirements 3.2.1 – 3.2.25 set out requirements for AFOLU projects that fall under the eligible project categories. Those applicable to this Project are listed below.	The Project adheres to the AFOLU requirements as outlined in the sections presented below and throughout the entirety of this document. AgreenaCarbon complies with all necessary documentation, e.g., AFOLU Non-Permanence Risk Tool as specified in Section 3.2.10.
	3.2.1 Falls within one of the AFOLU project categories	The Project is an ALM project as it involves improving agricultural land practices.
	3.2.2 Jurisdictional REDD+ overlapping projects must comply with REDD+ rules	The Project is not located in any REDD+ project areas as it is based in the pan-European geography.
	3.2.3 Where an implementation partner is acting in partnership with the project proponent, the implementation partner shall be identified in the project description.	The Project does not have any partner organizations and Agreena ApS is the sole Project Proponent.
	3.2.4 The project proponent shall demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in	Based on the validation process and onboarding as well as the nature of the project contracts, i.e., Benefit Contract, the Project participants and their associated PAIs must implement at least one Project Activity that complies,

	accordance with the project design.	as specified in VM0042 v2.0. More details are available in Section 1.11.
	3.2.5 Activities that convert native ecosystems (forests, natural vegetation and wetlands) to generate GHG credits are not eligible under the VCS Program. Evidence shall be provided in the project description that any ARR, ALM, WRC or ACoGS project areas were not cleared of native ecosystems to create GHG credits	The Project uses remote sensing data to check that agricultural fields have not been converted from native ecosystems boundaries including forested areas, natural vegetation and wetlands. Checks for deforestation, native ecosystem and wetland clearing are performed using datasets produced by the Global Land Analysis and Discovery (GLAD) laboratory, which are derived from Landsat data. More details are available in Section 5.3.1, subsection Quality Assurance (QA).
	3.2.5 - 3.2.7 For ALM project types, the project proponent shall, for the duration of the project, reassess the baseline every ten years and have this validated at the same time as the subsequent verification.	The reassessment of the baseline is a requirement under the VCS Standard, and how this will be implemented is described in Section 5.3 Monitoring Plan.
	3.2.8 Where ARR, ALM, IFM or REDD project activities occur on wetlands, the project shall adhere to both the respective project category requirements and the WRC requirements	The Project does not occur on wetlands and therefore this is not applicable.
	3.2.9 The project boundary for a WRC project shall include CH4 emissions sources for all WRC activities and N2O emissions sources for RWE activities, unless deemed de minimis or evidence is provided that it is conservative to exclude these sources.	Not applicable as this is not a WRC project. Further information has been included in the Monitoring Plan (Section 5.3) under checking for native ecosystems including wetlands.
	3.2.10 – 3.2.22 Non-Permanence Risk	The Project has prepared an AFOLU Non-Permanence Risk Report according to the requirements under VCS

		Standard v4.5 and has been submitted as part of Project validation.

1.4 Project Design

This Project is a grouped Project with multiple Project Activity Instances (PAIs) across pan-European geographies, The Project delineates 10 Geographic Areas within the European continent, corresponding to the 10 different countries containing the initial PAIs accompanying the submission of this Project for validation. The Geographic Area(s) are the areas in which the initial instances of the Project are located with same rationale for demonstration of additionality and same baseline scenario per GA. All future instances must be included within the designated GAs at project start. For the Project, the GAs are defined as countries and are contained within 10 countries where AgreenaCarbon has initial instances (Bulgaria, Denmark, Estonia, Latvia, Lithuania, Moldova, Romania, Spain, Ukraine, United Kingdom).

The Project focuses on improving ALM practices within European cropland. The Project activities comprise five specific improvements in ALM, detailed in Tables 1-1 and 1-9, summarised as improvements in tillage intensity, use of cover or catch crops, fertiliser type and management, and use of crop residues. The eligibility criteria for PAIs to enter the Project are described in detail in Section 1.4.1. The eligibility criteria are common across the whole Project area and conform to VM0042 v2.0. Specifically, to be eligible for participation, a PAI must adopt at least one Project-supported activity that is additional within its specific Geographic Area. Project participants choose which Project Activities, or set of activities, to implement as well as the frequency and intensity at which they will be implemented throughout the crediting period. Project participants may also choose to change the combination of Project Activities utilised throughout the crediting period. The Project's method for quantifying GHG emission reductions and removals (discussed in Chapter 4) necessitates that only PAIs which adopt at least one additional Project Activity are eligible to generate VCUs.

The Project activities, or combination of Project activities, implemented by a Project participant must be additional as per requirements outlined in Section 7 of VM0042 v2.0. The process to demonstrate that a given set of implemented Project activities is additional in each geography is described in Section 3.5. The additionality assessment of regulatory surplus, identification of barriers, and the evaluation of common practice are all assessed using country-specific data. Based on this, and in compliance with the requirements set Sections 3.6.13-3.6.15, in VCS (V.4.5), the Project is thus divided in 10 Geographic Areas (i.e., countries).

The baseline scenario for each Geographic Area is determined by any PAI that can demonstrate their capability to adopt at least one of the proposed five Project activities, and it is based on the Geographic Area's specific ALM specifications (see Section 3.4.1 and Table 3-4). The process for determining the baseline is uniformly applied across the entire Project area. However, the development of the baseline Schedule of Activities (SoA) and the quantification of the baseline

GHG emissions are determined for each individual PAI. Once a PAI seeking to enter the Project complies with the eligibility and additionality criteria, field specific data are collected to develop the baseline SoA. The annual SoA in the baseline scenario is applied on a five-year look back period using PAI-specific data as per Box 1, Point 1 in VM0042 v2.0. Furthermore, the Project assumes that the continuation of pre-Project activities is the most plausible baseline scenario. Hence, the baseline emissions are calculated for every PAI individually using the PAI-specific data collected.

Where farmer attested data are not available at the PAI level to construct the baseline SoA (for example, because the field is newly leased and only three out of five years are available), the missing data are filled-in using regional default values (country-specific) as per Box 1, Point 4 in VM0042 v2.0. Country-specific data are collected for all countries for all qualitative and quantitative data parameters required to develop the baseline SoA (e.g., fertiliser type, fertiliser application rate, see Section 5.1). Those data are then utilized to fill-in gaps where PAI-level data are unavailable (further details in Section 3.4). The data used to characterize each area are consistent with the determination of Geographic Areas at country level.

Based on the described Project design, the granularity at which baseline, additionality and eligibility are assessed, and the definition of Geographic Area, the project has 12,616 initial PAIs spanning ten countries or Geographic Areas in Europe, as illustrated in Table 1-2 in Section 1.1.1. The process for assessing the eligibility of each PAI in the Project is summarised in Figure 1-2.

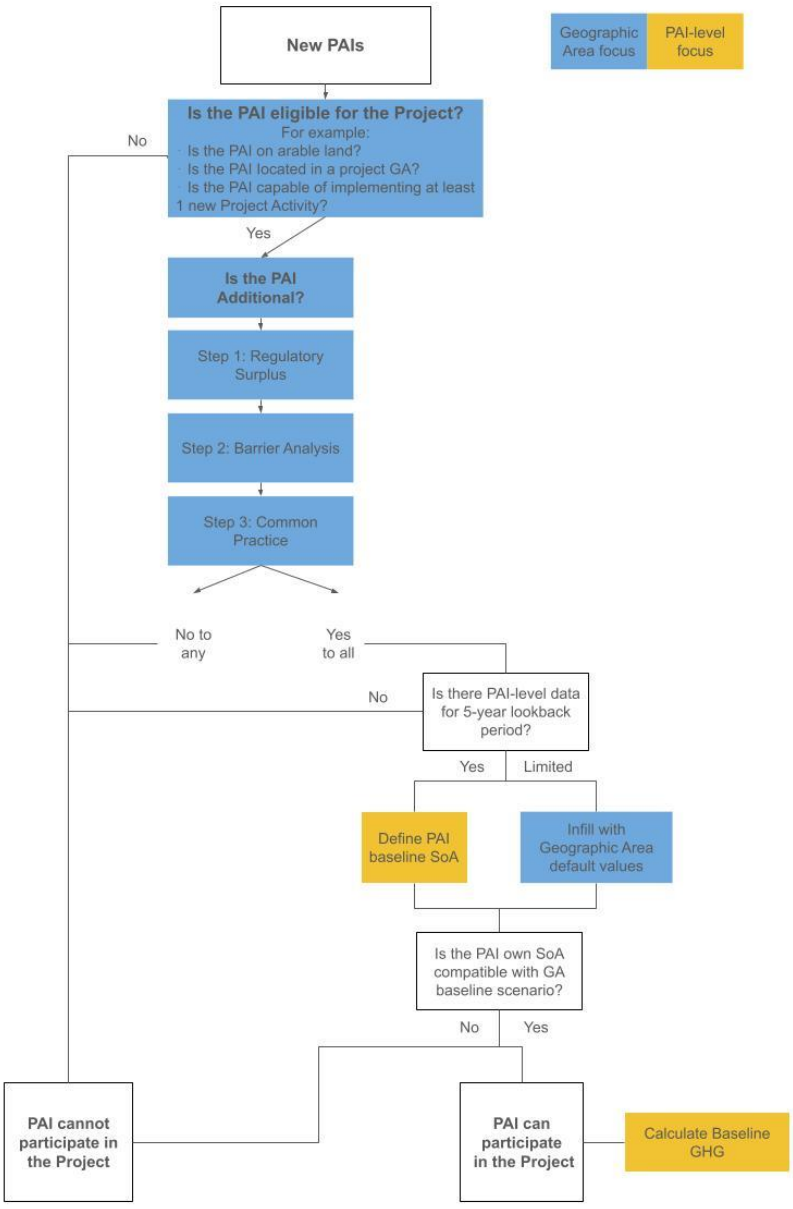


Figure 1-2. Steps involved in assessing eligibility, additionality, and the development of the baseline SoA for PAIs when entering the AgreenaCarbon Project.

1.4.1 Eligibility Criteria

The AgreenaCarbon Project is a grouped project located in the pan-European continent that will recruit new PAIs subsequently to validation. AgreenaCarbon assesses new participants and PAIs to ensure they meet the criteria set out by VCS Standard (v4.5) before including them in the Project, as outlined in Table 1-5 and Table 1-6.

Table 1-5. Grouped AgreenaCarbon Project eligibility criteria required for each Project Activity Instance (PAIs), from VCS Standard v4.5 Section 3.6.16.

Eligibility Criteria	Project Fulfilment of Criteria
Meet applicability conditions set out in the methodology applied.	AgreenaCarbon Project meets the conditions set out in Section 4 of the VM0042 v2.0 methodology and in Section 3.2. Each new PAI must meet the criteria outlined in the methodology (Section 4, VM0042 v2.0) and its relevant updates. The Project alignment with applicability conditions is listed in Table 1-4 above.
Use the technologies or measures in the project description.	Only the measures and technologies outlined in the Project Description (PD) are to be employed in new project instances. In addition, the AgreenaCarbon Project will adhere to Section 4.4 of the VM0042 v2.0 methodology to fulfill the requirements for Quantification Approach 1.
Apply technologies or measures in the manner as specified in the project description.	Only the measures and technologies outlined in the Project Description are to be employed in new project instances. Each PAI in the Project is required to use at least one of the Project Activities listed in this document (Table 1-1, detailed in Table 1-9), confirming use of improved ALMs including reducing tillage, applying cover crops, crop residue management, and reducing synthetic fertiliser.

Are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.	The PAIs entering the Project go through the same assessment for the baseline scenario as outlined in Section 3.4. The PAIs are subject to baseline scenarios which are determined, in each case, by producing a baseline schedule of activities that represent the continuation of pre-project ALM activities. Baseline schedules of activities are produced using a 5-year look-back period that is reassessed 10 years following the Project start-date. The creation of baseline schedules of activities considers the Geographic Area of the PAI as described in Section 3.4, Table 3-4. The baseline scenarios can be described as continuation of some or all conventional cropland farm management practices including conventional tillage, removing residues, applying synthetic fertiliser, and the absence of cover crop use. The specifications of ALM practices in the baseline define the minimum requirements for future PAI eligibility. The criteria are set out in Table 3-4 for each Geographic Area (country). These minimum requirements include: • Crop Planting & Harvesting • Crop types recorded in initial PAIs are specified in Table 3-4 along with their corresponding Crop Functional Group (CFG, as defined in VMD0053 V2). Future PAIs shall include crops belonging to the eligible Crop Functional Groups listed in Table 3-4 within the 5-year look-back period. The crops shall further comply with the quantitative specifications indicated in Table 3-4 per crop functional group and Geographic Area (country). • Nitrogen Fertiliser Application • Manure and synthetic N recorded in initial PAIs are specified in Table 3-4. Future PAIs shall include these requirements as listed in Table 3-4 within the 5-year look-back period. The Nitrogen fertiliser criteria shall further comply with the quantitative specifications indicated in Table 3-4 per Geographic Area (country).

	• Tillage • Tillage type recorded in initial PAIs are specified in Table 3-4. Future PAIs shall include these requirements as listed in Table 3-4 within the 5-year look-back period. The Tillage criteria shall further comply with the quantitative specifications indicated in Table 3-4 per Geographic Area (country). • Residue Management • Residue management recorded in initial PAIs are specified in Table 3-4. Future PAIs shall include these requirements as listed in Table 3-4 within the 5-year look-back period. The residue management criteria shall further comply with the quantitative specifications indicated in Table 3-4 per Geographic Area (country). For the quantification of emissions reductions, the baseline is determined for each improved land management practice activity using the baseline schedule of activities that occurs prior to the start date.
Have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area.	The additionality assessment outlined in Section 3.5 shows that Project participants must implement at least one Project Activity described in this document (Section 1.11, Table 1-1, details Table 1-9) that further passes assessment by: regulatory surplus, barrier analysis and the common practice test according to the variation across different political divisions where the grouped Project is operating. Additionality is assessed per country and as initial instances are additional and based on country groupings, future instances will be assessed using the same approach - i.e., on a country basis - and deemed additional if they meet the additionality and eligibility criteria detailed in this document.

Table 1-6. Inclusion of new Project Activity Instances and the Project fulfilment (VCS Standard v4.5 Section 3.6.17)

Inclusion Criteria	Project Fulfilment of Criteria

Occur within one of the designated geographic areas specified in the project description.	New PAIs will demonstrate that they are within one of the ten Geographic Areas contained in the initial activity instances, which delineate the geographic boundaries of the Project, as well as further geographic location data to align with assessment of political divisions for Additionality assessment.
Conform with at least one complete set of eligibility criteria for the inclusion of new PAIs.	New PAIs must comply with the complete set of eligibility conditions listed in this Section (1.4.1) to be eligible for inclusion. New PAIs must pass assessment as well as the QA/QC process that is described in Chapter 5 (Monitoring) to ensure only eligible PAIs are included.
Be included in the monitoring report with sufficient technical, financial, geographic and other relevant information to demonstrate conformance with the applicable set of eligibility criteria and enable evidence gathering by the validation/verification body.	Each monitoring report will include all required information, including geographic and technical, production information, to demonstrate conformance for each PAI that is included in the monitoring period. All new PAIs will be included in the monitoring report to undergo verification of the evidence provided by an approved VVB.
Have evidence of project ownership, in respect of each project activity instance, held by project proponent from the start date of each PAI (i.e. the date upon which the PAI began reducing or removing GHG emissions.	According to the contractual obligations within the Project, participants shall demonstrate ownership and land tenure of the area defined for each PAI from the date of inclusion in the Project. The Benefits Contract and the onboarding process with farmers assures this. Project ownership is further described in Section 1.7.
Have a start date that is the same or later than the grouped project start date.	All new PAIs will have a start date on or after the project start date.

Be eligible for crediting from the start date of the project activity instance through to the end of the project crediting period (only).	New PAIs and associated field boundaries will be eligible for crediting from the start date of inclusion through to the end of the Project, once all the relevant criteria are met. The AgreenaCarbon Project contracts have a 10-year duration and can be renewed to the end of the 20-year crediting period. The Project is eligible for quantification from the verification period up and until the end of the project crediting period only, which can be renewed up to 5 times according to the VCS Standard.
Not be or have been enrolled in another VCS project.	AgreenaCarbon Project's PAIs certify they are not enrolled in another crediting project when they sign the Benefit Contract. The Terms and Conditions of the contract include this provision which is signed by all new participants.
Adhere to clustering and capacity limit requirements.	The Project does not have any PAIs within ten kilometres of another Project. Remote sensing and the Verra registry check confirm that no other projects are operating in the vicinity of the Project PAIs and countries within the validation period. For future PAIs, all instances will be checked in accordance with the projects that are already registered to the Verra registry. All PAIs are captured within the one grouped project.

In addition to the eligibility criteria presented above, as a grouped project, the Project must adhere to section 3.6.22 of the VCS Standard v4.5 such that the Project Description for the grouped project must contain (in connection with VM0042 v2.0): a delineation of the geographic areas (captured within the KML file included with the PD); one or more determinations of the baseline PAIs in accordance with the methodology (found in Section 3.4); one or more determinations of additionality for PAIs in accordance with the methodology (Section 3.5); one or more sets of eligibility criteria for the inclusion of new PAIs; and a description of the GHG information system and controls associated with the project and its monitoring.

1.5 Project Proponent

Organization name	Agreena ApS
Contact person	Karolina Kenney

Title	Senior Standards Specialist
Address	Langebrogade 3F, 3. Sal 1411 Copenhagen K, Denmark,
Telephone	+45 31 35 88 71

1.6 Other Entities Involved in the Project

There are no other entities involved in the development of the Project outside of the AgreenaCarbon employees, contractors and advisors.

1.7 Ownership

Agreena ApS, as the project proponent holds enforceable agreements (Benefits Contracts) with all the farmers enrolled in the AgreenaCarbon Project (i.e., Project participants). These Benefits Contracts unequivocally delineate the respective responsibilities of Project participants and of Agreena ApS.

Agreena ApS controls 100% of the Project by virtue of the Benefits Contracts signed with participating farmers, including for the first harvest season and expected issuance. The Benefits Contracts entered between Agreena ApS and enrolled farmers put VCU ownership with Project participants as Agreena ApS acts as custodian of the VCUs on behalf of those participants who do not hold an account in the Verra Registry. Project participants are obligated to make all transfers of credits in the Verra registry to account holders in the registry.

Project ownership is traditionally distinct from land ownership, carbon right ownership, carbon credit ownership. A project proponent may hold rights in the land that generates GHG mitigation outcomes, but these rights may also belong to a third party. The AgreenaCarbon Project does not restrict admission to landowners only. Admission is open to farmers holding farm leases.

Every farmer that is an official participant on the AgreenaCarbon Project has entered into an agreement with Agreena ApS transferring project ownership to Agreena ApS. The duration of these agreements is not limited in time, although participants remain free to end their participation "with a minimum of six (6) months written notice before the beginning of the following Harvest Year." Any potential ensuing reversal of ERRs would be monitored and accounted for, as described in the PD section 5.3.

1.8 Project Start Date

The VCS Standard (v4.5) states in Section 3.8 that the start date "is the date on which activities that lead to the generation of reductions or removals are implemented.". For the AgreenaCarbon Project, the start date is September 15th, 2021, which is the earliest date in which Project-promoted activities to generate ERRs were implemented by Project participants. The accuracy of

this start date was confirmed using a cover crop verification model with NDVI imagery, which identified the earliest time window in which winter/spring cover crops were planted in the autumn of 2021.

The first farmers who joined the AgreenaCarbon Project did so in July 2021. After signing participation contracts, these early joiners concluded the 2021 harvest (growing season autumn 2020 - summer 2021) for summer cash crops, followed by the preparation of fields for the planting of winter/spring cover crops in autumn 2021 and for the growing season 2022. Thus, cover cropping is the first of the five Project-supported ALM activities (see Table 1-1, Section 1.1; details in Table 1-9, Section 1.11) that could be implemented by the very first PAIs. The calendar month in which Project participants may start preparing their land for cover cropping, and therefore the cover crop planting window, depend on a myriad of factors. These factors include previous season crop type and harvest date, subsequent cash crop type and planting dates, farm-specific characteristics, and stochastic events such as poor weather. In Europe, seeding of cover crops can usually take place any time between late summer and autumn, and after having harvested the previous season's cash crop.

The accuracy and conservativeness of the selected Project start date (i.e., 15th September 2021) was confirmed by an NDVI assessment, which was carried out on a sample of PAIs selected from 86 of the first Project participants (see Appendix 7). The comparative difference in vegetation cover between autumn 2020 and 2021 was calculated. The NDVI assessment detected a range of mean monthly values in which the sampled PAIs showcased a significant difference in vegetation cover (i.e., the hallmark of a growing cover crop being present), of which September 2021 was the earliest. However, if a change in NDVI became visible in September, it means that the PAIs were prepared and cover crops planted well beforehand, possibly in August. Therefore, the 15th of September 2021 is both an accurate and conservative start date for the AgreenaCarbon Project at a grouped level. The conservativeness and accuracy of this approach is further justified by the fact that cover crop implementation is rewarded according to whether Project participants planted them, not according to the length of time they have been conducting this practice. If a participant stipulates winter or spring cover crops as one of their Project Activities, this is verified for every single expected month of implementation to prove that this is the case.

Figure 1-3 below illustrates the AgreenaCarbon 2021/2022 harvest cycle, including:

a) July 2021: First signed contracts
b) August 2021 - October 2021: Period between which cover crops (CC) are planted - the 'CC planting window'
c) September 15th - September 14th: Full harvest year, which begins and ends with cash crop harvest

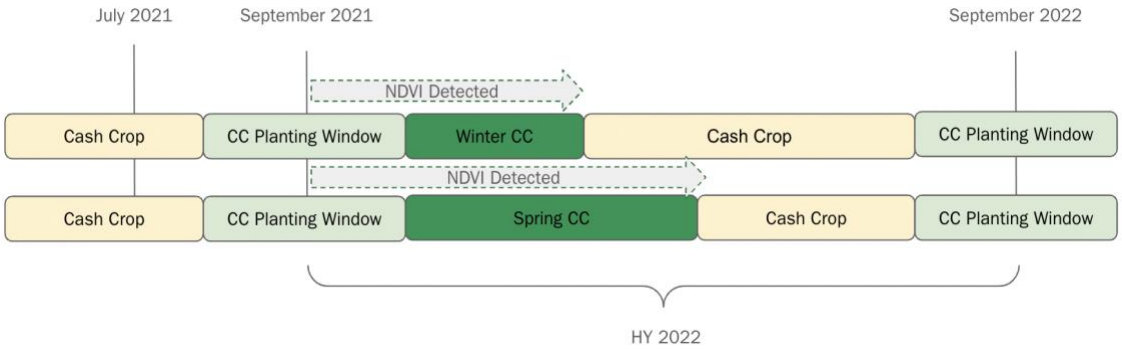


Figure 1-3. Full Harvest cycle for 2021/2022 to demonstrate median planting window as well as reasonable expectation for earliest detected NDVI.

1.9 Project Crediting Period

The Project crediting period is September 15, 2021, to September 14, 2041, totalling 20 years.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The Project is a large, grouped project (>1,000,000 tCO_2e/year).

Table 1-7. Estimated GHG emission reductions and removals across the 20-year crediting period.

Year	Estimated GHG emission reductions and removals (tCO_2e)
15th September 2021- 31st December 2021	21,231.79
1st January 2022- 31st December 2022	547,456.91
1st January 2023- 31st December 2023	543,554.32
1st January 2024- 31st December 2024	542,106.78
1st January 2025- 31st December 2025	541,894.34
1st January 2026- 31st December 2026	541,985.70
1st January 2027- 31st December 2027	547,456.91
1st January 2028- 31st December 2028	543,554.32
1st January 2029- 31st December 2029	542,106.78

1st January 2030- 31st December 2030	541,894.34
1st January 2031- 31st December 2031	541,985.70
1st January 2032- 31st December 2032	547,456.91
1st January 2033- 31st December 2033	543,554.32
1st January 2034- 31st December 2034	542,106.78
1st January 2035- 31st December 2035	541,894.34
1st January 2036- 31st December 2036	541,985.70
1st January 2037- 31st December 2037	547,456.91
1st January 2038- 31st December 2038	543,554.32
1st January 2039- 31st December 2039	542,106.78
1st January 2040- 31st December 2040	541,894.34
1st January 2041- 14th September 2041	520,160.62
Total estimated ERRs	10,867,398.91
Total number of years in crediting period	20 years
Average annual ERRs	543,369.95 tCO2-eq

1.11 Description of the Project Activity

There is no REDD+ component to the Project, and the Project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

The VM0042 v2.0 methodology is applicable under the condition that Project participants introduce or implement one or more new Project Activities to pre-existing agricultural management practices that qualify as additional per VM0042 v2.0 Section 7 requirements. Per VM0042 v2.0 Section 2, these practice changes may be defined as the cessation of a pre-existing practice (e.g., no tillage), adoption of a new practice (e.g., adoption of land management practices that reduces the GHG emissions and increase the carbon sequestration in the soil), or adjustment to a pre-existing practice that is expected to reduce GHG emissions and/or increase GHG removals (e.g., reduction of fuel usage).

The Project works with farmers across pan-European regions to achieve GHG emission reductions and removals. The farmers are onboarded via several different tracks which are described in the Farmer Onboarding Flow Standard Operating Procedure (SOP). The two tracks are:

- Self-service: The first step of the self-service model is the creation of their free user profile. From there the farmer can proceed to enter their farm data directly in the Agreena platform and can gain access to the onboarding and educational materials used in the Agreena-assisted Onboarding track.
- Agreena-assisted: Through phone calls and/or video calls with Key Account Managers and/or the Agreena Growth team.

In addition, the Agreena HelpDesk is available through the AgreenaCarbon platform (app.agreena.com) and Agreena website (agreena.com). Link to Help Centre: http://help.agreena.com/en/.

Contracting and onboarding sessions are held by Key Account Managers (KAM), Growth Specialists (GS) and Customer Success Managers (CSM). The objectives are to ensure that all farmers interested in joining the Project are eligible and have understood the terms and conditions of joining AgreenaCarbon. The onboarding sessions ensure that the farmers entering the Project are equipped with the same level of knowledge and understanding of the responsibilities and benefits across the entire geographical breadth of the Project.

Table 1-8. Communication and onboarding process for farmers to ensure pre-project conditions and accuracy of inputs.

Month	Communication Strategy
January - March	Outreach and Onboarding: ● Calls and events ● Issuance support
April – August	Closing contracts Outreach and Onboarding
August – December	Submit actuals Support verification Field inspections

The technologies and measures eligible as per Section 1.4.1 are a combination of approaches including soil sampling and remote-sensing modelling implementing the best available practices for MRV. The Project utilises in-house remote sensing to verify the PAI data and compliance with Project eligibility. The remote-sensing capabilities enable field boundary detection and

delineation, catch and cover crop presence/absence metrics, tillage verification and crop type classification are also performed using a range of satellite imagery sources. In addition, deforestation and native ecosystem detection is also supported by this technology. The robust MRV practices using remote sensing with AgreenaCarbon along with specifically trained teams, desk review, field inspections and soil sampling result in a high standard of measurement.[11]

Table 1-9. List of Project Activities from Table 1-1 including more detailed descriptions, as well as associations with Applicability Condition 1 in VM0042 v2.0, Section 4.

No.	Project Activity	Description	Applicability Condition 1
1	Reducing tillage to lower soil disturbance and increase residue retention and carbon inputs	Reduced mechanical soil disturbance decreases emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) by preventing further plant and microbial decomposition. Science-based evidence shows that reduced tillage practices will increase SOC.[12] A positive result from reducing tillage is the reductions in the use of fuel and energy due to a decrease in pass overs with machinery.	Applicability Condition 1 c) reduce tillage/improve residue management
2	Leaving crop residues on top of the soil to improve nutrient cycling and soil quality	Residues of the planted crops are left on the field to provide field cover, to reduce erosion, improve soil structure and increase carbon inputs in the soil.[13]	Applicability Condition 1 c) reduce tillage/improve residue management
3	Planting a cover crop through the winter or all the way through to the next harvest to increase organic matter carbon inputs	Cover crops are dedicated crops that are seeded just after harvest and last through late winter. They are re-seeded before seeding of cash crops to create green cover, which brings more organic amendments to the soil and provides a protective layer to prevent erosion and loss of soil moisture. Planting and growing	Applicability Condition 1 d) Improve crop planting and harvesting (e.g., improved agroforestry, crop rotations, cover crops)

[11] Information about the specifics and performance of remote-sensing technology are provided in a separate document and are business proprietary.

[12] Haddaway, N.R., Hedlund, K., Jackson, L.E. *et al.* How does tillage intensity affect soil organic carbon? A systematic review. *Environ Evid* **6**, 30 (2017). https://doi.org/10.1186/s13750-017-0108-9

[13] Ibid.

		green cover significantly reduce nutrient losses and risk of soil erosion. Stronger aggregate stability and increased Carbon input improves soil health and contributes to the build-up of soil organic carbon.[14] The practices include reducing winter and summer fallow frequency.	
4	Planting catch crops in between spring and winter crops	Planting and growing crops immediately after harvest that reduce nutrient loss.[15] These crops are not harvested.	Applicability Condition 1 d) Improve crop planting and harvesting (e.g., improved agroforestry, crop rotations, cover crops)
5	Reducing the rate of synthetic nitrogen fertiliser applied and switching to organic fertiliser (manure)	Organic fertilisers such as animal manures and composts can increase soil carbon content. They improve soil physical attributes and nutrient availability. These contributions can improve plant productivity which, in turn, results in carbon removals. The addition of organic fertilisers will effectively lower the synthetic fertiliser use.[16] Reduction in the application rate of synthetic nitrogen, either in isolation or alongside other Project Activities, also directly results in a reduction in GHG emissions from N_2O (subject to leakage and minimal impact on crop yields).[17]	Applicability Condition 1 a) Improve fertiliser (organic or inorganic) management

Following the contracting process, Project participants are then required to input their PAI management practices, providing information about practices they are currently undertaking as well as practices they undertook in the 5 previous years (i.e., during their historical look-back

[14] Taghizadeh-Toosi, A., Hansen, E. M., Olesen, J. E., Baral, K. R., & Petersen, S. O. (2022). Interactive effects of straw management, tillage, and a cover crop on nitrous oxide emissions and nitrate leaching from a sandy loam soil. *Science of The Total Environment*, *828*, 154316.

[15] Ibid.

[16] Zhang C, Zhao Z, Li F, Zhang J. Effects of Organic and Inorganic Fertilization on Soil Organic Carbon and Enzymatic Activities. *Agronomy*. 2022; 12(12):3125. https://doi.org/10.3390/agronomy12123125

[17] Menegat, S., Ledo, A. & Tirado, R. Greenhouse gas emissions from global production and use of nitrogen synthetic fertilisers in agriculture. Sci Rep. 2022; 12:14490. https://doi.org/10.1038/s41598-022-18773-w

period). Practice information is requested to ensure each PAI may be assessed for the presence of at least one eligible and additional Project Activity, as well as to be able to create a baseline schedule of activities for the PAI that is representative of the continuation of pre-project ALM practices, per VM0042 v2.0 Section 6. The list of historical look-back information requested for each PAI is presented in Table 1-10.

Table 1-10. List of ALM practices assessed in the 5-year historical look-back period for each PAI as related to each Project Activity listed in Table 1-1.

No.	Project Activity	ALM practices assessed in historical look-back
1	Reducing tillage to lower soil disturbance and increase residue retention and carbon inputs	• Presence of cultivation activities • Use of conventional tillage • Use of reduced tillage • Use of no-till
2	Leaving crop residues on top of the soil to improve nutrient cycling and soil quality	• Use of burning to manage crop residue • Use of removal to manage crop residue • Use of mulching to manage crop residue
3	Planting a cover crop through the winter or all the way through to the next harvest to increase organic matter carbon inputs	• Presence of cover crop through the winter or all the way through to the next harvest
4	Planting catch crops in between spring and winter crops	• Presence of catch crop between spring and winter crops
5	Reducing the rate of synthetic nitrogen fertiliser applied and switching to organic fertiliser (manure)	• Use, and rate of use if applied, of synthetic nitrogen fertiliser • Use and rate of use if applied, of organic fertiliser

Alongside the Project Activities, there is a need to demonstrate how various organisations, communities and other entities are involved in the activities listed in Table 1-9. Community engagement is a central feature to the Project and is further outlined in the AFOLU Non-Permanence Risk Tool as part of the validation process, as well as Section 2.2 Stakeholder Engagement. The way the organisation and communities are involved in the activities of the Project is through educational events, training days with and for local partners, monthly webinars and media content, as well as through the hosting and attending of local community events. Having KAMs in all the countries in which the AgreenaCarbon operates enables a closer contact to young and aspiring regenerative farmers.

1.12 Project Location

The Project boundary includes arable lands with mineral soil eligible for implementing the proposed Project Activities under VM0042 v2.0. The activities therefore can be applied to a broad range of climatic regions. Currently the AgreenaCarbon PAIs are located on the European continent, across ten nations.

A KML file includes all field boundaries associated with initial PAIs for the Project. The file undergoes a verification process with remote sensing as described in Section 5.3 Monitoring Plan. As new PAIs are added in each verification event, the KML file will be updated to reflect the new PAIs.

1.13 Conditions Prior to Project Initiation

1.13.1 Current and historical land-use

The conditions prior to the Project scenario currently and historically include intensive and extensive grassland, cropland and forestry production while also encompassing built up settlements across the pan-European regions. Figures 1-4, 1-5 and 1-6 lay out the land system, use and conditions (i.e., land cover, ecosystem, crop-type, and soil) prior to Project start date across the pan-European regions, encompassing all PAIs areas. As evident, prior to Project start date, the land use and system in Europe is mostly characterized by farmland and agricultural activities.

The agricultural industry is one of the largest sectors in Europe and in the EU, whereby around half of the land is farmed. In 2017, the EU agricultural industry produced an output value of EUR 427 billion, of which 50% came from crops and the rest from livestock and other secondary activities.[18] The size of farms in the EU is relatively small at an average of 16 hectares per farm in 2013, and only 15% of farms in total are this size or larger.[19] Most of the arable land in the EU is used for general field cropping (16.4%) followed by production of cereals, oilseed, and protein crops (15.2%), and olives (7.6%). Almost three quarters of the agricultural land in the EU is in six member states: France, Spain, Germany, Poland, Italy and Romania.

[18] https://copa-cogeca.eu/europeanfarming
[19] Eurostat, 2018. Farms and farmland in the European Union – statistics.

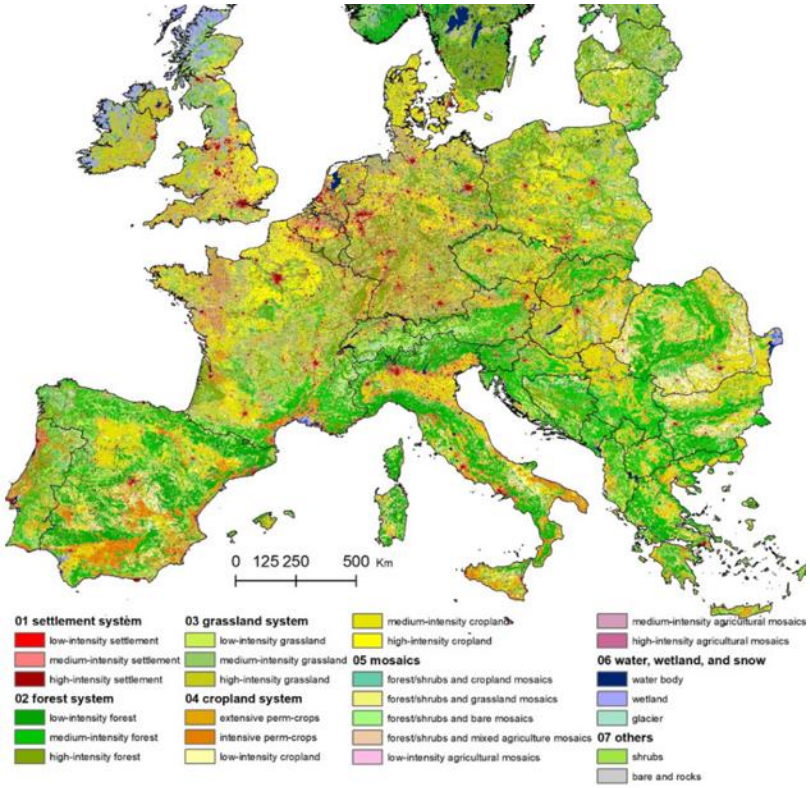


Figure 1-4. Distribution of land systems in Europe 2020.[20]

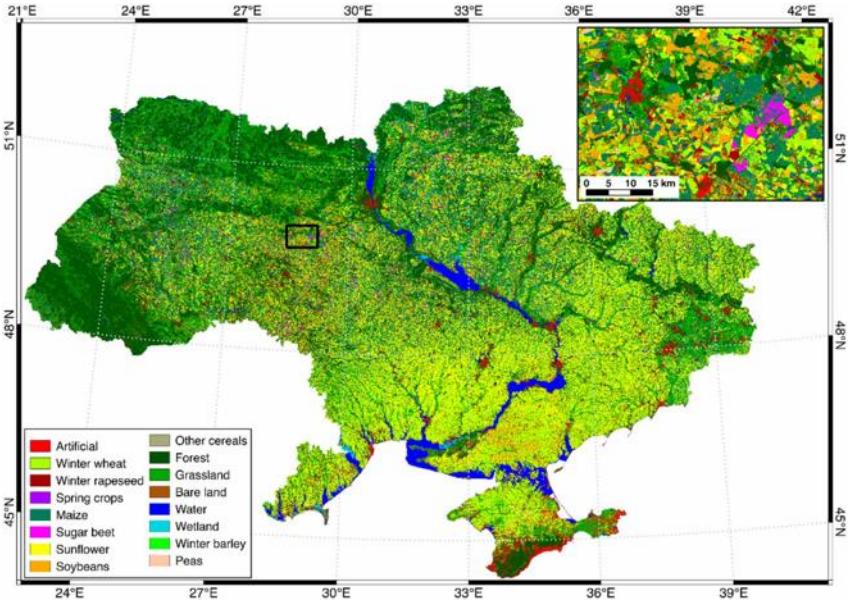


Figure 1-5. Distribution of arable land systems in Ukraine 2017.[21]

[20] Dou, Y., Cosentino, F., Malek, Z. et al. A new European land systems representation accounting for landscape characteristics. Landscape Ecol 36, 2215–2234 (2021).

[21] https://iopscience.iop.org/article/10.1088/1748-9326/abfc04

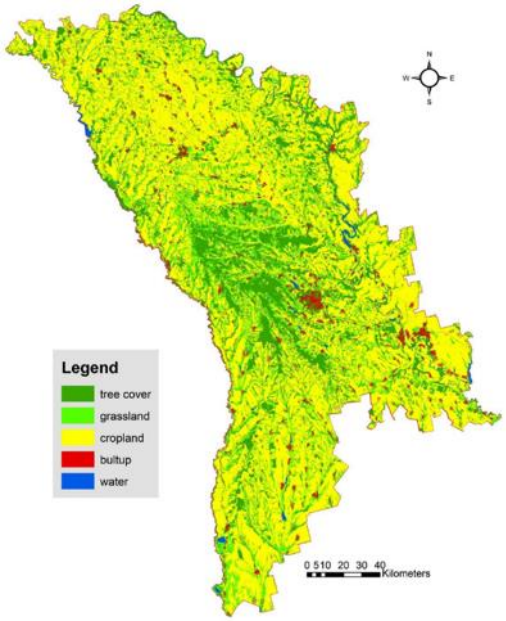


Figure 1-6. Distribution of land system in Moldova in 2020.[22]

Historic land use practices outside of the EU are similar. EU-level data collected before Brexit can be used to extrapolate historical land system conditions for the UK. The UK, like the rest of Europe, mainly grows wheat, barley and oats. In Moldova, agricultural land covers 59% of the country's total land area, of which 55% is used for annual crop product production (maize, wheat, sunflower, barley, oilseed, soybean, sugar beet) and has highly fertile chernozem soils (black soils). 71% of Ukrainian land is used for agriculture of which 56% is arable land.

For the current and historical land-use in the specific PAIs and regions, land use information is used to ensure Project eligibility and exclude ineligible areas (e.g., because of native ecosystems, deforestation, grassland, settlements). VM0042 v2.0 requires that PAIs do not include locations which have been cleared of native ecosystems within 10 years prior of Project start date. AgreenaCarbon ensures this through remote-sensing data as described in Chapter 5 (Monitoring). For each PAI, a baseline schedule of activities reflecting management practices prior to entry to the Project is created from the Project participants historical farm management data collected as described in Section 1.11 and Table 1-10, combined with remote sensing information, Project participants attestation and other relevant sources as detailed in Section 3.4 (Baseline Scenario).

1.13.2 Soil and Ecosystem Characteristics Prior to Project Initiation

Climate

The ecosystem types present prior Project start date fall within numerous categories, as the Project's geographical boundaries encompass most pan-European geographies. The four main

[22] https://www.pesd.ro/articole/nr.16/nr.2/pesd2022162021.pdf

climatic zones within the Project boundaries are defined by the IPCC classification[23],[24] as illustrated in Figure 1-7. Although there are additional climatic zones present in the Project area, they are not pertinent to the Project since they lie outside of agricultural land.

Cool Temperate Moist: This climate zone covers much of central and eastern Europe, including parts of Germany, Poland, the Czech Republic, and Austria. It is characterized by cool, wet winters and mild, relatively dry summers.[25]

Cool Temperate Dry: This climate zone covers parts of south-eastern Europe, including Turkey and parts of Greece. It is characterized by cool, wet winters and hot, dry summers, with relatively low rainfall throughout the year.[26]

Warm Temperate Moist: This climate zone covers much of Western Europe, including the United Kingdom, Ireland, and parts of France, Belgium, the Netherlands, and Germany. This zone is characterized by mild winters and warm summers, with relatively high rainfall throughout the year.[27]

Warm Temperate Dry: This climate zone covers parts of southern Europe, including Spain, Portugal, southern Italy, and Greece. It is characterized by mild, wet winters and hot, dry summers.[28]

[23]https://forest.jrc.ec.europa.eu/en/activities/lulucf/ipcc-classifications/

[24] ://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch03_Land%20Representation.pdf

[25] Ibid.

[26] Ibid.

[27] Ibid

[28] Ibid.

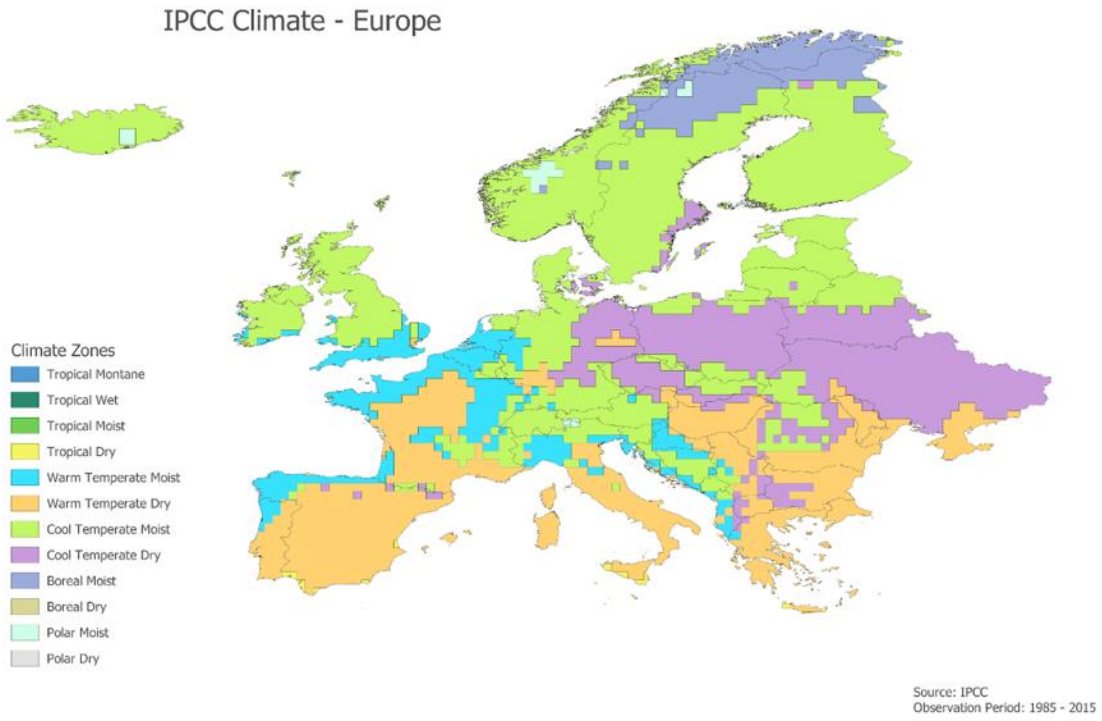


Figure 1-7. IPCC Climatic Zones present in the Project Area.[29]

Soil Type

Agricultural soils are classified according to twelve textural classes based on four recognized main groups: Sands, Silts, Clays, and Loams (Figure 1-8 A). Sands contain at least 80% sand particles and 15% or less clay particles by weight. Silts contain at least 80% silt and 12% clay particles. Clays contain at least 35% of clay particles. Loams are mixtures of sand, silt, and clay particles that exhibit the properties of those particles in equal proportions.[30] Soil texture is a very stable parameter and rarely changes over long timeframes.

The Project area encompasses ten countries in Europe during the initial validation period, resulting in a diverse range of soil types. The most widespread soil textural classes are sandy loam and loam soils (Figure 1-8 B). Sandy soils with low clay content are typically located in Scandinavia, the Baltic states, and Portugal. Soils with higher silt content are predominantly found in central European countries and eastern European countries (Bulgaria, Moldova, and Ukraine), whilst soils with higher clay content tend to be in central and southern Italy, France, and Spain.

SoilGrids[31] provides percentage values of silt, sand, and clay given a spatial location (i.e., longitude/latitude). A PAI's soil texture class is initially obtained by applying the USDA soil texture

[29] https://www.ipcc-nggip.iges.or.jp/faq/faq.html - (Q4-30)

[30] Soil texture — European Environment Agency. https://www.eea.europa.eu/help/glossary/eea-glossary/soil-texture.

[31] Poggio, L., de Sousa, L. M., Batjes, N. H., Heuvelink, G. B. M., Kempen, B., Ribeiro, E., and Rossiter, D.: SoilGrids 2.0: producing soil information for the globe with quantified spatial uncertainty, *SOIL*, **7**, 217–240 (2021).

definitions displayed in Figure 1-8 to the retrieved values; further refinement occurs if the instance has soil samples drawn from it as part of the Project's soil sampling monitoring programme. The provided sand, silt, and clay percentages are used as one of the inputs to the project-level stratification, detailed in Section 5.3.2.

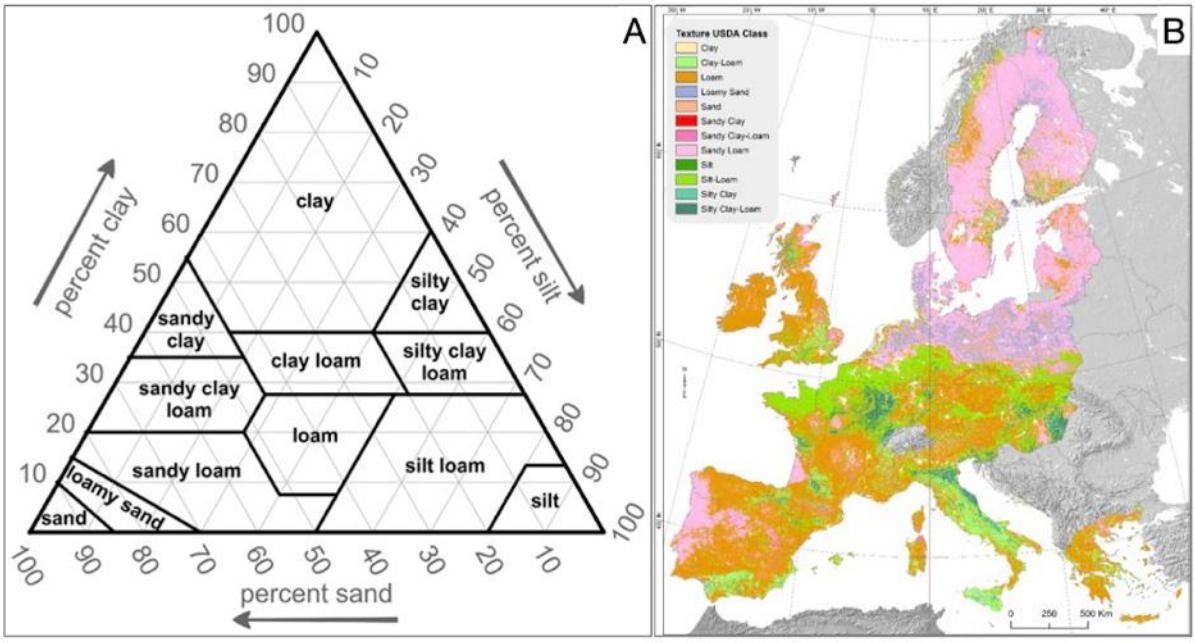


Figure 1-8. (A) USDA soil textural class matrix and (B) the spatial distribution of the soil textural classes (0-20 cm) in Europe derived from sand, silt, and clay maps.[32],[33]

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

PAIs will follow all applicable legal and regulatory requirements across the different countries in the Project area. As the Project encompasses different countries within and outside of the EU, there is an Internal Policy Tracker to identify any regulations for which Project participants might be subject to. The Internal Policy Tracker has been shared as a separately attached table and referenced as Appendix 2 under Regulatory Surplus, as the analysis of existing regulation is required to demonstrate additionality (Section 3.5). As evidenced by the tracker, there are no laws that prevent the implementation of Project-promoted ALM practices in Europe. Agreena ApS and the AgreenaCarbon Project participants follow national policies and work closely with advisors and stakeholders to remain up to date on information on the regulatory sphere.

[32] Ballabio, C., Panagos, P. & Monatanarella, L. Mapping topsoil physical properties at European scale using the LUCAS database. *Geoderma* 261, 110–123 (2016).

[33] Groenendyk, D. G., Ferré, T. P. A., Thorp, K. R. & Rice, A. K. Hydrologic-Process-Based Soil Texture Classifications for Improved Visualization of Landscape Function. *PLOS ONE* **10**, e0131299 (2015).

The Project operates in ten countries; seven are part of the European Union, two (Moldova and Ukraine) are in the process of aligning with European Union (EU) regulations in their path towards EU membership. Agreena ApS operates in the pan-European context which requires grouping countries by the same set of policies that are applicable to Project participants. There are three country-groupings with different sets of policies that apply to the various PAIs in the Project: European Union countries, United Kingdom, and Ukraine & Moldova.

It must be highlighted that the countries that are a member of the European Union, as well as the UK, would have the most developed and regulated agricultural policies. Countries such as Moldova or Ukraine have almost no existing regulations that guide the farmer in terms of farming practices and the policies are only related to land trading. However, countries like Moldova and Ukraine have recently initiated a long-term process of integration with the EU, which may result in stricter regulations in the agricultural sector with a focus on environmental impacts, aligned with the regulatory landscape of the EU. This gives a long-term perspective that the set of rules and national policies throughout the AgreenaCarbon Project area would have a common denominator in the EU rules and frameworks.

1.14.1 European Union (EU)

In the EU, the sphere of the agricultural sector and arable lands is regulated by the Common Agriculture Policy (CAP). The CAP is constituted by three Regulations[34] which are agreed upon at the EU level and establish the rules and conditions for all farmers.

The CAP was established in 1962 but has since undergone several reforms. It has several key objectives, including maintaining the livelihoods of the EU's farmers, preserving rural landscapes, safeguarding food supplies and the sustainable management of natural resources.[35] CAP has two pillars (the first of which is split into two parts):[36]

- Pillar I (1): common organisation of the market in agricultural products
- Pillar I (2): direct payments to farmers
- Pillar II: rural development policy

Direct payments are the most significant part of the policy, accounting for around 70% of the CAP budget.[37] These payments are made to farmers based on the amount of land they own and the types of crops they grow. The policy encourages farmers to adopt certain farming practices that

[34] EU Regulation 2021/2116, repealing EU Regulation 1306/2013 on the financing, management and monitoring of the CAP; EU Regulation 2021/2115, establishing rules on support for national CAP strategic plans, and repealing EU Regulations 1305/2013 and 1307/2013;

EU Regulation 2021/2117, amending EU Regulations 1308/2013 on the common organisation of the agricultural markets; 1151/2012 on quality schemes for agricultural products; 251/2014 on geographical indications for aromatised wine products; and 228/2013 laying down measures for agriculture in the outermost regions of the EU.

[35] European Commission, The Common Agricultural Policy at a glance

[36] European Parliament, The Common Agricultural Policy – factsheet

[37] *Ibid.*

promote sustainable agriculture, preserve biodiversity, and mitigate climate change. Any practices that qualify farmers for payments above the starting point are optional, as farmers cannot receive additional funds simply for complying with the law. There are a number of practices that are outlawed entirely, such as: the use of growth-promoting hormones;[38] battery cages for laying hens; the use of almost all genetically modified crops;[39] certain pesticides (e.g., neonicotinoids[40]); routine use of antibiotics in livestock farming.[41] Otherwise, farmers retain full autonomy and flexibility in managing their land.

Farm practices that can earn higher level subsidy payments under CAP include reducing tillage, practising crop rotation and soil conservation measures such as planting cover crops or maintaining buffer strips.[42] These are optional and non-mandatory, encouraged by these subsidies' voluntary schemes.

In summary, all the key principles of regenerative agriculture in an arable context (reducing soil disturbance, maintaining soil cover and improving crop rotations) are optional but encouraged under the CAP. These are the same principles that underpin the AgreenaCarbon Project.

The farmers are obligated to follow the set of legislative acts that are called Statutory Management Requirements (SMR), and they are listed in Regulation (EU) 2021/2115 in Annex II.[43] The SMRs are used for the national-based process called 'Cross compliance' which checks the compliance of the relevant EU laws by the farmer. The check for compliance with the current legal system is necessary to make farmers eligible to receive subsidies from the state (Basic Payment Scheme). Agreena ApS also puts a requirement in the contracts with Project participants (clause 17.6), stating that participants have to be acting in respect to all national laws in the jurisdiction where they operate. This described process applies to the countries which are members of the EU namely: Denmark, Romania, Lithuania, Estonia, Latvia, Bulgaria and Spain. More details on EU policy are available in Section 3.5.1.1.

1.14.2 United Kingdom

The Project also operates in non-EU countries like the United Kingdom, Ukraine, and Moldova. Since the UK exited the EU on 1st February 2020, the transition period for phasing out the EU CAP and adopting its own national policy is guided by the document 'Path to sustainable farming: An Agriculture Transition Plan 2021 to 2024.[44] The document outlines changes in the UK agricultural policies, mainly regarding subsidies.

[38] European Commission, *Growth hormones in meat*
[39] European Commission, *Genetically Modified Organisms*
[40] European Commission, *Neonicotinoids*
[41] European Public Health Alliance, *Ending routine farm antibiotic use in Europe through improving animal health and welfare*
[42] EU Soil Observatory Stakeholder Forum, *The post 2020 CAP and soil*
[43] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2115&from=EN
[44] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/940434/atp-adviser-pack.pdf

The UK's Environmental Land Management Scheme (ELMS) was introduced to replace the CAP following the UK's exit from the EU. It is similar in its overall structure and mechanism to the CAP insofar, as it incentivises desirable management practices through subsidy payments, but it neither mandates desirable practices nor outlaws undesirable ones. As with the CAP, soil conservation measures such reducing tillage, using cover crops and crop rotations are incentivised through subsidy payments yet not mandated by the ELMS.[45]

The ELMS policy comprises 3 distinct schemes:[46]

- The Sustainable Farming Incentive (SFI) will pay farmers to adopt and maintain sustainable farming practices that can protect and enhance the natural environment alongside food production, and support farm productivity
- Countryside Stewardship (CS) will pay for more targeted actions relating to specific locations, features and habitats
- Landscape Recovery will pay for bespoke, longer-term, larger scale projects to enhance the natural environment

There are few (and no major) differences between the EU and the UK in terms of which practices are prohibited. The precise mechanism of the schemes and the payment rates are different in each jurisdiction but just as with CAP, the key regenerative practices such as reducing tillage and planting cover crops are encouraged under ELMS but are not mandated. Therefore, these relevant Project Activities fulfil the requirements of regulatory surplus.

However, the mechanisms of cross-compliance will remain in power until 2024 in the same construction as is implemented in EU countries. The only difference is that it is stated that the SMR listed by the EU CAP policy remains in force. However, the difference is that the SMR set up in the EU in 2014 (in the previous programming period) would remain in power. This is because the SMR was agreed upon at that time while the UK was a full-time member of the EU. The list of SMR form 2014 is listed in annex II of Regulation no 1306/2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management, and monitoring of the common agricultural policy.[47]

1.14.3 Ukraine and Moldova

Ukraine and Moldova have distinct agricultural policy frameworks although they are very similar in practice to each other, and to a lesser extent there is some overlap with the EU. As with the EU and the UK there are very few farm practices that are outlawed entirely (i.e. certain pesticides, genetically modified organisms, and certain animal husbandry practices).

[45] UK Government, Environmental Land Management (ELM) update: how government will pay for land-based environment and climate goods and services, 15th February 2023
[46] *Ibid*
[47] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1306&from=en

Both Ukraine and Moldova provide various subsidies and support programmes to farmers to promote agricultural development. These include direct payments, financial assistance for purchasing machinery and equipment, and subsidies for specific agricultural activities.[48] For example, Moldovan agricultural policy has three key objectives which are the same as the principles that underpin the CAP (industry competitiveness, sustainable use of natural resources and improving farmer livelihoods).[49] Farm practices that further these aims are encouraged through the provision of agricultural subsidies, which is the primary mechanism as in other jurisdictions. Similarly, farm practices such as reducing tillage, planting cover crops and crop rotations are encouraged but not mandated thus meeting the requirements of regulatory surplus.

In the context of Moldova, the only legal act that is relevant for the AgreenCarbon Project is the act regulating the issue of land trading and ownership.[50] A similar legislative situation exists in Ukraine.[51]

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The Project is also certified under ISO 14064-2: 2019 Greenhouse gases standard. The Agreena ISO project has been validated and verified by Den Norske Veritas (DNV) in 2021, 2022, and 2023. The Project will ensure that the outcomes can be traced directly back to the PAI, so that they would not generate any Emission Reductions and Removals (ERRs) and subsequently VCUs in that given monitoring period. The following steps will be followed for this process:

- A subset of Agreena ISO outcomes, representing one metric tonne of carbon removed or reduced, are set aside for sale with key characteristics of the PAIs and relevant information for full traceability.
- These fields are marked as ISO fields and removed through the fallow classification from the list of PAIs entering the upcoming verification period. This ensures that these fields are still accounted for and reported but earn zero VCUs.
- PAIs are continuously monitored to ensure that no reversals occur. Farmer data is collected for the following verification for project activities and PAIs are entered into the next monitoring/verification period.
- A special write-up related to these PAIs will be included in the monitoring report to ensure full traceability that the data is properly collected.

[48] OECD, Ukraine | Agriculture Policy Monitoring & Evaluation 2020

[49] Moldova Parliament, Law 276 on the principles of subsidies in the development of agriculture and the rural environment

[50] Land code of the republic of Moldova of December 25, 1991 No. 828-XII https://cis-legislation.com/document.fwx?rgn=3321

[51] Land Code of Ukraine (земельний кодекс україни) which regulates the issues of land ownership and the process of purchasing agricultural lands by the foreign investors

To ensure that there is no double counting, the Project has defined and allocated the fields are ISO-eligible only and the resulting certificates are reserved for only ISO as well. The Project will make a clear distinction between PAIs as they enter the GHG programme.

This is managed in an internal inventory management system. All field certificates, PAIs and other information will be held in one place with a mapping to the resulting VCUs. The inventory system will ensure full traceability back to the field and ensure access security, governance, versioning and data organisation to ensure consistency and transparency. Third party registries are and will be used for the management of ISO certificates and any updates will be provided in the Monitoring Report at each verification period.

1.15.2 Projects Rejected by Other GHG Programs

The Project has not been rejected by any other GHG programme.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The Project does not participate in any emissions trading programmes.

1.16.2 Other Forms of Environmental Credit

The Project has not sought or received another form of GHG-related credit, including renewable energy certificates.

Supply Chain (Scope 3) Emissions

This section is not applicable as the Project is not currently tracking Scope 3 emissions. The AgreenaCarbon Project will notify Verra immediately if this changes.

1.17 Sustainable Development Contributions

As the Project is subject to multiple national jurisdictions, there is no singular national sustainable development priority. However, Project Activities take place within UN General Assembly member states that all have sustainable development frameworks aligned with the 2030 Agenda for Sustainable Development and the UN SDGs.[52,53,54] In particular, the Project supports the following SDGs:

The **SDG 2 (Zero hunger)** supports the implementation of more sustainable agricultural practices to create more resilient food production and thereby increase the proportion of land under

[52] https://knowsdgs.jrc.ec.europa.eu/policies-sdgs

[53] https://www.unglobalcompact.org.uk/halfway-to-2030-how-is-the-uk-performing-on-the-sustainable-development-goals/

[54] https://ukraine.un.org/en/sdgs4https://moldova.un.org/en/sdgs

sustainable agricultural management (target 2.4, indicator 2.4.1). To ensure that natural risks induced by climate change do not significantly decrease agricultural yield and damage agricultural soils, farmers need to adopt new and more sustainable management practices – such as those supported by the Project. The total amount of converted hectares of PAIs will be tracked and monitored throughout the Project period, as required by the VCS Standard v4.5. More information on monitoring is captured in Chapter 5 (Monitoring) and the total amount will be reported in the Monitoring Report.

SDG 13 (Climate action) is also encapsulated in the Project. The AgreenaCarbon Project inherently leads to GHG emission reductions through the generation of credits. This SDG encompasses strengthening the resilience and adaptive capacity to climate-related hazards and natural disasters (target 13.2) as well as reducing GHG emissions (indicator target 13.2.2). The soils' ability to function as a carbon sink has the potential to play a crucial part in climate change mitigation under the right circumstances and practices. The monitoring of SDG 13 will be done via the calculation of ERRs achieved through the RothC Model and the IPCC equations as allowed via Box 2 of the VM0042 v2.0 Methodology. The values will be presented in the Monitoring Report and the ERRs will be evaluated throughout the Project lifetime via the methods presented in Chapter 5 Monitoring. The overall contribution to this SDG is a reduction in GHGs as specified in indicator 13.2.2.

SDG 15 (Life on land) promotes the sustainable use of terrestrial ecosystems to halt land degradation (target 15.3) and limit biodiversity loss. The suite of practices adopted by Project participants improve soil health, as described under SDG 2. While improved soil quality is known to correlate with ecosystem health, the implemented practices also have the potential to improve local biodiversity in farmland systems, creating habitats for fungi, invertebrates, and insects, thus promoting bird species settlement. Changes in local biodiversity are not monitored in the Project, but the land area that is degraded will decrease consequently to Project implementation. This can be tracked via the number of hectares included in each Monitoring Report issued.

A Monitoring Report from AgreenaCarbon will be published at the end of harvest cycle(s), to disclose the management practices undertaken by Project participants and the ERRs achieved. Eurostat and UN SDG reports will be checked regularly as well. Eurostat is responsible for publishing an annual EU SDG report where the progress is tracked at the European level.[55] Seeing that neither Moldova nor Ukraine are part of the EU, their progress is not included in the report provided by Eurostat. Both Moldova and Ukraine are receiving funding and support from the UN and UNICEF, which has likewise assisted Ukraine in the publication of a monitoring report.[56]

[55] EEA, (2020). https://www.eea.europa.eu/publications/sdgs-and-the-environment

[56] https://www.unicef.org/ukraine/en/reports/sustainable-development-goals-ukraine-2020-monitoring-report

1.18 Additional Information Relevant to the Project

Leakage Management

The AgreenaCarbon Project follows the VCS Standard (Section 3.15, Quantification of GHG Emission Reduction and Carbon Dioxide Removals) requirements dictating that ALM projects shall quantify leakage emissions associated with the displacement of pre-project activities, unless deemed *de minimis*. The definition from VCS on carbon leakage is net changes of anthropogenic emissions by GHG sources that occur outside the Project boundary and are attributable to the Project. In the Project, carbon leakage could occur when Project Activities lead to increased emissions from other farmers elsewhere. According to VM0042 v2.0 (Section 8.4, Leakage), potential areas of carbon leakage that could occur in the AgreenaCarbon Project include: market leakage, manure leakage and leakage as a result of biomass residues used for bioenergy. Market leakage is related to potential decrease in productivity and manure leakage is the use of manure as a new source of fertiliser that has not been identified in the baseline. The farmers with residues removed in their baseline will be checked whether it was previously used for bioenergy.

Taking actions to reduce carbon leakage to minimal levels is an inherent feature of the Project. This is encapsulated in the accompanied AFOLU Non-Permanence Risk Tool. The Project will fully comply and implement the VM0042 v2.0 requirements on leakage directly to avoid and prevent leakage. Further information and quantification of leakage is presented in Section 4.3 (Leakage).

Commercially Sensitive Information

Commercially sensitive information, Project sensitive information and sensitive information as defined in the VCS Standard 4.5 (Section 3.5, Project Documentation) and Registration and Issuance v4.5 documents, has been excluded from the public version of the Project Description.

All contractual matters between Project proponent and participants have been removed to protect the privacy of the participants - including management data, soil sampling and financial information. In addition, information related to methodological approaches to analyses that will expose the Agreena ApS IP have been also removed. All information related to setting the baseline, additionality, monitoring and quantification of GHG emission reductions and removals have been kept in the public version as per VCS Standard v4.5 (Section 3.5.4).

Appendices not required under VCS Standard v4.5 will be removed, as the PD addresses all elements of the relevant template. Project participants' location data will also be excluded, and the KML will not be fully public, as it contains exact field locations for every farmer across AgreenaCarbon's markets.

The Project will also keep a portion of the ERR sheets out of the public version as per VCS definitions (v4.5) of *sensitive information*. The definition of sensitive information can be "scientific, technical or other information whose public disclosure could reasonably be expected to undermine or negatively affect the development and/or implementation of a program."

Section / Document	Information	Justification
Section 2.2.4 Stakeholder Engagement and Consultation	Four bullet points have been removed which contain names of companies with which Agreena is affiliated.	Contractual and business sensitive information.
Appendices 1-11	Additional project evidence related to various sections of the PD is considered supplementary material.	It is not directly tied to the quantification or the definition of the baseline or additionality tests. All requirements laid out in VCS 4.5 are answered in the body of the PD.
KML File	KML file with coordinates is submitted to Verra for review. The file itself contains farmer field locations for all farmers in the AgreenaCarbon Project.	Containing exact coordinates of Agreena affiliated farmers, putting privacy concerns at risk.
Supplementary Calculation Material	Calculation step-by-step supplementary material contains code from RothC and model-building information.	Per the definition of sensitive information can be “scientific, technical or other information whose public disclosure could reasonably be expected to undermine or negatively affect the development and/or implementation of a program.”
Supplementary Uncertainty Material	Steps taken to calculate the uncertainty of the AgreenaCarbon Project.	Per the definition of sensitive information can be “scientific, technical or other information whose public disclosure could reasonably be expected to undermine or negatively affect the development and/or implementation of a program.”

Further Information

No additional information needed for this section.

2 SAFEGUARDS

2.1 No Net Harm

When farmers adopt the outlined Project Activities there is an inherent benefit in comparison to the BAU scenario. These Project Activities deliver associated measurable climate benefits that can impact the surrounding ecosystem. Both co-benefits and negative impacts have been taken into consideration for the Project. However, negative impacts have been concluded to be negligible, as in the absence of the Project, participants would be continuing pre-project farm practices. The following co-benefits have been determined and are substantiated by peer reviewed literature but not monitored or verified by the Project.[57]

1) **Water quality** – As regenerative agriculture is based on the principle of mimicking natural processes and reducing reliance on synthetic inputs, regenerative farmers generally use significantly less nitrogen inputs and pesticides than conventional farmers. Typically, reductions of 30-60% are realised in the short term and sometimes eliminated entirely after a longer period of transition. Furthermore, the reduction of soil disturbance and presence of cover crops improve soil structure and nutrient take-up. As a result, runoff and leaching of nitrates and pesticides into water courses is drastically reduced under a regenerative regime. As agriculture is responsible for around 50% of water course pollution, large-scale adoption of regenerative agriculture can drive enormous improvements in water quality at landscape and national scales.[58]

2) **Drought and flood risk mitigation** – Avoidance of tillage and other soil disturbance means that soil under a regenerative management system has both higher water holding capacity (reducing the risk and severity of droughts) as well as more efficient infiltration (risk of flooding is also reduced).[59] For example, a silt loam soil with 4% organic matter holds more than twice as much water as one with 1% organic matter.[60]

3) **Soil preservation** – Around a third of the world's agricultural soils are acutely degraded, and it is estimated that 75-100 billion tonnes of topsoil are lost to erosion and degradation every year. A significant driver of erosion is excessive use of tillage and exposing bare soil during the winter months (e.g. a lack of cover crops).[61] Regenerative agriculture addresses these issues and thereby significantly reduces vulnerability to wind and rain erosion.[62]

4) **Biodiversity** – As regenerative agriculture is based on the principle of mimicking and applying natural systems, farms under these management regimes invariably preserve biodiversity better than conventional farming systems. The avoidance of synthetic pesticides and replacement with tools such as Integrated Pest Management (IPM) means that pollinators

[57] The Project ensures that there are no claims made on co-benefits that are not clearly monitored and verified using accepted tools to do so and is therefore not making claims related to, e.g. biodiversity or water quality on its project.
[58] https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2022.891709/full
[59] Antolini et al. (2019), Flood Risk Reduction from Agricultural Best Management Practices, JAWRA
[60] Hudson (1994), *Soil organic matter and available water capacity*, Journal of Soil and Water Conservation
[61] Rust & Williams, How Tillage Affects Soil Erosion & Runoff, USDA
[62] Madarász et al. (2021), Long-term effects of conservation tillage on soil erosion in Central Europe, Soil & Tillage Research

and farmland birds are protected.[63] In addition, cover crops provide over-winter habitat and forage for a host of farmland species. Similarly, the soil ecosystem of bacteria, fungi, nematodes and other microfauna is substantially improved by the presence of living roots (cover crops) and avoidance of physical disturbance and synthetic inputs.

5) **Farm financial resilience** – By reducing reliance on synthetic inputs (fertiliser, pesticides and diesel), regenerative farmers can reduce their input costs, generally by at least 30%. As a result, even if yields fall in the short term, farms can improve their overall profitability. By focusing on profit per hectare instead of yield per hectare, regenerative farmers are less vulnerable to changes in input and output prices as well as exogenous shocks like extreme weather events. Thus, particularly in the long run, regenerative farmers realise greater financial resilience, independence and economic prosperity. A recent study demonstrated that regenerative agriculture can be around 78% more profitable than conventional agriculture.[64]

6) **Food quality** – There is evidence that food grown under regenerative regimes has significantly higher quantities of key nutrients[65] including B vitamins, calcium, vitamin K, copper, phosphorus, vitamin E and more. There are a number of factors at play in the decline in nutrient density over recent decades, including a focus on yield at the expense of nutrition[66], management practices including fertilisation and tillage[67] and pesticides[68]. Given the importance of nutrition to human health, regenerative agriculture has an important role to play in improving health outcomes around the world, a major co-benefit of increasing regenerative agriculture adoption.

In relation to the co-benefits above, the Project, through the contracting and onboarding sessions, provides farmers with the relevant information on compliance with the Project and national regulations which further supports a No-Net Harm scenario. The EU has made efforts to reduce nitrogen pollution through the Nitrates Directive and has put limits on the application of fertilisers. Harmonisation with the EU nitrates directive is also a standard procedure for countries outside of the EU such as Ukraine and Moldova. Most European countries have introduced best agricultural practices in zones that are vulnerable to nitrate pollution. The UK has the Code of Good Agricultural Practice for Reducing Ammonia Emissions to store and properly apply organic manures.[69] Farmers in the EU are also expected to follow statutory management requirements (SMR) that cover public, animal and plant health, animal welfare and the environment. In addition

[63] Michels (2022), Regenerative Agriculture Effects on Invertebrate and Bird Communities And Insect-Provided Ecosystem Services, South Dakota State University

[64] LaCanne & Lundgren (2018), Regenerative agriculture: merging farming and natural resource conservation profitably, NCBI

[65] Montgomery et al. (2022) Soil health and nutrient density: preliminary comparison of regenerative and conventional farming. PeerJ

[66] Morris & Sands (2006), The breeder's dilemma – yield or nutrition?, Nature

[67] Jansen, Wiemken & Frossard (2006), The effects of agricultural practices on arbuscular mycorrhizal fungi, Geological Society

[68] Montgomery & Biklé (2016), The Hidden Half of Nature, W. W. Norton & Co.

[69] https://www.gov.uk/government/publications/code-of-good-agricultural-practice-for-reducing-ammonia-emissions/code-of-good-agricultural-practice-cogap-for-reducing-ammonia-emissions

to the SMR, farmers that receive Common Agriculture Policy (CAP) support must follow the standards on good agricultural and environmental condition of land (GAEC).[70] These standards are put in place in order to prevent soil erosion, maintain soil organic matter, maintain permanent grassland, protect biodiversity, and protect and manage water.

2.2 Local Stakeholder Consultation

2.2.1 General provisions

The stakeholders the Project has identified and engaged with throughout the project development are: local farmers and their representatives, agricultural associations and cooperatives, NGOs, academic and research institutes, technical and scientific experts and advisors (e.g., on soil science, carbon market, conservation agriculture…), policy leaders and policy experts, governmental representatives, and business actors in the agri-food sector and across the agricultural supply chain. The main stakeholder group are the farmers participating in the Project, who own or have operational rights over the fields they enrolled in the Project for the duration of their participation. No significant changes in the makeup of the stakeholder groups are expected in the Project.

Stakeholder groups differ in spoken language, individual customs, and cultures on a country-to-country basis. The main socioeconomic and cultural diversity is at the farmer level because each individual presents their own level of knowledge, education, experience, and unique social context. To address this diversity, the Project has established local teams in each market, which help with specific communication and language issues. For example, the interpreting and explaining of technical practices in a manner tailored to the local sociocultural context and addressing any questions regarding regenerative agriculture or the Project. Local market teams allow the Project to better cater towards language and cultural differences and interact with the stakeholders in a culturally appropriate manner.

Agreena's website and onboarding content are available in all local languages to: provide information on the Project; list inquiry emails; and offer access to inquiry virtual forms. Agreena has local phone numbers to a dedicated call centre for every country in which it operates. Project participants and partners are provided with continuous chat-support on the Platform, plus additional channels of year-round engagement activities (e.g., webinars and educational tours with farm visits). As part of the QA/QC process, the company carries out field inspections (see section 5.3.1 paragraph "Data Collection"), where farmers can provide in-person qualitative feedback. By taking these measures, the Project maintains open communication and consultation channels with all Project's participants regardless of where they are located and/or originate from.

[70] Council Regulation No. 2021/2115 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2115&from=EN

As this is a grouped project, such a holistic approach to local stakeholder engagement is embedded across all Agreena's market teams, to ensure that all farmers, despite their inter-cultural differences, are given the same level of support. Overall, these measures ensure all farmers and local stakeholders are included and engaged in a culturally appropriate manner throughout the geographical boundaries.

2.2.2 Farmer Socio-Economic and Cultural Diversity

The main stakeholders are the local farmers participating in the Project across the 10 geographic areas. Following EuroVoc provisions[71] these countries can be divided into four regions according to cultural, political, geographical and social similarities: Northern, Southern, Western, and Central & Eastern Europe.

At the economic level, Northern European farmers tend to have higher income and lower year-to-year income variability. Statistically speaking, the average farm size is smaller in Eastern European countries, a variable which in turn correlates with income volatility. Whereas in Southern Europe, where there is a tradition of perennial crops such as peach and hazel, the average farmer presents more income stability.[72]

Farmers in most Central & Eastern countries present unique characteristics, linked to their shared political past characterised by far-left regimes and governments. As aforementioned, the average farm size in this region is relatively small, and subsistence farming is especially common in Eastern countries.[73, 74] For example, in Moldova about 40% of all agricultural land was found to be fragmented in parcels smaller than 5 ha, and their owners often have non-agricultural sources of supplemental income.[75] The social capital was also found to be somewhat lower in Central & Eastern Europe;[76] producers' organisations, farmers' cooperatives, and willingness to collaborate are reported as less frequent in Romania and Bulgaria. These characteristics are particularly relevant for the purpose of the Project, since peer networks are a key avenue for farmers to engage in knowledge sharing and promote non-conventional practices like no-tilling.[77]

Nevertheless, cross-European studies often highlight key similarities in the social challenges, social context, cultural identity, and personal beliefs of farmers regardless of their geographical basin of origin. Most European farmers gain their agricultural knowledge and skills through hands-on experience, practical application, and peer-to-peer transmission within their

[71] https://eur-lex.europa.eu/browse/eurovoc.html?params=72,7206#arrow_914

[72] https://www.europarl.europa.eu/RegData/etudes/STUD/2015/540374/IPOL_STU(2015)540374_EN.pdf

[73] Florian, V., Rusu, M., Rosu, E., Chitea, M., Bruma, S., & Pocol, C. (2020). Behavioural factors and ecological farming. Case studies. Scientific Paper Series Management, Economic Engineering in Agriculture and Rural Development, 20(2).

[74] Kopytko, N., & Pruneddu, A. (2018). Triple-win strategy? Why is not everyone doing it? A participant-driven research method to reveal barriers to crop rotation in Ukraine. Climatic Change, 149(2), 189–204. https://doi.org/10.1007/s10584-018-2229-8

[75] Ignat, A., & Moroz, V. (2013). Agricultural land-use changes and rural transformation in the Republic of Moldova. Scientific Paper Series Management, Economic Engineering in Agriculture and Rural Development, 13(1).

[76] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

[77] Skaalsveen, K., Ingram, J., & Urquhart, J. (2020). The role of farmers' social networks in the implementation of no-till farming practices. Agricultural Systems, 181, 102824. https://doi.org/10.1016/j.agsy.2020.102824

social.[78,79,80,81] Social networks are an effective method of knowledge sharing and have also been shown to influence a farmer's attitudes and beliefs.[82] They can also play a role in shaping a farmer's sense of identity and values, including the acceptance of new agricultural philosophies and practices.[83]

The influence of peer pressure for social conformity is shown in the literature.[84,85] A recent study highlighted how British farmers practising no-tillage would mostly interact and engage with like-minded farmers regardless of geographical proximity; when fellow no-tillage practitioners were absent in nearby areas, farmers would establish remote connections via social media platforms.[86] This evidence suggests that the influence of social networks on a farmer's personal values, belief system, and preferred crop management practices can be independent of geographical boundaries, and exist across the cultural basins of Western, Central & Eastern, Southern and Northern Europe.

European farmers also tend to display a strong attachment to traditional practices and their historical identity as producers and as growers.[87] Upholding agricultural traditions and conservationism is a characteristic showcased by farmers throughout Europe, as is aversion to changing long-established agricultural practices and to risk taking. In turn, this fosters a low inception of non-conventional agricultural practices, like organic or regenerative farming, at a cross-European level.[88,89]

A third characteristic common to European farmers is a demographic crisis. The total numbers of farmers are declining across Europe, while their average age is increasing, bringing about generational replacement issues. Barriers to entry for young farmers, especially for those whose family is not in the farming business, are widely reported, and so is a decreasing rate of intra-

78 Rogers, E.M., Kincaid, D.L., 1981. Communication Networks; A New Paradigm for Research. Free Press, New York.

79 Oreszczyn, S., Lane, A., Carr, S., 2010. The role of networks of practice and webs of influencers on farmers' engagement with and learning about agricultural innovations. J. Rural. Stud. 26, 404–417.

80 Wood, B.A., Blair, H.T., Gray, D.I., Kemp, P.D., Kenyon, P.R., Morris, S.T., Sewell, A.M., 2014. Agricultural science in the wild: A social network analysis of farmer knowledge exchange. PLoS One 9, e105203.

81 Dolinska, A., d'Aquino, P., 2016. Farmers as agents in innovation systems. Empowering farmers for innovation through communities of practice. Agric. Syst. 142, 122–130.

82 De Lange, D., Agneessens, F., Waege, H., 2004. Asking social network questions: A quality assessment of different measures. Metodološki zvezki 1, 351–378.

83 Isaac, M.E., Erickson, B.H., Quashie-Sam, S.J., Timmer, V.R., 2007. Transfer of knowledge on agroforestry management practices: The structure of farmer advice networks. Ecol. Soc. 12, 32.

84 Isaac, M.E., Erickson, B.H., Quashie-Sam, S.J., Timmer, V.R., 2007. Transfer of knowledge on agroforestry management practices: The structure of farmer advice networks. Ecol. Soc. 12, 32.

85 Schneider, F., Ledermann, T., Fry, P., Rist, S., 2010. Soil conservation in Swiss agriculture—Approaching abstract and symbolic meanings in farmers' lifeworlds. Land Use Policy 27, 332–339

86 Skaalsveen, K., Ingram, J., & Urquhart, J. (2020). The role of farmers' social networks in the implementation of no-till farming practices. Agricultural Systems, 181, 102824. https://doi.org/10.1016/j.agsy.2020.102824

87 Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp

88 https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

89 https://www.surefarmproject.eu/wordpress/wp-content/uploads/2019/04/SURE-Farm-D.2.1-Report-on-farmers-perceptionof-risk-and-resilience-capacities.pdf

family succession.[90] This demographic crisis contributes to the lack of skilled, educated agricultural workers reported in most pan-European countries.[91] It is also important to note that agriculture is a male-dominated industry, and barriers to entry to female farmers have been reported across Europe.[92]

2.2.3 Farmers onboarding process

The Project area corresponds to the collection of 12,616 initial PAIs in total distributed across ten pan-European countries. During the onboarding process and prior to officially joining the Project, farmers are asked to provide a statement confirming that they own and/or have operational rights over the fields they wish to enrol for the duration of their participation in the Project. Therefore, the Project takes place exclusively in privately owned or leased arable land, and directly impacts *in situ* natural resources. QA/QC mechanisms ascertain the exact location of every PAI, and any discrepancy with farmers' declaration is promptly addressed (see section 5.3.1). Were they to occur, Agreena's QA/QC procedures would reliably pick up any unlawful encroachment or expansion of the Project Area. Within the geographical boundaries of the Project there are no indigenous people or local communities with customary and/or legal rights to the land and resources affected, nor any local communities who derive their livelihood from the Project area and/or affected natural resources.

No property rights disputes have occurred so far nor, due to the inherent nature of land rights in the pan-European geographies, are expected to occur in the future. Likewise, the Project has not and shall not infringe on property rights. If any conflict was to arise, Agreena shall promptly, effectively and fairly address them with a case-by-case approach prioritising direct farmer communication and based on a complete understanding of the relevant cultural and regulatory contexts. The Project prioritises conflict de-escalation, peaceful resolution, and maintaining a neutral stance, per provisions of the Grievance & Complaints Policy - see section 2.2.6 for further information.

The Project ensures that a transparent agreement is reached with prospective participants through the farmer onboarding process. Only after a farmer has gone through onboarding, has accepted the Terms & Conditions (TCs) and Benefit Contract (BC), do they become an official Project participant. Key Account Managers (KAMs) and Customer Success (CS) are the main personnel involved in the farmer onboarding process, whose main purpose is to equip all farmers in all countries with the same level of knowledge and understanding of the Project. If a farmer is in need of additional clarifications, they can do so through the various contact points.

KAMs reach out to prospective farmers to provide an overview of the AgreenaCarbon Project, verify farmers' interest in joining, and whether they would be a fit for the Project. Afterwards, farmers are invited to participate in a Validation Meeting co-lead by KAMs and CS reps. Validation Meetings are held in a language that the farmer can fully understand to ensure transparency and

[90] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

[91] Ibid

[92] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

are conducted in a culturally appropriate manner. Farmers are also encouraged to express any questions, doubts, or uncertainties, and are provided with points of contact for follow-up questions. The following topics are tackled in the Validation Meetings:

1. The purpose and duration of the Project.
2. Overview of the Project-promoted ALM activities (i.e., reduced tillage; cover and/or catch crops; mulching and residue management; shifting from synthetic to organic fertiliser).
3. Clarification that farmers can implement ALM activities at their own pace, plus the nature of and reversibility of the changes to key soil variables that the Project can bring about.
4. What would farmers have to do if they chose to join the Project, including the data they would have to provide, and how Agreena verifies, validates and monitors ALM practice implementation.
5. Clarification of benefit sharing process and credit generation.
6. The likely socioeconomic, environmental and well-being impacts. Agreena personnel are ready to address any questions farmers may have regarding the benefits and risks of joining the Project.
7. The personnel that will follow farmers throughout their project participation.

Farmers are then provided with a copy of the Terms & Conditions and Benefit Contract to review in their own time. The provisions of these documents further ensure that farmers consent to participate in the Project knowingly, being aware of what participation entails in terms of their responsibilities, rights, obligations. At the same time, the Validation Meetings ensure farmers gained a clear agronomic and ecological understanding of Project-supported ALM practices as well as of the Project itself.

Given that Project activities are self-enacted by farmers on the arable fields they have ownership and/or operational rights on, Project activities cannot occur without the prior knowledge and consent of farmers. As mentioned before, to this date no land use or benefit sharing conflict with regards to the AgreenaCarbon Project has occurred. Key regional partners regularly monitor and communicate to Agreena whether impacts to rural farmer communities should be considered. Thanks to the existing Grievance & Complaints Procedure focused on peaceful resolution and considering that no Indigenous People (IPs) or other customary rights holders are present in the areas affected by the Project, the AgreenaCarbon project is equipped with the tools and information necessary to not exacerbate land use & access conflicts if they were to ever occur.

The main risk associated with the Project is a potential short-term loss in crop yields. As tillage is reduced or eliminated altogether, the soil loses the strong structure tilling used to provide. The biophysical properties of the soil will be rebuilt by the invertebrates and microorganisms there present, but this takes time to happen. Some farmers may be forced to overcompensate by increasing fertiliser load, while others may purchase new farming equipment to adopt Project practices. However, the decrease in crop yield is just a result of the local soil adapting to the new regenerative management regime. After a period of adjustment, crops cultivated with regenerative ALM practices have been shown to have greater profitability per hectare than their traditionally managed counterparts, also thanks to greater return margins (see section 2.1 “No

Net Harm"). The higher profitability is tightly linked to the decreased reliance on oil-fuelled agricultural machinery and costly external inputs (e.g., more expensive, synthetic fertilisers) of regenerative farmers. Altogether, transitioning to regenerative farming offsets the initial yield loss risk in the long-term.

Both the risk of yield loss and the risk of increased fertiliser use are regularly monitored by the Project. Farmers have to provide PAI information, including information on total yield and quantity of fertilisers used, and the veracity of these reported data is checked through QA/QC mechanisms (see section 5.3.1). Participants are subject to national and EU-level regulations. The latter are renowned for being particularly strict and ecologically oriented, setting clear limits and guidelines on the application of synthetic fertilisers on agricultural crops. By ensuring that Project activities, including fertiliser application, are verified every harvest year and aligned with existing regulations, the Project mitigates against fertiliser overapplication. Plus, farmers can rely on continuously open communication channels with AgreenaCarbon personnel.

To mitigate the effect of yield loss during the initial transition phase, the Project provided a pre-payment to the first PAIs. The reduction/removals per PAI were calculated and the pre-payment was set to an estimated market value. Furthermore, the Project provides participants an estimated earnings potential with the project participants, to account for it in their budgeting. If the farmer joins the Project, they are compensated with the output and, depending on the sale of the certificate in the market, the farmer can be compensated further. Additionally, Agreena is piloting various additional support systems to further mitigate the effect of yield loss, such as onboarding prepayment for small farmers and partnerships with financial institutions for improved credit options to unlock early financial compensation.

A second potential risk to Project participants is of social nature. Participants might experience a lack of support and negative judgements from neighbouring farmers, who might perceive their efforts to transition and change their ALM practices as a disruption of the status-quo, and thus react negatively. In turn, this could lead to feelings of loneliness and isolation within their local network. To mitigate against such risk, the Project provides farmers with access to support from CS personnel, invites participants to regular social events (e.g., webinars) to connect with like-minded farmers, and shares relevant news and events regarding the Project and regenerative farming on social media channels.

2.2.4 Stakeholder Engagement and Consultation

The Project works with numerous parties to develop and adapt the Project, following the process of stakeholder consultation described in the VCS Standard. As a result of the stakeholder assessment process, the Project identified a total of six relevant stakeholder groups: farmers, agricultural cooperatives and associations; agricultural industry actors and trade associations from the agri-food sector; technical, scientific and policy experts and advisors; governmental institutions and policymakers; research and academic bodies; and NGOs. Organisations like the Danish Trade Council and embassies supported the consultations, particularly with the identification of stakeholder groups' representatives in key locations.

In order to ensure stakeholder representation, as per section 3.18.2 of VCS Standard (v 4.5), at least one representative of each stakeholder group identified was involved in the stakeholder consultation processes. In collaboration with government organisations, the Project identified and consulted with one or more representatives of the six relevant stakeholder groups. This provided the Project with a comprehensive, cross-country understanding of the perspectives each stakeholder group held on Project design and implementation. For example, representatives of AgroBaltic attended the consultations, offering insights on the necessities and realities of farmers in Estonia, Latvia and Lithuania. The following list presents representatives from the six salient stakeholder groups identified that participated in consultations and engagement activities. It should be noted that some representatives may be relevant to more than one stakeholder group. For more information on the engagement events organised, and the representatives invited, consult Appendix 4.

The list of stakeholders has been redacted from the Public Version of the document.

Since the Project inception, Agreena has used a variety of procedures and methods for consulting with stakeholders and gathering input from the communities which it serves at both grouped (European) and local (national) market level. Consultations have been conducted throughout the Project's development using quantitative and qualitative approaches, with both formal and semi-structured engagements: in-person and online meetings, qualitative dialogues and consultations, partner feedback, site-visit surveys, webinars, formal local events, personal interviews, and focus groups. Further supporting evidence given to the VVB, whereas mechanisms for ongoing communications are presented in section 2.1.5 of this document.

Formal grouped project-level consultations took place in-person and online with conservation agriculture expert agronomists, farmers, and an external carbon advisory board (composed of experts in European regenerative agriculture, soil science, policy and voluntary carbon markets), with the main objective of receiving extensive and thorough feedback on the Project and PD from European and global lenses. The most relevant updates that resulted from these meetings are below:

- 12 November 2020 - In-person; Copenhagen, Denmark
- 3-5 May 2022 - Online. Key project design changes being made as a result of the input collected: AgreenaCarbon will solely focus on mineral soils, and action for grasslands and drained peatlands might be explored in the future; additional market outreach and education was pursued.
- 13-14 July 2022 - Online. Key project design changes made as a result of the input then collected: the Soil Sampling Protocol, and procedures for Leakage calculations were discussed, detailed and agreed upon; the VM00042 Methodology was selected.
- 20-21 October 2022 - Online. Key project design changes made as a result of the input then collected: a combination of satellite imagery and ground-truthed data was selected as the main process for soil analysis; the breadth and thoroughness of data collected from

farmers in the onboarding session and field inspections was widened to what is now included in the PD.

- 2-3 February 2023 – In-person, Copenhagen, Denmark. Key project design changes made as a result of the input then collected: Baseline Calculation shall be carried out relying on the Consistency Approach.
- 24-25 May 2023 – Online. No significant project design updates were made following this meeting.

Local market-level qualitative meetings and formal events took place in-person and in partnership with the Danish Ministry of Foreign Affairs. As aforementioned, collaboration with the local Danish Trade Council took place to identify relevant stakeholder groups representatives and invite them to these in-person consultations. Following each local market-level meeting, Agreena led larger, formal educational events whose programme included an overview of the AgreenaCarbon Project, presentations of the Project, and a Q&A session with company CEO and local experts. Bidirectional English-local language translation services were provided. The most relevant updates implemented as a result of the stakeholders' feedback received in these local market-level consultations are below:

- 27-28 Sept 2022, 7-8 November 2022, 16 November 2022 – In-person; Budapest, Hungary. Key project changes implemented as a consequence of the input then received: the Project would start to build Case Studies, kickstart local educational events and farm visits to improve awareness and information sharing of regenerative agricultural practices.
- 17-18 October 2022, 18 October 2022 - In-person; Warsaw, Poland. Key project changes implemented as a consequence of the input there received: the Project started improving social media presence, which was reported to be fundamental in key Central & Eastern European markets.
- 19- 20 October 2022, 1 March 2023 – In-person: Prague, Czech Republic
- 20-21 October 2022, 17 January 2023 – In-person: Bucharest, Romania

Stakeholder consultation feedback was recorded via notetaking, and the documentation was placed onto AgreenaCarbon's Cloud Drive and intranet with employee-access. Then, it was fed into the Regulatory, Program, Product, Customer Success and Senior Leadership teams for appropriate action to be taken within the respective parts of the organisation. Another way in which stakeholders' input is incorporated into the Project is by assessing the questions Customer Success receives directly from farmers. For example, farmers asked for new crop types to be allowed in the Project, which were assessed and included if fitting within the criteria for crop type assessment.[93] This approach further helps drive the adaptation of the Project. Detailed evidence

[93] Crop Type List Database and analysis has been provided to the VVB with references to where information was taken.

is provided to the Validation and Verification Body, and photos and video recordings were taken in some cases.

2.2.5 Mechanism for Ongoing Communications

The Project has developed mechanisms for continuous ongoing communications and feedback collection from stakeholders, farmers and business partners. Local farmers and partners are provided contact points with specific Market Lead and Farmer Success personnel, ensuring that the latter can fully understand the language, culture, and costumes of the former. The Project has dedicated local phone numbers for each of the ten countries in which it operates, and all local languages available on the website, enabling all farmers to easily contact relevant personnel and submit necessary forms. Project participants and partners are also offered continuous chat support and year-round engagement activities: webinars, educational tours with farm visits, randomised qualitative personal interviews, and annual site-visits (see section 5.3.1). By taking these measures, the Project can maintain open communication and consultation channels with every farmer across the ten pan-European countries in which it operates.

Farmer input is reviewed mainly by the Program and Customer Success teams. Dedicated personnel analyse each piece of feedback to individuate areas of improvement. For example, by pinpointing mega trends in farmers comments, and resolving feedback that does not warrant further action. Due to the sheer scale of information and qualitative feedback obtained through bi-annual field-inspections and year-round communication channels (e.g., chat support, call centre), only a selection of the most crucial Project updates from these sources of feedback is presented in the PD. Upon demand for more tech-friendly approaches from internal communications with farmers and QA/QC procedures, the Project improved platform usability processes to increase digital tools accessibility and started conducting personal interviews. An additional in-person feedback channel focusing on pinpointing common traits and challenges shared by Project participants was established. Upon request for additional information, the Project began implementing “user personas”, archetypical avatars that participants can identify with according to their goals, backgrounds, and relative skills. The Project also expanded the type of crops accepted in the Project, after reviewing that they are not illegal or invasive species.

Furthermore, in 2024 the Project created a Farmer Ambassador Program, held for selected farmers across the Project to attend meetings in Copenhagen for workshops and discussions to understand how the AgreenaCarbon Project can better support farmers, and amplify their voice. This newly created programme for farmers provides the Project with additional, valuable insights and action points, and strengthens relationships with project participants to empower the expansion of regenerative solutions.

2.2.6 Code of Conduct, Grievance & Complaints Procedure

The Project monitors workers’ rights and operates at the pan-European level, where there are internationally adopted conventions. The Project expects all farmers participating to respect local, national and international laws. With its diverse workforce, all AgreenaCarbon employees and

partners are expected to act in compliance with our Code of Conduct[94], developed on the basis of the UN Guiding Principles on Business and Human Rights, the International Labour Organization's Declaration on Fundamental Principles and Rights at Work. Thus, the Project operates with a clear rejection of discriminatory practices on the basis of nationality and gender, of any form of harassment, and in the absolute respect of human and workers' rights. All communication and engagement materials are crafted following these principles.

The Project has three main avenues for internal and external stakeholders to report their grievances and/or concerns regarding potential breaches:

1. Grievance mechanism (for external stakeholders, including farmers) - Available on Agreena website[95]
2. Customer Success or Account Managers (for farmers, who can reach out to their respective point of contact to raise any concern)
3. Whistleblower hotline (for employees) - Available via Notion, the internal intranet

The AgreenaCarbon Project aims to ensure that all concerns, complaints, and grievances related to the Project are acknowledged, heard, and addressed in a timely and effective manner. Doing so ultimately contributes to the successful long-term execution of the Project, and to the satisfaction of all stakeholders. The Grievance and Complaints Procedure[96] establishes a fair, transparent, and culturally appropriate process for resolving disputes that may arise between the Project and any individual, community, or group affected by the planning, implementation, and ongoing operations of the Project. To this date, there have been no reports or cases regarding sexual harassment or discrimination as part of the Project, nor any Grievance of Complaint of other nature.

As an AFOLU project, the Project will publish its PD and a VCS annual monitoring report, which will undergo validation and verification respectively.

2.3 Environmental Impact

The Project does not anticipate net harm to the land and/or community. On the contrary, it anticipates only benefits through improvement of environmental and ecological parameters as well as farmers' income (see section 2.1). All EU environmental regulations are considered in this regard and are followed closely. Please see Section 1.14 "Compliance with Laws, Statutes, and other Regulatory Frameworks" for additional information. The AgreenaCarbon Project has limited impact outside of the PAIs enrolled in the Project. Any risks associated with the Project activities implementation (e.g., potential initial loss of yields) are limited to the farmers engaged directly with the Project, whereas environmental co-benefits might ripple to neighbouring fields and land.

[94] https://agreena.com/wp-content/uploads/2023/05/Agreena_Supplier_Code_of_Conduct.pdf
[95] https://agreena.com/wp-content/uploads/2023/05/Agreena-Grievance-and-Complaints-Procedure.pdf
[96] https://agreena.com/wp-content/uploads/2023/05/Agreena-Grievance-and-Complaints-Procedure.pdf

As Rehberger et al. (2023)[97] point out, environmental services like soil and water quality, or biodiversity protection, can be maximised with regenerative agriculture. These environmental benefits are directly linked to climate change adaptation, and regenerative farmers are more resilient to the negative impacts of climate change.[98]

The Project area consists of historically arable fields farmed for commercial purposes, owned and/or managed by the farmers participating in the Project. As the Project takes place exclusively on private land, there is no negative impact on local communities. Moreover, no indigenous people (IP) or other customary rights holders to Project-affected areas, and no local communities whose livelihood hinges on Project-impacted resources were identified. Given the inherent nature of land rights in pan-European geography, no tenure/access rights dispute has or is expected to arise as a result of Project implementation. Please refer to the KML file for all field locations in the Project.

2.4 Public Comments

The public comment period for this Project ran from 20 January 2023 to 19 February 2023 and all comments have been responded to under the validation process. Two comments have been brought forward and addressed by the VVB and proven to not be valid due to the source of the comments. Full comments have been addressed and presented in the Validation report.

The first comment received contains seven (7) paragraphs of concerns, listed by paragraph and therefore each concern has been addressed through the Validation report. It is important to note, that several of the concerns presented by the commenter are pertaining to the VM0042 v2.0 methodology itself, not AgreenaCarbon's Project Description and therefore Project Proponent cannot respond to these as it does not have control over the revision process of methodologies under Verra. The other comment was made by an anonymous commenter and has not been verified.

2.5 AFOLU-Specific Safeguards

The Project's advisers are on call with the farmers participating in the Project during working hours (CET and GMT) and work regularly with key partners in the regions of the Project. The partners ensure that local stakeholders are actively involved and that the farmers and local community, if applicable, are taken into consideration. All property rights and ownership are established clearly at onboarding into the Project and specified in the Benefits Contract. The full description of Stakeholder engagement which aligns with the AFOLU-Specific Safeguards is provided in Section 2.2 "Local Stakeholder Consultation" and the accompanying Appendix 4.

[97] Rehberger (et al., 2023). "What climate and environmental benefits of regenerative agriculture practices? an evidence review". Environmental Research Communication (5;5), doi: 10.1088/2515-7620/acd6dc
[98] Rehberger (et al., 2023). "What climate and environmental benefits of regenerative agriculture practices? an evidence review". Environmental Research Communication (5;5), doi: 10.1088/2515-7620/acd6dc

Agreena regularly attends fairs and public events to educate new farmers on the potential benefits and risks associated with changing agricultural practices. There is an information email and telephone number on the Agreena website www.agreena.com to make sure that stakeholders are able to contact the advisers and get the answers they need.

As stated in the Section 2.2 subsection "Local Stakeholder Consultation", the Project is actively involved with agencies and stakeholders connected to the local area. The Project also follows closely with new regulations and any new environmental standards that may come into play within the VCM and is strictly adhering to the latest requirements around additionality, permanence, leakage, and similarly crucial topics for Project implementation.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

VM0042: Methodology for Improved Agricultural Land Management, Version 2.0, 30 May 2023, Sectoral Scope 14

Additional Tools:

- VCS Standard, version 4.5 – 4 October 2023
- VCS Program Definitions, version 4.4 – 29 August 2023
- VCS Program Guide, version 4.4 – 29 August 2023
- Registration and Issuance Process, version 4.4 – 4 October 2023
- AFOLU Non-Permanence Risk Tool, version 4.0 – 19 September 2019
- VMD0053 Model Calibration, Validation, and Uncertainty Guidance for the Methodology for Improved Agricultural Land Management, version 2.0 – 30 May 2023

3.2 Applicability of Methodology

The Project will meet the applicability conditions of VM0042: Methodology for Improved Agricultural Land Management, Version 2.0, 30 May 2023, Sectoral Scope 14 (revised from Version 1.0). The activity will include the adoption of new or implementation of changes to ALM practices of which are included in VM0042 v2.0. The applicability conditions of VM0042 v2.0 are as follows and apply to the AgreenaCarbon Project.

Table 3-1. Applicability Conditions for VM0042 v2.0 and AgreenaCarbon Project fulfilment of the conditions.

	Applicability Conditions	AgreenaCarbon Fulfillment of Conditions
1	Projects must introduce or implement one or more new changes to pre-existing agricultural management practices which: Improve fertiliser (organic or inorganic) management; Improve water management/irrigation; Reduce tillage/improve residue management; Improve crop planting and harvesting (e.g., improved agroforestry, crop rotations, cover crops); Improve grazing practices	AgreenaCarbon requires that farmers begin at least one activity that meets these requirements, as described in section 1.11 and explicitly detailed in Table 1-9.
	Projects that introduce or implement quantitative adjustments (e.g., decrease in fertiliser application rate) must exceed five percent of the pre-existing value, calculated as the average value over the historical look-back period, developed for the baseline schedule of activities (see Section 6). Appendix 1 of VM0042 gives additional details and guidance on practices and on determining practice change.	The AgreenaCarbon Project uses quantitative adjustments and fulfils the applicability condition through the farmer's transition and via use of the baseline schedule of activities created from the historical look-back period. Details are described in Table 3-4.
	Project activities must be implemented on land that is either cropland or grassland at the project start date and remains cropland or grassland throughout the project crediting period.	All land entering the Project is arable land. This is further verified through AgreenaCarbon remote sensing models as described in Section 5.3.
	Empirical or process-based models used to estimate stock change/emissions via QA1 must fulfil criteria 4 a-c of VM0042 v2.0 Applicability Conditions.	Rothamsted Carbon Model (RothC) a) is publicly available, b) is used in numerous peer reviewed scientific studies, c) supports project model simulations, d) is validated per Section 5.2 of VMD0053 v2.0) uses the same model version in baseline and project scenarios. The MVR provided for assessment during validation and presented during verification confirms this.
	Applicability Conditions	Justification

	The project area must not have been cleared of native ecosystems within the 10-year period prior to the project start date.	AgreenaCarbon uses farmer attestation, regional data and remote-sensing to check whether land has been cleared of native ecosystems in the last 10 years. Further information has been provided in Section 5.3 under Quality Assurance.
	The project activity is not expected to cause a sustained reduction in productivity of greater than 5 percent, as demonstrated by peer-reviewed and/or published studies on the activity in the region or a comparable region	Yield loss can be expected in the start of a transition to regenerative agriculture, yet numerous studies exist to show that after 2-3 years the yield will be at the same levels as pre-transition. In a study on conservation (reduced) tillage in Central Europe, it was found that the ten-year average following transition, had a surplus of 7.9% (deficit in the first 3 years followed by a surplus).[99] SOM increase leads to overall increase in soil health.[100,101] In Section 4.3 on Leakage in this PD, the Project demonstrates that there will not be a loss in productivity or yield greater than 5% due to the implementation of Project measures.
	The project activity is not a biochar application.	None of the project activities specified or allowed in the AgreenaCarbon project allow for biochar application and field inputs are closely tracked through onboarding, validation and verification as outlined in the Monitoring Section 5.3.
	The project activity does not occur on a wetland.	AgreenaCarbon uses farmer attestation, regional data and remote-sensing to ensure project instances do not occur on wetlands. Checks for deforestation, native ecosystem and wetland clearing are performed using datasets produced by the Global Land Analysis and Discovery (GLAD) laboratory, which are derived from Landsat data. The GLAD datasets include annual tree deforestation (vegetation greater than 5 metres in height) and 5-yearly land cover change, which includes cropland and native ecosystem categories for short vegetation and wetlands. Each field boundary is assessed against these two datasets to ensure that fields were not created by the clearing of forests, native ecosystems or wetlands during the last 10 years. See Section 5.3 for further information.

3.3 Project Boundary

The Project extends to the incorporation of Project activities that aim to reduce GHG emissions from croplands and must be able to quantify effects from the three main GHGs in relation to agricultural production: Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Emission reductions and removals through transitioning to regenerative agriculture practices covers three GHG categories:

- SOC stocks (SOC): Carbon sequestered in the soil – improving carbon stocks through reduction of tillage intensity, adoption of cover crops and other factors.
- Indirect Emissions (Ind.Em.): refers to emissions that result from the mineralization of carbon and nitrogen (CO_2, CH_4 and N_2O). Indirect N_2O emissions consist of emissions from leaching and runoff, and emissions from N volatilisation.
- Fuel & Energy (F&E): Emissions from combustion of fossil fuel (lower machinery intensity) and energy required to produce synthetic fertilisers and pesticides.

The project extends to several activities, focused on reducing emissions and increasing removals in the soil carbon pool followed by different biochemical processes as shown in Table 3-2 and the respective GHGs are generated through the following processes. For context, the project boundary, and initial project activity instance (PAI) locations are presented in Figure 3-1.

[99] https://www.tandfonline.com/doi/full/10.1080/14735903.2016.1150022
[100] https://linkinghub.elsevier.com/retrieve/pii/S016719872030430X
[101] https://www.gwct.org.uk/media/841575/AHDB-Tillage-Report-2017.pdf

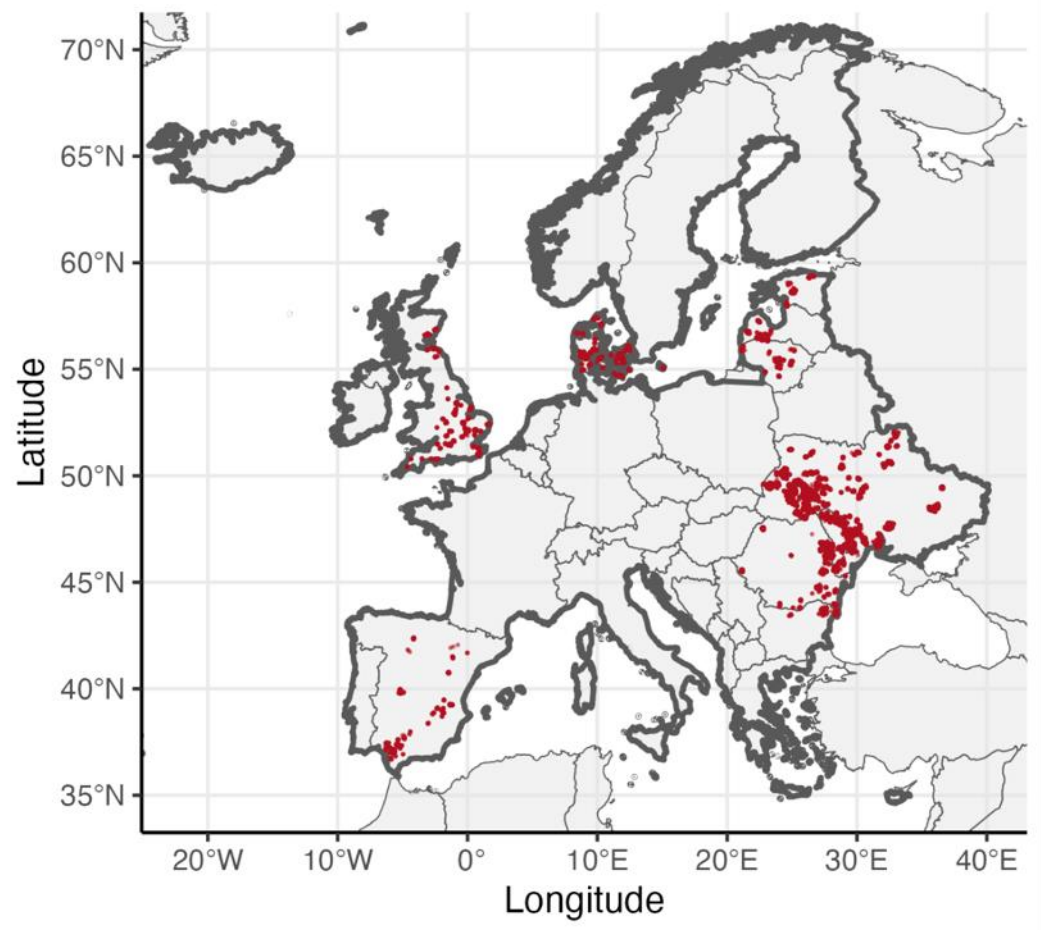


Figure 3-1: Project boundary, country boundaries, and initial PAIs (red •).

Table 3-2. Relevant GHG sources, sinks and reservoirs for the project and baseline scenarios.

Source	Included?	Justification/Explanation
Aboveground woody biomass	No	Aboveground woody biomass pool is not expected to significantly change compared to the baseline. It is also not present in the project area as the project is only implemented on arable land.
Aboveground non woody biomass	No	Carbon pool does not have to be included because it is not subject to significant changes, or potential changes are transient in nature.

Belowground woody biomass	No	Belowground woody biomass pool is not expected to significantly change compared to the baseline. It is also not present in the project area as the project is only implemented on arable land.
Belowground non woody biomass	No	Carbon pool does not have to be included because it is not subject to significant changes, or potential changes are transient in nature.
Dead wood	No	Carbon pool is not included because it is not subject to significant changes or potential changes are transient in nature.
Litter	No	Carbon pool is not included, because it is not subject to significant changes or potential changes are transient in nature.
Soil organic carbon	Yes	Major carbon pool affected by project activity that is expected to increase in the project scenario.
Wood products	No	Carbon pool is optional for ALM project methodologies and may be excluded from the project boundary.

Table 3-3. Project boundary and GHG sources, sinks and reservoirs including the gases.

Source	Gas	Included?	Justification/Explanation
Soil organic carbon	CO_2	Yes	Quantified as stock change in the pool, rather than an emissions source (see Table 2).
Fossil fuel	CO_2	Yes	The sources of fossil fuel emissions from vehicles (mobile sources, such as trucks, tractors, etc.) and mechanical equipment required by the ALM activity are included in the project boundary in the baseline and

			project scenario using Eq. 7 and Eq. 8 in VM0042 v2.0.
Liming	CO_2	Yes	Application of limestone or dolomite as soil amelioration may represent a significant source of CO_2.
Soil methanogenesis	CH_4	No	Soil Methanogenesis is not included in the project boundaries. The source is not expected to change in the project scenario relative to the baseline scenario, as the project does not include PAIs with temporary or permanent waterlogged soils.
Enteric fermentation	CH_4	No	Livestock is not included in the Project and therefore the source is not included in the project boundary in the baseline and project scenario.
Manure deposition	N_2O	No	Livestock is not included in the Project and therefore the source is not included in the project boundary in the baseline and project scenario.
	N_2O	No	Livestock is not included in the Project and therefore the source is not included in the project boundary in the baseline and project scenario.
Use of nitrogen fertilisers	N_2O	Yes	Nitrous oxide (N20) from use of nitrogen fertilisers and nitrogen fixing species within the project boundaries will be calculated according to methodology VM0042 v2.0 (), section 8.2.9 and quantified under Quantification approach 3, using Equations 17 to 26.
Use of nitrogen fixing species	N_2O	Yes	Nitrogen fixing species are planned to be planted in the project, therefore nitrous oxide (N_2O) emissions from nitrogen fixing species will be included in the project

			boundary in the baseline and project scenario.
Biomass burning	CO_2	No	Carbon stock decreases due to burning are accounted as a carbon stock change.
	N_2O		
	N_2O		
Woody biomass	CO_2	No	See Table 3-4 below.

*All sources and gases in Table 3-2 and Table 3-3 are accounted for in the same way in both baseline and project scenarios.

3.4 Baseline Scenario

The baseline scenario represents the activities and associated GHG emissions that would occur in the absence of the Project Activity. Continuation of pre-project agricultural management practices is considered the most plausible baseline scenario. The baseline is used to set a reference value of GHG emissions reductions and removals which will be used to compare against the GHG emission reductions and removals that occur after adoption of the Project Activities.

The baseline scenario is determined for every Geographic Area (country) by all PAI that can demonstrate their capability to improve at least one of the proposed five Project Activities described in Table 1-1. The process for determining the baseline is uniformly applied across the entire Project. However, the development of the annual Schedule of Activities (SoA) for the baseline scenario and the quantification of the baseline GHG emissions are determined for each PAI individually.

For each PAI, the Project produces a baseline SoA reflecting management practices for the 5 years prior to participation, repeating the pattern of practices in the historic look-back period forward to represent each PAI's baseline scenario for the first 10 years of the project. The baseline SoA is central to the Projects GHG quantification methodology for both removals and reductions; it is used as described in the accompanying Model Validation Report (MVR) for the VMD0053 v2.0 module to estimate baseline changes in soil carbon stocks following Quantification Approach 1; it is used to define historic use of fossil fuel, cropping practices, fertiliser application, for which the corresponding CO_2 and N_2O emissions are estimated following Quantification Approach 3. Section 4.1 provides further details for how baseline SoAs are used in quantification for the Project.

The first baseline scenario period is 10 years following the Project's start date, after which re-baselining will occur. The AgreenaCarbon project applies a 5-year historic look-back period, resulting in a baseline SoA that is repeated twice over the initial baseline scenario period. This 5-year historic look-back period exceeds the minimum 3-year period, ensures lengthier crop

rotations are captured in the SoA, and is more accurate for PAIs that do not have a regular crop rotation.

As per VM0042 v2.0, re-baselining will involve updating the commercial crop production component of each PAI's SoA, and conservative regional default values will be updated to use agricultural production data from the 5 years preceding the end of the first baseline scenario period.

3.4.1 Development of schedule of activities in the baseline scenarios

In line with the hierarchy of qualitative and quantitative information detailed in Box 1 of VM0042 v2.0, historical management and farmer attestation data are preferential sources of information to create a baseline SoA for each PAI. As described in section 1.11 and listed in Table 1-10, farmer inputs are requested about ALM practices during the 5-year look-back period for each PAI to ensure pre-project management activities are appropriately represented in the baseline SoA. Where preferential sources of data are unavailable, per Box 1 of VM0042 v2.0 and as described in Table 3-4, the Project will default to the use of regional statistical data that conservatively represent unreported quantities and practices during the baseline SoA. Using these data sources, a complete baseline SoA is created to include data for every year in the historic look-back period, per VM0042 v2.0 footnote 4.

Regionally appropriate default values are defined using country specific statistical data for the adoption rates of discrete agricultural practices, or proportions of coverage over arable land area. When required to complete a baseline SoA, default values are selected by using probabilistic measures matched with the possible values a variable could be assigned for a given year. Where possible, the same statistical data sources used in assessing Common Practices are applied. For primary production crop and corresponding yield, publicly available data from the FAO are used, see Table 3-4 for details. Essentially, this approach ensures the PAI's baseline activities are representative of common practices for the region, in cases where more specific attested farmer data are not available. Technical details and an illustrative example of the approach are presented in Appendix 10.

The complete SoA is the central input into the Project approach to quantifying SOC stock change as presented in Section 4.1, as well as project stratification for soil sampling (which serves to initialise the SOC stock change model), as presented in Section 5.3.2.

Table 3-4. Minimum specifications for ALM practices and data collection for the baseline schedule of activities for each PAI.

<table>
<tr><th>ALM Practice</th><th>Practice Variable</th><th>Qualitative/ Quantitative</th><th>Values Applied</th><th>Justification / Explanation</th></tr>
<tr><td><u>Crop planting and harvesting</u></td><td>Primary Production Crop Type(s)</td><td>Qualitative</td><td>
<table>
<tr><th>Crop Functional Groups</th><th>Crop Types</th></tr>
<tr><td>1</td><td>Barley, Beetroot, Borage, Buckweat, Carrot, Cotton, Flax/linseed, Mustard, Oats, Onion, Other non-N-Fixing forage, Phacelia, Potatoe, Quinoa, Rapeseed, Rye, Spinach seeds, sugar beet, Sunflower, Triticale and Wheat</td></tr>
<tr><td>2</td><td>Perennial grasses</td></tr>
<tr><td>3</td><td>Hemp, Maize, Millet and Sorghum</td></tr>
<tr><td>4</td><td>Beans, Clovers, lentil, other legume, Other N-fixing forage, Peas, Sainfoin and Soybean</td></tr>
<tr><td>5</td><td>Alfalfa, Grass-clover mix, Lupine and Vetch</td></tr>
</table>
<table>
<tr><th>Geographic Area / Country</th><th>Crop Functional Groups</th></tr>
<tr><td>Bulgaria</td><td>1, 3, 4, 5</td></tr>
<tr><td>Denmark</td><td>1, 3, 4, 5</td></tr>
<tr><td>Estonia</td><td>1, 3, 4, 5</td></tr>
<tr><td>Latvia</td><td>1, 3, 4, 5</td></tr>
<tr><td>Lithuania</td><td>1, 3, 4, 5</td></tr>
<tr><td>Moldova</td><td>1, 3, 4, 5</td></tr>
<tr><td>Romania</td><td>1, 3, 4, 5</td></tr>
<tr><td>Spain</td><td>1, 3, 4, 5</td></tr>
<tr><td>Ukraine</td><td>1, 3, 4, 5</td></tr>
<tr><td>United Kingdom</td><td>1, 3, 4, 5</td></tr>
</table>
</td><td>Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed.

Where farmer attestation is missing for any year(s) within the baseline SoA, default values for crop types are selected in accordance with the statistical proportions of production crop types in the PAI's region, as aligned with Box 1, option 4 from VM0042 v2.0. Such values are obtained from FAO (faostat_qcl).

Statistical values for the proportions of crop types were computed by analysing the arable land covered by the subset of crops participating in the AgreenaCarbon Project during the 2022 harvest year. The average proportion of land occupied by each unique crop type covers the 5 years SoA preceding the Project start date, from 2017 to 2021.

The Crop Functional Groups (CFGs) in the project were defined using the criteria presented in the Model Validation Report (MVR) according to VMD0053 requirements page 13 Topic 1, which establishes that crops in the project domain can be "grouped into functional groups across crops</td></tr>
</table>

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sharing unique combinations of the following attributes":[7]
• N fixation (Y/N);
• Annual/perennial (A/P) (defined in accordance with the NRCS Conservation Compliance categorization of crops[2]);
• Photosynthetic pathway (C3/C4/CAM);
• Growth form (tree/shrub/herbaceous) (trees and shrubs have woody plant growth, versus herbaceous species that do not grow woody plant material);
• Flooded/not flooded.

Using the criteria mentioned above, the crop species that are found within the projects first instances were categorised into five CFGs based on shared characteristics. See Appendix 10.</td>
</tr>
<tr>
<td></td>
<td>Primary Production Crop Date(s) Planted</td>
<td>Quantitative</td>
<td>Geographic Area (Country): Bulgaria
<table><tr><th>Crop Functional Group</th><th>Crop Planting Dates</th></tr><tr><td>1</td><td>1st March – 31st December</td></tr><tr><td>3</td><td>1st April – 30th June</td></tr><tr><td>4</td><td>1st April – 30th June</td></tr><tr><td>5</td><td>1st April – 30th June</td></tr></table>
Geographic Area (Country): Denmark
<table><tr><th>Crop Functional</th><th>Crop Planting Dates</th></tr></table></td>
<td>Data collected as aligned with Box 1, option 4.

Regional average planting dates, along with the crop yields are determined with Crop Calendars for Europe based on criteria and data from International Production Assessment Division[102,103] as aligned with Box 1, option 4 from VM0042 v2.0. See Appendix 10.</td>
</tr>
</table>

[102] IPAD (2024): Crop Calendars for Europe. International Production Assessment Division (IPAD). Foreign Agricultural Services (FAS) of the United States Department of Agriculture (USDA). Available Online: https://ipad.fas.usda.gov/rssiws/al/crop_calendar/europe.aspx
[103] USDA, Foreign Agricultural Service, International Production Assessment Division, Crop Calendars for Europe: https://ipad.fas.usda.gov/rssiws/al/crop_calendar/europe.aspx

Group	
1	1st March – 31st December
3	1st March – 30th April
4	1st March – 31st October
5	1st March – 30th April

Geographic Area (Country): Estonia

Crop Functional Group	Crop Planting Dates
1	1st March – 31st December
3	1st April – 31st May
4	15th March – 31st October
5	1st April – 31st May

Geographic Area (Country): Latvia

Crop Functional Group	Crop Planting Dates
1	1st March – 31st December
3	1st April – 31st May
4	15th March – 31st October
5	1st April – 31st May

Geographic Area (Country): Lithuania

Crop Functional Group	Crop Planting Dates
1	1st March – 31st December
3	1st April – 31st May
4	15th March – 31st October
5	1st April – 31st May

Geographic Area (Country): Moldova

Crop Functional Group	Crop Planting Dates
1	1st March – 31st December
3	1st April – 30th June

4	1st April – 31st October
5	1st April – 30th April

Geographic Area (Country): Romania

Crop Functional Group	Crop Planting Dates
1	1st March – 31st December
3	1st April – 30th June
4	1st April – 31st October
5	1st April – 30th April

Geographic Area (Country): Spain

Crop Functional Group	Crop Planting Dates
1	1st March – 31st December
3	1st April – 30th June
4	1st March – 15th December
5	1st March – 31st May

Geographic Area (Country): Ukraine

Crop Functional Group	Crop Planting Dates
1	1st March – 31st December
3	1st April – 30th June
4	1st April – 31st October
5	1st April – 30th June

Geographic Area (Country): United Kingdom

Crop Functional Group	Crop Planting Dates
1	1st March – 31st December
3	1st March – 30th April
4	1st March – 31st October
5	1st April – 30th April

	Primary Production Crop Date(s) Harvested/ terminated	Quantitative	Geographic Area (Country): Bulgaria **Crop Functional Group** / **Crop Harvesting Dates** 1 / 1st February – 31st December 3 / 15th May – 15th November 4 / 1st April – 31st October 5 / 1st April – 31st October Geographic Area (Country): Denmark **Crop Functional Group** / **Crop Harvesting Dates** 1 / 1st February – 31st December 3 / 15th May – 31st October 4 / 1st April – 31st October 5 / 15th August – 30th September Geographic Area (Country): Estonia **Crop Functional Group** / **Crop Harvesting Dates** 1 / 1st February – 31st December 3 / 15th August – 15th October 4 / 1st April – 31st October 5 / 15th August – 30th September Geographic Area (Country): Latvia **Crop Functional Group** / **Crop Harvesting Dates** 1 / 1st February – 31st December 3 / 15th August – 15th October 4 / 1st April – 31st October 5 / 1st October – 31st November Geographic Area (Country): Lithuania	Data collected as aligned with Box 1, option 4. Regional average harvest dates, along with the crop yields are determined with Crop Calendars for Europe based on criteria and data from International Production Assessment Division (IPAD, 2024)[104], as aligned with Box 1, option 4 from VM0042 v2.0.

[104] IPAD (2024): Crop Calendars for Europe. International Production Assessment Division (IPAD). Foreign Agricultural Services (FAS) of the United States Department of Agriculture (USDA). Available Online: https://ipad.fas.usda.gov/rssiws/al/crop_calendar/europe.aspx

Crop Functional Group	Crop Harvesting Dates
1	1st February – 31st December
3	15th May – 15th October
4	1st April – 31st October
5	1st April – 31st October

Geographic Area (Country): Moldova

Crop Functional Group	Crop Harvesting Dates
1	1st February – 31st December
3	15th May – 15th November
4	1st April – 31st October
5	1st April – 31st October

Geographic Area (Country): Romania

Crop Functional Group	Crop Harvesting Dates
1	1st February – 31st December
3	15th April – 15th November
4	1st April – 31st October
5	15th September – 31st October

Geographic Area (Country): Spain

Crop Functional Group	Crop Harvesting Dates
1	1st February – 31st December
3	15th April – 15th November
4	1st April – 31st October
5	1st April – 31st October

Geographic Area (Country): Ukraine

Crop Functional Group	Crop Harvesting Dates
1	1st March – 15th Aug

			3 | 1st April – 15th April 4 | 1st April – 15th April 5 | 1st April – 15th April Geographic Area (Country): United Kingdom Crop Functional Group | Crop Harvesting Dates 1 | 1st February – 31st December 3 | 15th July – 15th September 4 | 1st April – 31st October 5 | 15th August – 31st September	
	Primary Production Crop yield	Quantitative	Geographic Area (Country): Bulgaria Crop Functional Group | Crop Yield (t /ha) 1 | 0.7 t /ha – 23 t /ha 3 | 1.0 t /ha – 21 t /ha 4 | 0.4 t /ha – 7 t /ha 5 | 1.3 t /ha – 10.6 t /ha Geographic Area (Country): Denmark Crop Functional Group | Crop Yield (t /ha) 1 | 0.5 t /ha – 44 t /ha 3 | 0.5 t /ha – 60 t /ha 4 | 2.4 t /ha – 11.5 t /ha 5 | 2.4 t /ha – 89 t /ha Geographic Area (Country): Estonia Crop Functional Group | Crop Yield (t /ha) 1 | 0.5 t /ha – 43 t /ha	Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for crop yields are selected in accordance with the statistical average values for crop yields in the PAI's region, as aligned with Box 1, option 4 from VM0042 v2.0. Such averages are derived from values retrieved from the FAO (*faostat_qcl*)[105] and Eurostat (*apro_cp; apro_acs*) databases[106], covering the 5-year baseline SoA preceding the Project start date, from 2017 to 2021.

[105] https://www.fao.org/faostat/en/#data/QCL
[106] https://ec.europa.eu/eurostat/databrowser/view/apro_cpshr/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.apro_cpsh

3	0.5 t /ha – 26 t /ha
4	1.8 t /ha – 11 t /ha
5	2.4 t /ha – 32 t /ha

Geographic Area (Country): Latvia

Crop Functional Group	Crop Yield (t /ha)
1	0.5 t /ha – 27 t /ha
3	0.5 t /ha – 32 t /ha
4	1.9 t /ha – 11.6 t /ha
5	1.6 t /ha – 32 t /ha

Geographic Area (Country): Lithuania

Crop Functional Group	Crop Yield (t /ha)
1	0.7 t /ha – 23 t /ha
3	1.0 t /ha – 21 t /ha
4	1.4 t /ha – 14 t /ha
5	1 t /ha – 16.5 t /ha

Geographic Area (Country): Moldova

Crop Functional Group	Crop Yield (t /ha)
1	0.5 t /ha – 61 t /ha
3	1 t /ha – 33 t /ha
4	0.4 t /ha – 7.4 t /ha
5	1.1 t /ha – 13.4 t /ha

Geographic Area (Country): Romania

Crop Functional Group	Crop Yield (t /ha)
1	0.5 t /ha – 39 t /ha
3	1.0 t /ha – 26 t /ha
4	0.4 t /ha – 3.4 t /ha
5	1.1 t /ha – 3.7 t /ha

Geographic Area (Country): Spain

Crop Functional Group	Crop Yield (t /ha)
1	0.5 t /ha – 87 t /ha
3	1.0 t /ha – 37 t /ha
4	0.4 t /ha – 5.6 t /ha
5	0.9 t /ha – 24 t /ha

Geographic Area (Country): Ukraine

Crop Functional Group	Crop Yield (t /ha)
1	0.5 t /ha – 62 t /ha
3	0.5 t /ha – 34.6 t /ha
4	0.2 t /ha – 13.4 t /ha
5	1.4 t /ha – 21.3 t /ha

Geographic Area (Country): United Kingdom

Crop Functional Group	Crop Yield (t /ha)
1	0.5 t /ha – 66 t /ha
3	0.5 t /ha – 40 t /ha
4	2.4 t /ha – 11.6 t /ha
5	2.4 t /ha – 32.3 t /ha

	Cover/ Intermediate Crop Type(s)	Qualitative		Data collected obtained through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for cover crop adoption rates are derived from average cover/intermediate crop areas within the PAI's region, as aligned with Box 1, option 4 from

Cover Crop Type	Months of green cover	Seeded	Terminated
None	0	n/a	n/a
Spring Cover Crop	5	After summer harvest	Before Spring Planting
Winter Cover Crop	3	After summer harvest	Before Winter for Spring Planting
Catch Crop	2	After summer harvest	Before Autumn Planting

			<table><tr><th>Geographic Area / Country</th><th>Cover Crop Type</th></tr><tr><td>Bulgaria</td><td>None; Spring Cover Crop; Winter Cover crop; Catch Crop</td></tr><tr><td>Denmark</td><td>None; Spring Cover Crop; Winter Cover crop</td></tr><tr><td>Estonia</td><td>None</td></tr><tr><td>Latvia</td><td>None; Winter Cover crop</td></tr><tr><td>Lithuania</td><td>None; Spring Cover Crop; Winter Cover crop</td></tr><tr><td>Moldova</td><td>None; Spring Cover Crop; Winter Cover crop; Catch Crop</td></tr><tr><td>Romania</td><td>None; Spring Cover Crop; Winter Cover crop</td></tr><tr><td>Spain</td><td>None; Winter Cover crop</td></tr><tr><td>Ukraine</td><td>None; Spring Cover Crop; Winter Cover crop</td></tr><tr><td>United Kingdom</td><td>None; Spring Cover Crop; Winter Cover crop; Catch Crop</td></tr></table>	VM0042 v2.0. Such values are obtained from the Eurostat database (*ef_mp_soil; sc_cov_intcr*). The derivation of the share of arable land having cover crops in the Project area is found in Section 3.5.3 and is representative of the latest data aligned with the 5-year baseline SoA preceding the Project start date, from Eurostat 2016. When default factors of cover cropping occur, it is further assumed that the farmer planted cover crops until spring as a conservative estimate. Intermediate crop types of spring and winter cover crops and catch crops are defined based on criteria and data from International Production Assessment Division[107]
	Cover/ Intermediate Crop Date(s) Planted	Quantitative	<table><tr><th>Geographic Area / Country</th><th>Cover Crop Planted Dates</th></tr><tr><td>Bulgaria</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr><tr><td>Denmark</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr><tr><td>Estonia</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr><tr><td>Latvia</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr><tr><td>Lithuania</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr><tr><td>Moldova</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr><tr><td>Romania</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr><tr><td>Spain</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr><tr><td>Ukraine</td><td>Dependent on the 'Primary Crop Terminated dates' in Table 3-4</td></tr></table>	Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed. Where farmer attestation is missing for any year(s) within the baseline SoA, it is assumed that the farmer planted cover crops until spring. Intermediate crops are dependent on the termination/harvest of the primary crop in order to be planted. Therefore, the cover crop planting dates were assumed to be < 1 month after the harvest of the most common crop type in that region, as determined in Crop Calendars for Europe based on criteria and data from International Production

[107] IPAD (2024): Crop Calendars for Europe. International Production Assessment Division (IPAD). Foreign Agricultural Services (FAS) of the United States Department of Agriculture (USDA). Available Online: https://ipad.fas.usda.gov/rssiws/al/crop_calendar/europe.aspx

			United Kingdom: Dependent on the 'Primary Crop Terminated dates' in Table 3-4	Assessment Division[108]. in alignment with Box 1, option 4 in VM0042 v2.0.
	Cover/ Intermediate Crop Date(s) Harvested/terminated	Quantitative	Geographic Area / Country: Cover Crop Planted Dates Bulgaria: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 Denmark: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 Estonia: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 Latvia: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 Lithuania: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 Moldova: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 Romania: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 Spain: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 Ukraine: Dependent on the 'Primary Crop Terminated dates' in Table 3-4 United Kingdom: Dependent on the 'Primary Crop Terminated dates' in Table 3-4	Data collected-through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed. Where farmer attestation is missing for any year(s) within the baseline SoA, it is assumed that the farmer harvested cover crops until spring. Intermediate crops are dependent on the planted dates of the primary crop in order to be terminated/harvested. Therefore, the cover crops are assumed to be terminated < 1 month before the planting of the most common crop type in that region, as determined in Crop Calendars for Europe[109] , in alignment with Box 1, option 4 in VM0042 v2.0.
	Cover/ Intermediate Crop yield	Quantitative	N/A; this value is not measured.	Cover/Intermediate Crop yield is not used in any Quantification Approach applied in the Agreena Project.
Organic Fertiliser Application	*Manure/ Compost (Y/N)*	Qualitative	Geographic Area / Country: Manure/ Compost Application Bulgaria: Y/N Denmark: Y/N	Data collected through farmer signed attestation as aligned with Box 1, option 1, then option 4 in Box 1 is followed.

[108] IPAD (2024): Crop Calendars for Europe. International Production Assessment Division (IPAD). Foreign Agricultural Services (FAS) of the United States Department of Agriculture (USDA). Available Online: https://ipad.fas.usda.gov/rssiws/al/crop_calendar/europe.aspx
[109] USDA, Foreign Agricultural Service, International Production Assessment Division, Crop Calendars for Europe: https://ipad.fas.usda.gov/rssiws/al/crop_calendar/europe.aspx

			Estonia: Y/N Latvia: Y/N Lithuania: Y/N Moldova: Y/N Romania: Y/N Spain: Y/N Ukraine: Y/N United Kingdom: Y/N	Where farmer attestation is missing for any year(s) within the baseline SoA, default values determining whether organic fertiliser was applied are selected in accordance with the statistical values representing the rate of adoption of organic fertilisers within the PAI's region, as aligned with Box 1, option 4 from VM0042 v2.0. Such values are obtained from the FAO database (*faostat_esb*), using data covering the 5-year baseline SoA from 2016 to 2021. The derivation of the share of arable land applying organic fertiliser for regions in the Project area, and hence the adoption rate of organic fertilisers is found in Section 3.5.3.
	Manure/ Compost type	Qualitative	**Geographic Area / Country** / **Manure / Compost Type** Bulgaria: Manure Fertiliser Denmark: Manure Fertiliser Estonia: Manure Fertiliser Latvia: Manure Fertiliser Lithuania: Manure Fertiliser Moldova: Manure Fertiliser Romania: Manure Fertiliser Spain: Manure Fertiliser Ukraine: Manure Fertiliser United Kingdom: Manure Fertiliser	Data collected through farmer signed attestation as aligned with Box 1, option 1, then option 4 in Box 1 is followed. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for the organic fertiliser type are selected in accordance with the statistical values for the use of different manure types in the PAI's region, as aligned with Box 1, option 4 from VM0042 v2.0. Such values are obtained from the FAO database (*faostat_esb*) using data covering the 5-year baseline SoA from 2016 to 2021.

<table>
<tr>
<td></td>
<td>Manure/ Compost application rate</td>
<td>Quantitative</td>
<td>
<table>
<tr><th>Geographic Area / Country</th><th>Manure application rate</th></tr>
<tr><td>Bulgaria</td><td>104.0 kg N/ha</td></tr>
<tr><td>Denmark</td><td>144.0 kg N/ha</td></tr>
<tr><td>Estonia</td><td>104.0 kg N/ha</td></tr>
<tr><td>Latvia</td><td>104.0 kg N/ha</td></tr>
<tr><td>Lithuania</td><td>104.0 kg N/ha</td></tr>
<tr><td>Moldova</td><td>104.0 kg N/ha</td></tr>
<tr><td>Romania</td><td>104.9 kg N/ha</td></tr>
<tr><td>Spain</td><td>154.1 kg N/ha</td></tr>
<tr><td>Ukraine</td><td>104.0 kg N/ha</td></tr>
<tr><td>United Kingdom</td><td>169.7 kg N/ha</td></tr>
</table>
</td>
<td>Data collected through farmer signed attestation as aligned with Box 1, option 1, then option 4 in Box 1 is followed.

Where farmer attestation is missing for any year(s) within the baseline SoA, default values were derived from regional statistics using the EuropeAgriDB v1.0[110] and Eurostat (lan_lcv_ovw)[111] databases.</td>
</tr>
<tr>
<td><u>Inorganic Nitrogen Fertiliser Application</u></td>
<td>Synthetic N fertiliser (Y/N)</td>
<td>Qualitative</td>
<td>
<table>
<tr><th>Geographic Area / Country</th><th>Synthetic N fertiliser application</th></tr>
<tr><td>Bulgaria</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>Denmark</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>Estonia</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>Latvia</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>Lithuania</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>Moldova</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>Romania</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>Spain</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>Ukraine</td><td>Synthetic N fertiliser Y/N</td></tr>
<tr><td>United Kingdom</td><td>Synthetic N fertiliser Y/N</td></tr>
</table>
</td>
<td>Data collected through farmer signed attestation as aligned with Box 1, option 1, then option 4 in Box 1 is followed.

Where farmer attestation is missing for any year(s) within the baseline SoA, default values determining whether synthetic fertiliser was applied are selected in accordance with the rate of adoption of synthetic fertilisers within the PAI's region, as aligned with Box 1, option 4 from VM0042 v2.0. Such values are obtained from the FAO database (faostat_esb) using data covering the 5-year baseline SoA from 2016 to 2021.

The derivation of the share of arable land applying synthetic fertiliser for countries in the Project area, and hence the adoption rate of inorganic fertilisers is found in Section 3.5.3.</td>
</tr>
</table>

[110] https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772
[111] https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw__custom_12738492/default/table

<table>
<tr><td></td><td></td><td></td><td></td><td>The statistical values derived for the PAI's region are used to define default values in accordance with the methodology described in Appendix 10</td></tr>
<tr><td></td><td>N application rate in synthetic fertiliser</td><td>Quantitative</td><td><table><tr><th>Geographic Area / Country</th><th>Synthetic N fertiliser application rate</th></tr><tr><td>Bulgaria</td><td>170.0 kg N/ha</td></tr><tr><td>Denmark</td><td>200.0 kg N/ha</td></tr><tr><td>Estonia</td><td>170.0 kg N/ha</td></tr><tr><td>Latvia</td><td>170.0 kg N/ha</td></tr><tr><td>Lithuania</td><td>170.0 kg N/ha</td></tr><tr><td>Moldova</td><td>170.0 kg N/ha</td></tr><tr><td>Romania</td><td>124.5 kg N/ha</td></tr><tr><td>Spain</td><td>138.5 kg N/ha</td></tr><tr><td>Ukraine</td><td>170.0 kg N/ha</td></tr><tr><td>United Kingdom</td><td>230.7 kg N/ha</td></tr></table></td><td>Data collected through farmer signed attestation as aligned with Box 1, option 1, then option 4 in Box 1 is followed.

Where farmer attestation is missing for any year(s) within the baseline SoA, default values as presented in the parallel table per geographic area/ country. The values used are derived from the EuropeAgriDB v1.0[112] and Eurostat (lan_lcv_ovw)[113] databases.

To ensure conservativeness, the default application rate value is further reduced by 5%, resulting in a baseline SoA that already accounts for the minimum quantitative change required as a Practice Activity per VM0042 v2.0 Section 2.

Functionally, this means that, in the case these default values are used, a PAI will need to demonstrate a reduction in synthetic fertilisation rates of at least 9.75% less than the regional average to qualify as a Practice Activity.</td></tr>
<tr><td><u>Tillage</u></td><td>Tillage Type:
Conventional (Y/N)
Reduced (Y/N)</td><td>Qualitative</td><td><table><tr><th>Geographic Area / Country</th><th>Tillage Types</th></tr><tr><td>Bulgaria</td><td>Conventional (Y/N); Reduced (Y/N)</td></tr><tr><td>Denmark</td><td>Conventional (Y/N); Reduced</td></tr></table></td><td>Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available then option 4 in Box 1 is followed.</td></tr>
</table>

[112] https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772
[113] https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw__custom_12738492/default/table

	No-till (Y/N)			Where farmer attestation is missing for any year(s) within the baseline SoA, default values for tillage are selected in accordance with the statistical proportions of tillage practices in the PAIs region, as aligned with Box 1, option 4 from VM0042 v2.0. Such values are obtained from the Eurostat database (*ef_mp_prac*). The derivation of the share of conventional till, reduced till and no till for countries in the Project area is found in section 3.5.3. The statistical values derived for the PAI's region are used to define default values in accordance with the methodology described in Appendix 10.
	Depth of tillage	Quantitative		Data collected as aligned with Box 1, option 4. Tillage depth is determined directly from the attested Tillage Type in reference to the "Tillage definition manual". All quantitative values applied are presented in the "Tillage definition manual" in Supplementary Information. Refer to Box 1 data hierarchy, item 4.

	(Y/N): No-Tillage (Y/N)
Estonia	Conventional (Y/N); Reduced (Y/N): No-Tillage (Y/N)
Latvia	Conventional (Y/N); Reduced (Y/N): No-Tillage (Y/N)
Lithuania	Conventional (Y/N); Reduced (Y/N): No-Tillage (Y/N)
Moldova	Conventional (Y/N); Reduced (Y/N): No-Tillage (Y/N)
Romania	Conventional (Y/N); Reduced (Y/N): No-Tillage (Y/N)
Spain	Conventional (Y/N); Reduced (Y/N): No-Tillage (Y/N)
Ukraine	Conventional (Y/N); Reduced (Y/N): No-Tillage (Y/N)
United Kingdom	Conventional (Y/N); Reduced (Y/N): No-Tillage (Y/N))

Geographic Area / Country	Tillage depths
Bulgaria	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
Denmark	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
Estonia	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
Latvia	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
Lithuania	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
Moldova	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
Romania	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
Spain	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
Ukraine	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)
United Kingdom	Conventional (>10 cm); Reduced (<= 10 cm): No-Tillage (0 cm)

<table>
<tr><td></td><td>Frequency of tillage</td><td>Quantitative</td><td>NA; this value is not measured.</td><td>Frequency of tillage is not used in any Quantification Approach applied in this Project.</td></tr>
<tr><td></td><td>Percent of soil area disturbed</td><td>Quantitative</td><td>NA; this value is not measured.</td><td>Percent of soil area disturbed is not used in any Quantification Approach applied in this Project.</td></tr>
<tr><td><u>Residue Management</u></td><td>Crop Residue Management:
- Removed (Y/N)
- Mulched (Y/N)</td><td>Qualitative</td><td><table><tr><th>Geographic Area / Country</th><th>Crop residue management type</th></tr><tr><td>Bulgaria</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>Denmark</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>Estonia</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>Latvia</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>Lithuania</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>Moldova</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>Romania</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>Spain</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>Ukraine</td><td>Removed (Y/N); Mulched (Y/N)</td></tr><tr><td>United Kingdom</td><td>Removed (Y/N); Mulched (Y/N)</td></tr></table></td><td>Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed.

Where farmer attestation is missing for any year(s) within the baseline SoA, default values for residue management are selected in accordance with the statistical proportions of residue management practices in the PAI’s region, as aligned with Box 1, option 4 from VM0042 v2.0. Such values are obtained from the Eurostat database (ef_mp_soil).

The derivation of the share of hectares for countries in the Project area mulching crop residue is found in section 3.5.3.

The statistical values derived for the PAI’s region are used to define default values in accordance with the methodology described in Appendix 10.</td></tr>
<tr><td></td><td>Percent of crop residue removed</td><td>Quantitative</td><td><table><tr><th>Geographic Area / Country</th><th>Percent of crop residue removed by crop type</th></tr><tr><td>Bulgaria</td><td>Removed 75%; Mulching 100%</td></tr><tr><td>Denmark</td><td>Removed 75%; Mulching 100%</td></tr><tr><td>Estonia</td><td>Removed 75%; Mulching 100%</td></tr><tr><td>Latvia</td><td>Removed 75%; Mulching 100%</td></tr><tr><td>Lithuania</td><td>Removed 75%; Mulching 100%</td></tr><tr><td>Moldova</td><td>Removed 75%; Mulching 100%</td></tr><tr><td>Romania</td><td>Removed 75%; Mulching 100%</td></tr><tr><td>Spain</td><td>Removed 75%; Mulching 100%</td></tr><tr><td>Ukraine</td><td>Removed 75%; Mulching 100%</td></tr></table></td><td>Data collected as aligned with Box 1, option 4.

For a given residue management practice value within the baseline SoA, it is assumed that 75% of the residue was removed from a PAI and 100% of the residue is retained when mulched. The value for</td></tr>
</table>

			United Kingdom: Removed 75%; Mulching 100%	removed residue (75%) is a conservative estimate based on recent literature values.[114] [115]
Water Management/ Irrigation	*Irrigation/ Flooding (Y/N)*	Quantitative	NA; this value is not measured.	Not relevant for Project, as water management/irrigation are not in scope.
Grazing Practices	*Grazing(Y/N)*	Quantitative	NA; this value is not measured.	Not relevant for Project, as grazing practices are not in scope.

[114] Scarlat, N., Fahl, F., Lugato, E., Monforti-Ferrario, F., & Dallemand, J. F. (2019). Integrated and spatially explicit assessment of sustainable crop residues potential in Europe. Biomass and Bioenergy, 122, 257-269.
[115] Ingwersen, J., Poyda, A., Kremer, P., & Streck, T. (2024). Harvest residues: A relevant term in the carbon balance of croplands?. *Agricultural and Forest Meteorology*, *349*, 109935.

3.5 Additionality

The Project uses the definition of additionality identified in VM0042 v2.0, which states that a project proponent must demonstrate a regulatory surplus, identify barriers that would prevent the implementation of Project Activities and establish that the adoption of proposed Project Activities is not common practice. The three-step process for determining additionality takes particular care to ensure that the Project is going above the 'business-as-usual' scenario. The three-step additionality test for this Project was conducted considering both country-level differences and their unique contexts as well as European- and regional-level similarities. This was deemed most appropriate for the AgreenaCarbon project- a grouped project operating at a pan-European scale involving ten countries as of its start date- to meet the requirements of Section 7 Additionality of VM0042 v2.0. As per the definition of Geographic Areas specified in Section 1.4 and in alignment with VCS v4.5 3.6.10-3.6.16, The Project has assessed additionality on a per-country, i.e. per Geographic Area, level and therefore each geographic area has one additionality assessment relevant to it.

In summary, the Additionality assessment has demonstrated that; (i) all Project Activities (Table 1-1) comply with regulatory surplus conditions and will continue to be monitored; (ii) the potential barriers identified for all Project Activities have been identified and mitigation actions have been put in place to address them; (iii) and the common practice test is completed for every PAI in the Project, using attested farmer data gathered about ALM practices during the historical look-back period as described in Section 1.11 and listed in Table 1-10. Where applicable, the same data sources are used to create baseline schedules of activities, ensuring pre-project ALM practices are accounted in baseline quantification. See Section 3.4 Baseline Scenario for details.

Following the EuroVoc division, which is based on geographical, institutional, and sociocultural factors, the ten initial countries are grouped as following: Northern Europe, comprising Denmark and the Baltic states of Latvia, Lithuania, and Estonia; Southern Europe, comprising Spain; Western Europe, comprising the United Kingdom; Central & Eastern Europe, comprising Bulgaria, Romania, Ukraine, and Moldova. Please refer to the EuroVoc thesaurus[116] for a complete taxonomy of all European countries. These groupings are used to demonstrate how similar barriers can exist for more than one country in the same region, but are not used as a basis to assess additionality as per VCS v4.5 requirements.

3.5.1 Step 1: Regulatory Surplus

According to methodology, section 3.14.1 of VCS Standard v4.5, "Regulatory surplus means that Project Activities shall not be mandated by any law, statute, or other regulatory framework, or for UNFCCC non-Annex I countries, any systematically enforced law, statute, or other regulatory framework."

[116] https://eur-lex.europa.eu/browse/eurovoc.html?params=72,7206#arrow_914

Within this validation process, the Project is proceeding with the analysis of the ten countries that contain the first instances, and will outline the country classification, followed by the systematic review of legal documents under EU legislation (i.e., CAP) and the UK, Moldova and Ukraine Specific legislation that is part of AgreenaCarbon's Internal Policy Tracker (Appendix 2). The monitoring of the regulatory surplus defines how the Project will run a full analysis in new markets. The Project will undertake this systematic approach and will include the new analysis in future verification reports.

To begin with the assessment, the ten countries were grouped according to the United Nations Framework Convention on Climate Change (UNFCCC) classification (Table 3-5). The Convention divides countries into three main groups:

- *Annex I Parties* – Consists of industrialised countries that were members of the OECD in 1992, plus countries with economies in transition.
- *Annex II Parties* – Consists of the OECD members of Annex I, but not the countries with economies in transition.
- *Non-Annex I Parties* – Mostly developing countries some of which are especially vulnerable to the adverse impacts of climate change.

Table 3-5. UNFCCC Classification of the ten countries in AgreenaCarbon Project

Country	Group	Region	Project activities shall not be:
Bulgaria	Annex I	EU	Mandated
Denmark	Annex I	EU	Mandated
Estonia	Annex I	EU	Mandated
Latvia	Annex I	EU	Mandated
Lithuania	Annex I	EU	Mandated
Moldova	Non-Annex I	Non-EU	Systematically enforced
Romania	Annex I	EU	Mandated
Spain	Annex I	EU	Mandated
Ukraine	Annex I	Non-EU	Mandated
UK	Annex I	Non-EU	Mandated

To identify laws, statutes and regulations that could potentially be mandating the implementation of Project Activities in each one of the ten countries, Agreena performed a comprehensive and

systematic review of legal documents, of which the methodology is described in full detail in Appendix 1.

3.5.1.1 EU Common Agricultural Policy (CAP)

The CAP was one of the first major policies enacted by the European Economic Community, the precursor to the EU. Created by the Treaty of Rome in 1958 and put in place in 1962, its aim was to increase the self-sufficiency of Europe's food system and reduce shortages in the wake of the second world war. The CAP directly contributes to socio-economic objectives such as food security and support to rural communities through the provision of direct income support and includes social safeguards such as provisions to simplify access to CAP support for small farmers or to improve the position of farmers in the value chain.

The CAP is a common policy for all EU countries, and it is managed and funded at European level from the resources of the EU's budget. The CAP funding makes up about one-third of the EU budget during the period 2021-2027. All EU countries have to offer a basic payment, a payment for the climate, environment, and animal welfare to promote sustainable farming practices (eco-schemes). As it is compulsory for EU countries to provide these payments, they are often referred to as obligatory payments. Eco-schemes are obligatory for EU countries to provide to farmers, but voluntary for farmers to participate.

All ten countries in the AgreenaCarbon Project are located in Europe (seven belong to the European Union). In the European region, the agricultural sector is guided by CAP, which provides the rules for and regulates the flows of financial support for the farmers. The CAP has an internal mechanism called cross-compliance or conditionality, which sets a threshold of basic rules to which farmers must comply in order to receive EU income support. The rules are aggregated into two groups:

- Statutory management requirements (SMR), which apply to all farmers whether or not they receive support under the CAP;
- Good agricultural and environmental conditions (GAEC), apply only to farmers receiving support under the CAP. The GAECs are beyond the statutory requirements.[117]

The SMR includes EU rules on public, animal and plant health, animal welfare, and the environment. They do not stipulate any specific farming techniques or any activities of the Project. The GAECs, on the other hand, provide general recommendations on good farming practices, and there is partial complementarity with the Project (see Table 3-6). While adhering to them is a base requirement to receive payments under the CAP, they are voluntary in nature. Therefore, there is no concern under the CAP within the regulatory surplus requirements of Additionality.

[117] The detailed list of requirements was listed in Annex III of Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021. The set of GAEC's defined by the above-mentioned regulations has further national detail interpretations. Which will also be taken into account during the assessment.

Within CAP there are basic income supports (BISS), formerly known as basic payments or single farm payments, that are the foundation of EU's income support to farmers[118]. These foundational payments require the above rules of SMR and GAEC to be followed. Additional schemes, young farmers support and eco-schemes (CAP 2023-2027) are voluntary opportunities to receive funding as farmers within Europe.

Table 3-6. GAECs and their relation to the AgreenaCarbon Project.

GAEC Definition	Agreena Requirement
GAEC 3: Ban on burning arable stubble, except for plant health reasons	This ban was mirrored in the Project entry requirements on prohibiting the burning of residues on the fields.
GAEC 5: Tillage management, reducing the risk of soil degradation and erosion, including consideration of the slope gradient.	The Agreena Project proposes reducing tillage as one of the key project activities that can be implemented in the Project. The intention for reducing tillage is to reduce soil disturbance which reduces the oxidation of carbon stored in the soil structures.
GAEC 6: Minimum soil cover to avoid bare soil in periods that are most sensitive.	AgreenaCarbon includes project activity focusing on providing cover crops as a way to increase biomass input into the soil which is transforming the soil's organic matter.
GAEC 7: Crop rotation in arable land, except for crops growing in or underwater.	Crop rotation is encouraged through cover crops but is not an Agreena requirement.

The GAECs are supplemented by a variety of laws, regulations, and guidelines at member state level. These laws and regulations impose certain obligations on agricultural land management, notably a prohibition to deteriorate soils. However, no GAECs impose obligations to implement any of the activities of the Project. The following table breaks down GAEC 5 and 6, as written per country in the Member States' Strategic Plans, which have been implemented starting 2023. It highlights the variability between countries and difference in outcomes for each as well as the intention of the GAEC, meaning to avoid erosion or sensitivity to weather patterns. Table 3-7 depicts the ways in which the different member states interpret the two GAECs most relevant to the AgreenaCarbon Project Activities definitions.

In the AgreenaCarbon Project it is assumed that all farmers are receiving CAP basic income support, and therefore need to follow the associated rules. The conditions prior to project

[118] https://agriculture.ec.europa.eu/common-agricultural-policy/income-support_en

initiation are incorporated into the historic look-back period for each PAI to determine the baseline, and therefore capturing data on whether any Project Activities occurred before the Project start date. In Section 3.5.3 the common practice assessment includes a regional assessment of the previous practices and allows the Project to understand whether farmers are already implementing these practices in the regions within the Project boundary.

Table 3-7. GAECs across the countries in the AgreenaCarbon Project.

Country	GAEC 5: Tillage	GAEC 6: Ground cover
Bulgaria	Absence of mechanised activities on flooded or waterlogged soils	30% of the soil covered in the Oct to Feb season with roofs crops or residues
Denmark	Areas with an estimated soil erosion risk of 7.5 tonnes soil erosion per ha/year	Dependent on soil type, Denmark must have some portion of the post-Harvest season covered
Estonia	Areas with a slope of more than 10%, appropriate techniques must be used	At least 50% of land must be winter vegetation incl. either intercrops, stubble or plant residues
Latvia	Less tillage in areas with slopes greater than 12%	Depending on the territory different percentages from the period 15 November to 15 February
Lithuania	In areas sensitive to erosion (greater than 12%), it is prohibited to grow certain root crops	November 15 to March 1 at least 50 percent the area of arable land declared by the applicant must be occupied by agricultural plants or uncut stubble or other plant remains
Romania	Less tillage in areas with slopes greater than 12%	20% of the surface area must be protected during the most sensitive period of the year mainly between November 1 and 15 February
Spain	Maximum tillage not to be used on slopes greater than or equal to 10%, unless compensated by terraces	Depending on crop type, plots must have bare soil between October to March on a certain portion of the soil
The Project Definitions	**Conventional Tillage**: working depth of **10cm or more**, on 100% of the soil surface, at any point during the growing season. **Reduced Tillage**: soil disturbance **up to 10cm** (1 - 9.9cm) on 100% of the soil surface. **No Tillage**: the maximum soil disturbance during the entire	**Winter cover crops:** Cover crops sown after the cash crop, which persist until winter conditions become too harsh for them to persist. Winter cover crops provide green cover for approximately four months. For example, a wheat crop is harvested in August, at which time a winter cover crop is sown, germinates, and provides green cover in September, October, November, and December until it eventually dies. In April, pea is sown.

	harvest year was to seeding depth (0-5 cm), without any other tillage or soil disturbance besides that which is necessary to place the seed in the soil.	**Spring cover crops:** Cover crops that are sown after the cash crop, and persist through the winter, until the sowing of the next cash crop in spring. Spring cover crops provide green cover for up to seven months. For example, an oat crop is harvested in August, at which time a cover crop is sown. It germinates and provides green cover starting from September, survives the winter until March, at which time the cover crop is terminated and a pea crop is sown.

In addition to the rules of SMRs and GAECs within the basic income support of CAP, the 2023-2027 CAP also includes Eco-schemes. Eco-schemes involve going beyond the existing GAECs to incorporate specific 'green' farming practices.

To specify and make it clear that eco-schemes, while tracked by the Project, are still not relevant as mandatory requirements even when practices are closely linked. The eco-schemes are not included in the country analysis as they do not threaten the regulatory surplus status due to the voluntary nature. In order to highlight this, the Spanish eco-schemes, which are most relevant to the Project Activities are presented in the box below.

The Spanish Strategic Plan[119] outlining the planned funding for the 2023-2027 CAP specifies several eco-schemes that are closely in line with the activities set out by AgreenaCarbon. The following are the most relevant are as follows:

1) Eco-scheme 4: No tillage and direct seeding on 40% direct seeding on 40% of the arable area
2) Eco-scheme 6: Spontaneous or sown plant cover
3) Eco-scheme 7: Inert cover (mulching) on 40% interrow area available

The objective of these eco-schemes is to improve soil quality, yet the key criterion within the Spanish plan is the requirement that farmers can only opt for one type of practice without the possibility of combining practices. There is also no obligation for farmers to continue after one year. Farmers are rewarded a EUR 25 incentive to continue into the second year, but this incentive is non-binding.[120] While there is a possibility farmers may be electing to conduct the same practices as in AgreenaCarbon, there are nine eco-schemes in total of which they can select one. The nature of the eco-schemes is an important consideration in that the voluntary nature does not affect the regulatory surplus status of the project. The lack of permanence and lack of payment for the specific practice of SOC improvement and measuring it as such

[119] https://www.mapa.gob.es/es/pac/pac-2023-2027/plan-estrategico-pac.aspx
[120] https://ieep.eu/wp-content/uploads/2023/02/Environment-and-climate-assessment-of-Spains-CAP-Strategic-Plan_IEEP-2023.pdf

makes the clear case that farmers in Spain are still well within the framework of regulatory surplus requirements.

The Spanish Strategic Plan highlights the fact that even the most relevant eco-schemes will not affect the additionality of the project, yet they are still examined as a means to track and understand the level of funding reaching farmers from the CAP for the same practices.

3.5.1.2 EU Country Specific Legislations

The specific country outputs related to the GAECs and the number of legislative search hits are presented below. The full analysis and structure of the methodology is included as part of Appendix 2.

Bulgaria

Bulgaria has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **2,549 search hits** came out of the legislative review. After excluding irrelevant documents, a total of **three were left**. None of these laws mandate any of the project activities. Instead, the existing laws set general principles that fail to define specific obligations to implement certain activities (see Appendix 1 for full analysis).

As all EU member states, Bulgaria sets forward incentives for farmers to adopt certain activities. Within the Bulgarian CAP Strategic plan, a list of GAECs and eco-schemes are provided for farmers. The GAECs relevant to the AgreenaCarbon Project, in line with the fact that farmers must implement these in order to be eligible for the voluntary eco-scheme subsidies, are GAEC 5 and 6 on tillage and ground cover, respectively. GAEC 5 sets out to limit tillage operations across the slope or along the horizontals of terrain. In addition, soil disturbance must not occur on flooded or waterlogged soils. GAEC 5 is therefore not relevant as a mandated practice as the desired output from the requirement is to limit erosion and runoff, not to build up carbon in the soil. GAEC 6 sets out to limit bare soil in sensitive periods, specifically it is mandatory to include a minimum of 30% of overwintering crops on PAIs over 10 ha in the form of cover crops or residue from previous crop. As AgreenaCarbon rewards farmers for 100% field coverage and through a strict requirement on when the soils should be covered, this does not constitute a one-to-one crossover between the Bulgarian GAEC 5 and Agreena and is not a mandated requirement.

Denmark

Denmark has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **499 search hits** came out of the legislative review. After excluding irrelevant documents, a total of **two were left**. None of these laws mandate any of the project activities. Instead, the existing laws set general principles that fail to define specific obligations to implement certain activities see Appendix 1 for full analysis).

As all EU member states, Denmark sets forward incentives for farmers to adopt certain activities. Within the Danish CAP Strategic plan, a list of GAECs and eco-schemes are provided for farmers.

GAEC 5 sets out to limit tillage operations through a ploughing ban on areas with a high erosion risk due to water runoff. Alternative approaches can also be taken through laying out of field edges, or fallow areas. GAEC 5 is therefore not relevant as a mandated practice as the desired output from the requirement is to limit erosion and runoff, not to build up carbon in the soil. GAEC 6 sets out to limit bare soil in sensitive periods through the use of a multitude of options including plant remains, fallow crops, natural vegetation, etc. during sensitive periods. All crops are required to be covered from harvest to 1 October, which is well below the AgreenaCarbon requirements for coverage, making GAEC 6 in Denmark outside of the mandatory requirements.

Estonia

Estonia has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **275 search hits** came out of the legislative review. After excluding irrelevant documents, **none were left**. None of these laws mandate any of the project activities. Instead, the existing laws set general principles that fail to define specific obligations to implement certain activities (see Appendix 1 for full analysis).

As all EU member states, Estonia sets forward incentives for farmers to adopt certain activities. Within the Estonian CAP Strategic plan, a list of GAECs and eco-schemes are provided for farmers. GAEC 5 sets out rules to manage areas with a slope higher than 10% through, e.g. growing grasses, protective strips, and/or minimal tillage. As the focus is on sloped areas and allows for multiple options it cannot be verified that it is aligned directly with the AgreenaCarbon project. GAEC 6 sets out to limit bare soil in sensitive periods specifically with requirements for coverage of 50% of arable land and permanent cropland using intercrops, stubble or plant residues. Due to the fact that there is additional flexibility for farmers under the Estonian GAEC 6, there is not enough evidence to point to this as a requirement.

Latvia

Latvia has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **30 search hits** came out of the legislative review. After excluding irrelevant documents, **none were left**. None of these laws mandate any of the project activities. Instead, the existing laws set general principles that fail to define specific obligations to implement certain activities (see Appendix 1 for the full analysis).

As all EU member states, Latvia sets forward incentives for farmers to adopt certain activities. Within the Latvian CAP Strategic plan, a list of GAECs and eco-schemes are provided for farmers. GAEC 5 sets out to limit tillage operations on sloped land of at least 20m and with a gradient of more than 6 degrees or 10.5% should be kept fallow for 1 October to 15 March. The requirement is not in direct alignment with AgreenaCarbon as the objectives and outputs are different and do not focus on carbon. GAEC 6 sets out to limit bare soil in sensitive periods, specifically during the autumn and winter period from 15 November to 15 February with 65% in nitrate sensitive areas. The time periods laid out in GAEC 6 are less strict than under the AgreenaCarbon project and are therefore not comparable.

Lithuania

Lithuania has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **734 search hits** came out of the legislative review. After excluding irrelevant documents a total of **one was left**. This law does not mandate any of the project activities. Instead, this specific law sets general principles that fail to define specific obligations to implement certain activities (see Appendix 1 for the full analysis).

As all EU member states, Lithuania sets forward incentives for farmers to adopt certain activities. Within the Lithuanian CAP Strategic plan, a list of GAECs and eco-schemes are provided for farmers. GAEC 5 sets out to limit tillage operations in areas sensitive to erosion, specifically on slopes steeper than 12% focussing specifically on erosion. GAEC 5 is therefore not relevant as a mandated practice as the desired output from the requirement is to limit erosion and runoff, not to build up carbon in the soil. GAEC 6 sets out to limit bare soil in sensitive periods every year from November 15 to March 1 on a minimum of 50% of arable land declared by the applicant. AgreenaCarbon requires PAIs within the project to be 100% covered when entered into the project and is therefore not comparable to GAEC 6 which is mandated only when farmers want to receive subsidies.

Romania

Romania has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **865 search search hits** came out of the legislative review. After excluding irrelevant documents, a total of **one was left.** This law does not mandate any of the project activities. Instead, this specific law sets general principles that fail to define specific obligations to implement certain activities (see Appendix 1 for the full analysis).

As all EU member states, Romania sets forward incentives for farmers to adopt certain activities. Within the Romanian CAP Strategic plan, a list of GAECs and eco-schemes are provided for farmers. GAEC 5 sets out to limit tillage operations specifically on slopes greater than 12% and with creeping plants along contour lines. This GAEC is focused on reducing the risk of soil degradation and erosion and is therefore not targeting the same objective as Agreena Carbon. GAEC 6 sets out to limit bare soil in sensitive periods on at least 20% of the arable surface of the holding including keeping it fallow. This does not constitute the same practice as under AgreenaCarbon which requires full coverage on PAIs in the project.

Spain

Spain has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **2.144 search hits** came out of the legislative review. After excluding irrelevant documents, a total of **three were left.** None of these laws mandate any of the project activities. Instead, the existing laws set general principles that fail to define specific obligations to implement certain activities (see Appendix 1 for full analysis).

As all EU member states, Spain sets forward incentives for farmers to adopt certain activities. Within the Spanish CAP Strategic plan, a list of GAECs and eco-schemes are provided for farmers. GAEC 5 sets out to limit tillage operations on sloped lands greater than or equal to 10 percent and are subject to degradation and erosion and is therefore not targeting the same practice. In addition, it is required to till only in a certain direction on sloped fields. GAEC 6 sets out to limit bare soil in sensitive periods and in sensitive areas that are predefined. The definitions laid out by the Spanish plan are not in line with the requirements under AgreenaCarbon and are therefore not shown to be mandated.

3.5.1.3 Non-EU Country Specific Legislation

United Kingdom

The United Kingdom was a member of the EU since 1973 and since then was fully participating in the evolution of the CAP. The UK left the EU on 31 January 2020 which did not provide any rapid changes in the agricultural policy. The government of Great Britain has introduced a transitional period with the system of GAECs remaining valid until 2024. In the meantime, the UK works to develop a new set of similar GAEC basic conditions for farmers. Agreena monitors the regulatory landscape of UK and if needed the Project documentation would be adjusted.

The role of the GAECs is the same as in the EU context, i.e., to provide farmers with guidance aiming to reduce the impact of agricultural production on the environment. Meeting the guidance set in the GAEC's is voluntary for the farmer. Besides lack of access to public funding, there are not any consequences for farmers if they do not uptake the practices. The UK regulations are strictly for promoting soil health management and therefore the project activities proposed by Agreena are above the regulatory obligation that farmers across the UK need to follow.

The United Kingdom has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **510 search hits** came out of the legislative review. After excluding irrelevant documents, a total of **three were left.** None of these laws mandate any of the project activities. Instead, the existing laws set general principles that fail to define specific obligations to implement certain activities.

Moldova

Moldova is a non-EU country and a non-Annex I country and shall be considered as less developed in terms of the agri-environmental policy compared to the EU countries. Therefore, its regulations related to agriculture are focusing on land ownership and water management. In other words, there are no mandates within Moldova for on-farm practices that make them ineligible for funding or the like. The Project is the only incentive mechanism pushing farmers in these countries to change to new practices such as reduced tillage or cover cropping. Nevertheless, the full country scoping of laws is still conducted as part of the Project internal processes.

Moldova has over the years adopted a variety of laws and regulations to set environmental standards for farming. A total of **92 search hits** came out of the legislative review. After excluding

irrelevant documents, **none were left.** None of these laws mandate any of the project activities. Instead, the existing laws set general principles that fail to define specific obligations to implement certain activities (see Appendix 1 for the full analysis).

Ukraine

Similarly to Moldova, Ukraine is not governed by the CAP, yet the full scoping of the policies using the keywords was done for Ukraine. A total of **628 search hits** came out of the legislative review. After excluding irrelevant documents **two were left.** None of these laws mandate any of the project activities. Instead, the existing laws set general principles that fail to define specific obligations to implement certain activities (see Appendix 1 for the full analysis).

3.5.1.4 Monitoring and Maintenance of Regulatory Surplus

The regulatory analysis has demonstrated that the Project Activities are not mandated by any EU law, statute, or other regulatory framework. Therefore, the Project complies with the Regulatory Surplus requirement under the Additionality definition of VCS Standard v4.5.

The laws, statutes and regulatory frameworks that govern agricultural practices can vary significantly between each European member state and even between their states and provinces. These regulations are constantly evolving, and the Project will map and analyse them over time for each of the individual member states. This is carried out by the Internal Policy Tracker which is maintained by the Regulatory and Standards Affairs Team at Agreena.

Also, relevant laws, statutes, and regulatory frameworks will be addressed as the Project continues to expand to other countries, and as regulations continue to evolve over time. In each case, a new detailed country assessment of the regulatory surplus requirement will be attached to the monitoring report.

3.5.2 Step 2: Identify Barriers

According to VM0042 v2.0 methodology, Project proponents must "determine [...] cultural and/or social barriers" to implementation of Project Activities in the area(s) of interest. Various institutional, social, economic and cultural barriers to adoption of regenerative, sustainable, and agro-ecological farming practices were identified via literature review in the ten countries the AgreenaCarbon Project takes place in, and are presented below along with relevant references. As outlined in Section 3.5, the EuroVoc division has been applied for this analysis.

The following table (3-8) summarises the key barriers to diffusion of regenerative and sustainable farming practices across the ten countries the Project takes place, as described in peer-reviewed literature. Although behavioural and normative barriers are of social nature, they have been categorised separately. Moreover, only the barriers that have been explicitly mentioned by the literature to be applicable in a given country are here reported with the letter Y, or 'yes'. However, that is not to say that the barriers not signalled by Y are certainly not present in a given country, since exhaustive peer-reviewed research is not currently available.

Table 3-8: Overview and summary of key barriers to regenerative agriculture diffusion across the ten countries in which the AgreenaCarbon Project takes place.

Key Barriers		Northern Europe				Southern Europe	Western Europe	Central and Eastern Europe			
		LV	LT	EE	DK	ES	UK	UA	MD	RO	BG
Social	Unwillingness and distrust towards collaboration and cooperation	Y	Y					Y	Y	Y	Y
	Lack of social networks and capital	Y	Y	Y		Y			Y	Y	Y
	Demographic crisis (declining and ageing population, low entry of young and female farmers)	Y	Y	Y	Y	Y	Y		Y		Y
	Land fragmentation							Y	Y		
	Lack of skilled workers									Y	

		Y					Y				
Behavioural	Negative attitudes and beliefs	Y	Y			Y			Y		
	Lack of interest in ecological issues/sustainable farming		Y	Y					Y	Y	Y
	Traditionalistic mindset				Y	Y	Y	Y	Y	Y	
	Lack of farmers entrepreneurship and long-term vision		Y					Y	Y		Y
	Risk and change aversion		Y		Y	Y	Y	Y	Y	Y	Y
Institutional	Lack of supportive policies and regulatory tools	Y	Y	Y	Y	Y	Y	Y		Y	Y
	Lack of political agenda	Y		Y						Y	
	Lack of public technical										

	advisory services	Y	Y	Y		Y	Y			Y	
Knowledge	Lack of Knowledge and skills	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Lack of Educational opportunities	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Economic	Lack of market incentive		Y	Y	Y	Y	Y	Y	Y		Y
	Lack of financial resources							Y	Y		

As exemplified by Table 3-8, there are clear commonalities between barriers across the ten countries. Most notably, a demographic crisis, low knowledge and lack of educational opportunities, lack of information sharing channels (e.g., governmental advisory bodies, peer-to-peer social networks), lack of institutional support or market incentives, and aversion to risk-taking and innovating traditional farming practices. The latter is potentially interlinked with the overall decline in farmers' number and their ageing, caused in turn by rural out-migration and barriers to entry to female and young farmers, who are more prone to challenge conventional farming practices and engage with ecological agricultural practices than older cohorts[121].There are potential synergies and feedback loops between the most common barriers to regenerative agriculture diffusion[122]. The sections below present barriers to regenerative agriculture diffusion in each country across the four European regions Agreena operates in.

3.5.2.1 Northern Europe

Lithuania

Social barriers in Lithuania include the European-wide farmer demographic crisis: an overall decline in numbers accompanied by an increase in average age of farmers, underlined by barriers to entry to new, young and female farmers (who are on average more willing to explore non-traditional farming practices).[123,124] Moreover, the cooperation amongst farmers was found to be low.[125] Given the importance of social networks and inter-farmer interactions for the diffusion of no-tillage and other agroecological practices,[126] this lack of social capital constitutes an important barrier to regenerative agriculture diffusion in Lithuania. An additional social barrier is the mindset of Lithuanian consumers, who are disinterested in sustainable agricultural products, leading to minimal market and social incentives to transition away from traditional farming, and a generalised negative and/or indifferent view of sustainable agriculture.[127]

[121] Lozada, L.M., Karley, A. (2022) The Adoption of Agroecological Principles in Scottish Farming and their Contribution towards Agricultural Sustainability and Resilience. The James Hutton Institute, UK
[122] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[123] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1-5
[124] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[125] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[126] Skaalsveen, K., Ingram, J., & Urquhart, J. (2020). The role of farmers' social networks in the implementation of no-till farming practices. Agricultural Systems, 181, 102824. https://doi.org/10.1016/j.agsy.2020.102824
[127] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

Behavioural barriers include disinterest in innovating farms' business models and/or production methods. The path-dependency of Lithuanian farmers is interlinked with "farmers fatigue": they feel isolated and unmotivated, with no long-term vision for their farms[128]. Given that the economic, agronomic and environmental benefits of agro-ecological and regenerative agriculture practices appear in a medium- to long-term time frame, these are important normative and psychological barriers. Farmers fatigue is likely fostered by institutional barriers: insufficient institutional support to initiate transition to regenerative ALM practices, with the Lithuanian regulatory landscape presenting low promotion and incentivisation of ecological farming, and no clear political agenda.[129]

Lastly, there is a low level of knowledge on sustainable farming amongst farmers and existing advisory farming bodies.[130,131] Not unlike other European farmers, practical and on-the-farm experience constitutes the main bulk of training for Lithuanian farmers[132] while peer-to-peer social learning is a main avenue for knowledge and innovation diffusion.[133] However, since in Lithuania farmers tend to avoid collaboration, there is a clear blockage to sharing experiences of no-tillage and other sustainable ALM practices.[134]

Latvia

Social and behavioural barriers are similar to the Lithuanian ones: an ageing and decreasing farmer population, with little inter-generational turnover, and a culture of non-cooperation, of aversion to collaboration also by joining sector associations.[135,136] As discussed before, this in turn hampers the peer-to-peer learning and knowledge diffusion process known to foster large-scale adoption of regenerative agriculture approaches.

[128] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[129] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[130] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[131] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1-5
[132] https://www.europarl.europa.eu/RegData/etudes/BRIE/2017/608788/EPRS_BRI(2017)608788_EN.pdf
[133] Skaalsveen, K., Ingram, J., & Urquhart, J. (2020). The role of farmers' social networks in the implementation of no-till farming practices. Agricultural Systems, 181, 102824. https://doi.org/10.1016/j.agsy.2020.102824
[134] Rust, Niki A et al. (2021): *Have Farmers Had Enough of Experts?* Environmental management (New York) 69.1 (2021): 31–44. https://link.springer.com/content/pdf/10.1007/s00267-021-01546-y.pdf
[135] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[136] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1-5

Institutional barriers include lack of incentives, targeted policy goals, and institutional support to farmers who want to change their conventional practices.[137] Moreover, partnerships between public and private actors within the agricultural sector are neither frequent nor thorough, and discussion arenas are lacking.[138]

As identified in the literature, many farmers are not knowledgeable about regenerative agriculture practices, their benefits, or agri-environmental schemes.[139] The advisory service for sustainable farming is provided by the same body offering advice on conventional agriculture, indicating that there is no experts' know-how and support readily available to Latvian farmers interested in regenerative agriculture practices. Also, there is little practice-specific training for the soft and hard skills necessary to adopt non-traditional practices,[140] leading to a lack of skilled farm workers.

Estonia

Despite the existence of multiple producers' organisations for organic farming, membership was as low as 10% in 2013[141] suggesting (a) a generalised disinterest towards non-conventional sustainable farming practices, and (b) unwillingness to cooperate with peers. These social barriers may be fostered by insufficient institutional support, lack of financial incentives to adopt sustainable farming practices, and low political willingness to explore non-traditional agronomic approaches.[142,143]

Institutional barriers are accompanied by low level of knowledge regarding sustainable farming practices, and of educational opportunities.[144,145] Like in many other European countries, Estonian farmers are living through a demographic crisis. As stated before, the skewed age

[137] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1-5
[138] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1-5
[139] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1-5
[140] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[141] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1-5
[142] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1-5
[143] Rust, Niki A et al. (2020): Social capital factors affecting uptake of sustainable soil management practices: a literature review https://library.wur.nl/WebQuery/wurpubs/fulltext/530470
[144] https://www.europarl.europa.eu/RegData/etudes/BRIE/2017/608788/EPRS_BRI(2017)608788_EN.pdf
[145] Novak, Z., Fekete-Farkas, M., & Szu cs I. (2005). Challenges and barriers of sustainable development of agriculture in the Central and Eastern European Countries. Management and Sustainable Development, 12.

structure is not conducive to regenerative farming diffusion because younger generations are more open to innovate traditional farming practices.[146,147]

Denmark

Like other European countries, Danish farmers have a skewed age structure, with underrepresented young farmers (<35 y.o.) and issues of generational renewal.[148] The conservative attitudes displayed by most Danish farmers, who take pride in upholding the traditional farming practices transmitted in their families, underlies yet another social barrier: high caution and risk aversion.[149]

Another key barrier is lack of knowledge, with limited targeted research efforts and opportunities for specialised training or education.[150] Only one farmer school in Denmark offers a curriculum covering regenerative agriculture from an agronomic perspective, but without a marked focus on the climate and biodiversity aspects.[151] The lack of awareness about the benefits of regenerative agriculture extends to consumers, who do not generally appreciate the ecological co-benefits of these practices, thus limiting the opportunity for market differentiation and resulting consumer-driven market incentives. An important institutional barrier is lack of targeted subsidies, legislative instruments and policy support, which are geared mostly towards the needs of conventional and organic agriculture.[152]

3.5.2.2 Southern Europe

Spain

Spanish farmers face two main institutional barriers. Firstly, there is an overall lack of policies and regulatory instruments that could support agro-ecological practices diffusion across the

[146] Larsson, M., Morin, L., Hahn, T., & Sandahl, J. (2013). Institutional barriers to organic farming in Central and Eastern European countries of the Baltic Sea region. Agricultural and Food Economics, 1(1). https://doi.org/10.1186/2193-7532-1

[147] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

[148] https://www.europarl.europa.eu/RegData/etudes/STUD/2015/540374/IPOL_STU(2015)540374_EN.pdf

[149] Jameson, P., Midtiby, L., Walbom, L., Skovgård Moller, S., & Mikkelsen J. (2024). The Potential of Regenerative Agriculture in Denmark. Available at: https://web-assets.bcg.com/a0/71/59d6ae4f40c4a8b81bfecba3afd7/bcg-the-potential-of-regenerative-agriculture-in-denmark-feb-2024.pdf

[150] Jameson, P., Midtiby, L., Walbom, L., Skovgård Moller, S., & Mikkelsen J. (2024). The Potential of Regenerative Agriculture in Denmark. Available at: https://web-assets.bcg.com/a0/71/59d6ae4f40c4a8b81bfecba3afd7/bcg-the-potential-of-regenerative-agriculture-in-denmark-feb-2024.pdf

[151] https://regenerativ.dk/den-regenerative-jordbrugsskole/

[152] Jameson, P., Midtiby, L., Walbom, L., Skovgård Moller, S., & Mikkelsen J. (2024). The Potential of Regenerative Agriculture in Denmark. Available at: https://web-assets.bcg.com/a0/71/59d6ae4f40c4a8b81bfecba3afd7/bcg-the-potential-of-regenerative-agriculture-in-denmark-feb-2024.pdf

peninsula.[153,154] Then, existing policies often present rigid applicability criteria, making them unsuitable to small-scale projects, plus an administrative and bureaucratic complexity such to dissuade farmers from engaging with sustainable farming.[155]

From a social and behavioural barrier perspective, new, young and female entrants face severe barriers to work in the agricultural sector. The existing farmer population is composed mostly of older age groups[156] and is characterised by substantial risk and change aversion,[157] a traditionalist mindset, and widespread negative attitudes towards sustainable farming.[158] A recent study[159] highlighted how the generally negative attitudes of Spanish farmers towards ecological farming practices could be linked to farmers attributing a low personal importance to environmental issues and displaying low eco-centric values. Subpar institutional support goes hand in hand with creating a feeling of loneliness, helplessness, and fear towards change among farmers.[160]

Another important barrier is the limited availability of technical knowledge on good agroecological practices (e.g., soil management) and their multiple benefits[161] of expert advice, and low social capital, whereby Spanish farmers find difficulty in accessing information from either advisory bodies or their peers.[162]

Additional and similar barriers to adoption of regenerative agriculture are found in other Southern European countries, which have comparable sociocultural and institutional contexts: Italy and

[153] González-Rosado, M., Parras-Alcántara, L., Aguilera-Huertas, J., Lozano-García, B. (2021) Building an agroecological process towards agricultural sustainability: A case study from Southern Spain. Agriculture 11, p. 1024. Available at: https://doi.org/10.3390/agriculture11101024

[154] Palomo-Campesino, S., García-Llorente, M., González, J.A. (2021) Characterizing agroecological and conventional farmers: uncovering their motivations, practices, and perspectives toward agriculture. Agroecology and Sustainable Food Systems 45, 1399–1428. Available at: https://doi.org/10.1080/21683565.2021.1933671

[155] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

[156] https://www.researchgate.net/publication/326415588_Report_on_current_farm_demographics_and_trends

[157] https://www.surefarmproject.eu/wp-content/uploads/2019/04/SURE-Farm-D.2.1-Report-on-farmers-perception-of-risk-and-resilience-capacities.pdf

[158] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategie

[159] Palomo-Campesino, S., García-Llorente, M., González, J.A. (2021) Characterizing agroecological and conventional farmers: uncovering their motivations, practices, and perspectives toward agriculture. Agroecology and Sustainable Food Systems 45, 1399–1428. Available at: https://doi.org/10.1080/21683565.2021.1933671

[160] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

[161] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

[162] Luján Soto, R., Padilla, M.C., Méndez, M.R., Pinto-Correia, T., Boix-Fayos, C., Joris de Vente, J. (2021) Participatory monitoring and evaluation to enable social learning, adoption, and out-scaling of regenerative agriculture. Ecology and Society 26, art29. Available at: https://doi.org/10.5751/ES-12796-260429

Greece. In Greece, peach farmers lamented that there were neither sufficient market incentives nor suitable scientific research to help them transition towards agro-ecological farming; at the same time, there was low trust and willingness to collaborate with other farmers or actors in the agricultural supply chain.[163]. Analogous knowledge, social and institutional barriers were found in Italy. Italian farmers did not feel supported by local authorities in transitioning from a traditional to a ecological-oriented production system. This was linked to a lack of targeted regulatory instruments and education opportunities, without easily accessible and readily available agroecological expert advice.[164,165] The existing sustainable agriculture awareness campaigns and initiatives were criticised for using inaccessible language catered to an expert audience, not farmers[166]. The social structure was found to be insufficient among winemakers in the Chianti region, who displayed aversion to collaborating with their peers. Italian farmers also showed significant risk aversion,[167] an important behavioural barrier.

3.5.2.3 Western Europe

United Kingdom (UK)

Like in many other countries within the pan-European region, British farmers are ageing and decreasing in total numbers[168] with young and female new entrants facing often insurmountable barriers to acquiring and farming land, partially because farm plots are generally passed on among family-members.[169,170]

Such socio-institutional barriers in turn foster cultural barriers: a strong attachment to the traditional practices passed on generation after generation, and an over-reliance on familiar

[163] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[164] Long, T. B., Blok, V., & Coninx, I. (2016). Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy. Journal of Cleaner Production, 112, 9–21. https://doi.org/10.1016/j.jclepro.2015.06.044
[165] Garini, C.S., Vanwindekens, F., Scholberg, J.M.S., Wezel, A., Groot, J.C.J. (2017) Drivers of adoption of agroecological practices for winegrowers and influence from policies in the province of Trento, Italy. Land Use Policy 68, 200–211. Available at: https://doi.org/10.1016/j.landusepol.2017.07.048.
[166] Long, T. B., Blok, V., & Coninx, I. (2016). Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy. Journal of Cleaner Production, 112, 9–21. https://doi.org/10.1016/j.jclepro.2015.06.044
[167] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[168] https://www.researchgate.net/publication/326415588_Report_on_current_farm_demographics_and_trends
[169]https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[170] Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp

approaches with well-established risks and outcomes.[171] Indeed, it is younger and female farmers that are typically more open to risk-taking and exploring innovative approaches like regenerative agriculture to increase farms' long-term sustainability and productivity.[172] By contrast, older farmers are described as somewhat path-dependent, disinterested in changing the ALM practises past generations have honed and maintained.[173] Because a lot of regenerative agriculture knowledge and experience sharing happens through social media platforms[174], older farmers and those located in remote areas or with a poor internet connection may simply be cut out from peer discussions.[175] This can lock farmers in an echo chamber, whereby their social networks, if isolated from new ideas, can prevent them from learning about regenerative farming while reinforcing the prevalence of conventional practices.[176] Plus, if their peers have a starkly negative view of regenerative agriculture, a farmer may be less prone to try such practices to avoid becoming a cast out within its community. A last cultural barrier was identified[177] in the way British farmers perceive their role as food producers. Regenerative farming, which often entails no interference, clashes with the deep-rooted, single-focused historical pressure on farmers to increase their crop yield.

The creation of traditionalists echo chambers is furthered by an overall low level of knowledge and awareness regarding regenerative and/or sustainable agriculture, since the curriculum of most agricultural schools and colleges is not up to date with modern research on such topics.[178]

[171] https://www.surefarmproject.eu/wp-content/uploads/2019/04/SURE-Farm-D.2.1-Report-on-farmers-perception-of-risk-and-resilience-capacities.pdf
[172] Lozada, L.M., Karley, A. (2022) The Adoption of Agroecological Principles in Scottish Farming and their Contribution towards Agricultural Sustainability and Resilience. The James Hutton Institute, UK
[173] Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp
[174] Skaalsveen, K., Ingram, J., & Urquhart, J. (2020). The role of farmers' social networks in the implementation of no-till farming practices. Agricultural Systems, 181, 102824. https://doi.org/10.1016/j.agsy.2020.102824
[175] Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp
[176] Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp
[177] Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp
[178] Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp

A notable exception is the Scotland Rural College (SRUC), which has recently adapted its curriculum to address the country-level shortage of skilled, educated agricultural professionals and labourers.[179]

Lastly, a recent study[180] identified a market & business barrier; farmers can be constrained in their ability to try alternative ALM practices by their leasing agreement. Regenerative farming increases farmers' margins, but the initial investment needed to acquire implements and the potential short-term productivity decrease were deemed too high of a risk by many interviewees.[181]

3.5.2.4 Central & Eastern Europe

Country-specific studies for Bulgaria, Romania, Ukraine and Moldova can be supplemented with research focusing on Hungary and Poland, which share important cultural, political, and socioeconomic similarities common to the Central & Eastern European region.

Generally speaking, farmers from this European region tend to be indifferent if not critical of agro-ecological farming, and display a deep-rooted traditionalistic identity.[182,183] In Hungary, farmers consider conventional ploughing as an intrinsic part of historical soil cultivation practices, hence are resistant to the reduced tilling approach proposed by regenerative farming philosophies[137]. Farmers from both Poland and Hungary report feeling unsupported by governmental institutions, advisory services, supply chain actors, and their local social networks in exploring non-traditional practices, and criticised the lack of specialised learning opportunities.[184,185] Hungarian farmers present a culture of individualism, whereby farmers distrust the idea of collaborating with each

[179] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[180] Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp
[181] Hurley, P.D., Rose, D.C., Burgess., P.J., Staley, J.T. (2023) Barriers and Enablers to Uptake of Agroecological and Regenerative Practices, and Stakeholder Views towards 'Living Labs'. Report from the "Evaluating the productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems" project SCF0321 for DEFRA. 20 February 2023. Cranfield University and UK Centre for Ecology and Hydrology. 33 pp
[182] Barnes, A. P., Thompson, B., & Toma, L. (2022). Finding the ecological farmer: A farmer typology to understand ecological practice adoption within Europe. Current Research in Environmental Sustainability, 4, 100125. https://doi.org/10.1016/j.crsust.2022.100125
[183] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[184] Barnes, A. P., Thompson, B., & Toma, L. (2022). Finding the ecological farmer: A farmer typology to understand ecological practice adoption within Europe. Current Research in Environmental Sustainability, 4, 100125. https://doi.org/10.1016/j.crsust.2022.100125
[185] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

other and agricultural actors, and thus establish social networks for mutual learning and support.[186] It is argued that this cultural trait, shared by many Central and Eastern European countries, can be ascribed to the social trauma of the forced, nationalised collective farming systems of communist and far-left regimes.[187] This constitutes an important cultural barrier to the adoption and development of regenerative agriculture in this geopolitical region. As previously mentioned, farmer-to-farmer social learning is a key mechanism for the diffusion of regenerative agriculture.[188] Without integration in a proactive social network engaged in non-conventional farming practices, and willingness to support each other, farmers are hampered in their transition towards regenerative agriculture.

Bulgaria

Like in all other pan-European countries, the average age of Bulgarian farmers has been increasing, and there are marked out-migration trends from rural to urban areas[189]. The ageing, decreasing farmer population presents low knowledge and awareness of non-traditional farming practices, and is challenged by ever-changing agricultural regulations and market prices[190]. The institutional and market instability pushes farmers to prioritise caution and low risk production systems, plus undermine long-term business planning and vision.

Social barriers include a lack of knowledgeable farm workers and of social capital. Bulgarian farmers are reluctant to engage in peer-to-peer networks, knowledge sharing, and collaboration, and also display high financial risk aversion.[191] In terms of cultural barrier, the vast majority (97%) of Bulgarian farmers were reported to engage in conventional farming practices and to rely on high chemical pesticide and fertiliser use.[192,193] In turn, this signals that there might be a widespread disinterest and/or negative attitudes towards regenerative farming, which entails an approach based on ecological interactions and reduced external inputs use.

[186] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[187] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies
[188] Skaalsveen, K., Ingram, J., & Urquhart, J. (2020). The role of farmers' social networks in the implementation of no-till farming practices. Agricultural Systems, 181, 102824. https://doi.org/10.1016/j.agsy.2020.102824
[189] https://www.researchgate.net/publication/326415588_Report_on_current_farm_demographics_and_trends
[190] https://www.surefarmproject.eu/wp-content/uploads/2019/05/D3.1-Report-on-current-farm-demographics-and-trends-RP1.pdf
[191] https://www.surefarmproject.eu/wp-content/uploads/2019/04/SURE-Farm-D.2.1-Report-on-farmers-perception-of-risk-and-resilience-capacities.pdf
[192] https://www.surefarmproject.eu/wp-content/uploads/2019/04/SURE-Farm-D.2.1-Report-on-farmers-perception-of-risk-and-resilience-capacities.pdf
[193] https://www.surefarmproject.eu/wp-content/uploads/2019/05/D3.1-Report-on-current-farm-demographics-and-trends-RP1.pdf

Romania

Farmers younger than 35 are especially underrepresented, and the general farmer population displays low knowledge and awareness of sustainable farming practices.[194,195] The existing educational institutions and public advisory services provide insufficient training and information to effectively support farmers in transitioning to regenerative agriculture.[196] The fact that local authorities and governmental bodies generally offer limited personnel to help farmers, and that there is no regulatory framework supporting transition to ecologically minded practices, are important institutional barriers.[197] The subpar level of knowledge and information sharing mechanisms constitute another barrier, since most Romanian farmers rely on intergenerational knowledge to shape their farming approach.[198]

Additional social and cultural barriers include the prevalence of subsistence farming, typically on small plots.[199] Not only does subsistence farming decrease the financial resources available to farmers to invest in regenerative practices, but it can also increase risk aversion, as it creates an additional incentive to maintain yield levels constant year after year. Indeed, Romanian farmers scored lower than European counterparts in willingness to take risks like financial investments and new agricultural practices. The mindset of Romanian farmers is also characterised by a general disinterest towards ecological issues and ecological farming systems.[200] Lastly, there is a widespread reluctance to collaborate with other farmers, enter peer-to-peer networks or agricultural cooperatives, an overall distrust towards the idea of sharing resources and knowledge with other farmers.[201,202]

Moldova

[194] https://www.surefarmproject.eu/wp-content/uploads/2019/05/D3.1-Report-on-current-farm-demographics-and-trends-RP1.pdf

[195] https://www.surefarmproject.eu/wp-content/uploads/2019/05/D3.1-Report-on-current-farm-demographics-and-trends-RP1.pdf

[196] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

[197] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

[198] Florian, V., Rusu, M., Rosu, E., Chitea, M., Bruma, S., & Pocol, C. (2020). Behavioural factors and ecological farming. Case studies. Scientific Paper Series Management, Economic Engineering in Agriculture and Rural Development, 20(2).

[199] https://www.surefarmproject.eu/wp-content/uploads/2019/05/D3.1-Report-on-current-farm-demographics-and-trends-RP1.pdf

[200] Barnes, A. P., Thompson, B., & Toma, L. (2022). Finding the ecological farmer: A farmer typology to understand ecological practice adoption within Europe. Current Research in Environmental Sustainability, 4, 100125. https://doi.org/10.1016/j.crsust.2022.100125

[201] https://www.researchgate.net/publication/326415588_Report_on_current_farm_demographics_and_trends

[202] https://www.researchgate.net/publication/355486371_Report_on_Key_Barriers_of_Agro-ecological_Farming_Systems_in_Europe_and_Co-constructed_Strategies

In a recent paper, Zaharco[203] identified farmers' predominantly negative attitudes towards agroecological and regenerative practices as the main barrier to their diffusion. Previous research[204] substantiates Zaharco's findings and expands on a likely driver. By 2011, ~40% of the agricultural land in Moldova was fragmented into plots smaller than 5 hectares, which are perceived by their owners as a safety net, a resource to fall back on in times of financial distress. Generally speaking, these small landowners have additional non-rural sources of income and tend to engage in subsistence farming. That is to say, most of the produce grown on these micro-farms is consumed *in situ* rather than sold to generate income. Thus, not only a considerable percentage of Moldovan farmers might simply not have the financial resources to take on the investments necessary to transition to regenerative agriculture, but also likely lack the motivation to put time and effort in changing their farming practices. Such land hyper-fragmentation hampers the modernisation process of the agricultural sector, as institutions are interfaced with a significantly higher magnitude of stakeholders than in other European countries. Indeed, lack of institutional support and regulatory incentives was identified as a key institutional barrier[205]. Additional social barriers include out-migration and depopulation of rural areas, low level of knowledge among farmers on the benefits of regenerative practices, and an overall indisposition towards collaboration and inter-farmer support.[206]

Ukraine

Ukraine presents unique challenges and barriers to the diffusion of eco-oriented agricultural practices. First, the on-going armed conflict with Russia exacerbated market instability and political uncertainty and created a novel source of psychological distress. Second, the Ukrainian government enacted a land sale moratorium in 2001, whereby private citizens could own but not sell agricultural land, lifted only in 2021. Throughout those years, the Ukrainian agricultural industry actors were mostly either large agro-holdings companies, which would lease their land through mostly short-term land tenancy agreements, or smallholders focused on cash crops monocultures (e.g., rapeseed and sunflower) to compete in such an unfavourable market.[207] Historically, both the small landowners and tenant farmers in Ukraine received little to no support

[203] Zaharco, S. (2022). Ecological Agriculture development in the Republic of Moldova; evolution and benefits. Scientific Paper Series Management, Economic Engineering in Agriculture and Rural Development, 22(1).
[204] Ignat, A., & Moroz, V. (2013). Agricultural land-use changes and rural transformation in the Republic of Moldova. Scientific Paper Series Management, Economic Engineering in Agriculture and Rural Development, 13(1).
[205] Ignat, A., & Moroz, V. (2013). Agricultural land-use changes and rural transformation in the Republic of Moldova. Scientific Paper Series Management, Economic Engineering in Agriculture and Rural Development, 13(1).
[206] Ignat, A., & Moroz, V. (2013). Agricultural land-use changes and rural transformation in the Republic of Moldova. Scientific Paper Series Management, Economic Engineering in Agriculture and Rural Development, 13(1).
[207] Kopytko, N., & Pruneddu, A. (2018). Triple-win strategy? Why is not everyone doing it? A participant-driven research method to reveal barriers to crop rotation in Ukraine. Climatic Change, 149(2), 189–204. https://doi.org/10.1007/s10584-018-2229-8

from the government, whose policies tended to (a) contribute to pricing instability, (b) create an unfavourable business environment, and (c) provided minimal support to innovating the agricultural industry towards sustainable, ecological farming practices.[208]

In turn, these social and institutional barriers, and the uncertainty they inevitably bring about, shaped the behaviour of Ukrainian farmers towards a short-term, survival-oriented mentality[209]. Farmers would either lack the financial resources and necessary knowledge to implement non-traditional, regenerative farming practices, or would not feel confident in taking business decisions with long-term payoffs and initial risks (such as regenerative agriculture) because of their tenancy agreements and would prioritise instead short-term profit with yield maximisation.[210] Moreover, there is a tradition of monoculture, with a focus on high-paying crops like sunflowers, which leads farmers to resist practices going against traditional farming.[211]

3.5.3 Step 3: Common Practice Test

The common practice test is the most widely recognized tool by the international community for additionality. In accordance with the method for common practice from VM0042 v2.0, a project proponent must determine whether the proposed activity or suite of activities are common practice within the spatial boundary of the project. Following the threshold determined by the "CDM Methodological Tool: Common Practice"[212] and VM0042 v2.0, common practice is defined as a certain practice having greater than 20% adoption in a specific region.

VM0042 v2.0 requires that evidence must be provided through publicly available information contained in censi or other government data. The Project provides evidence through Eurostat (2021) for projects enrolled in the EU and supplemented by the National GHG Inventory Reports (submitted to the UNFCCC). In the case that evidence on a single Project Activity or suite of Project Activities is not available, the Project will use reference values from other regions with similar geopolitical characteristics, or consult with a qualified independent local expert. According to VM0042 v2.0, evidence for additionality can be extracted from independent research sources.

VM0042 v2.0 states that if a Project Activity, such as reduced tillage rates in the countries covered in the Project are greater than 20%, then the Project must include a proportionally higher ratio of other activities with lower adoption rates to bring the weighted average of the proposed Project Activities below 20%. In addition, if a Project is already implementing a Project Activity, for example reduced tillage, prior to project start, the common practice test will have to be

[208] ibid
[209] ibid
[210] ibid
[211] ibid
[212] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-24-v1.pdf

undertaken for any new Project Activities that are started. For Project Activities that are non-additional at a country level, a weighted average between that activity and one or more other Project Activities will be calculated to get a new weighted average adoption rate to reassess additionality.

For countries where there is a lack of data, the adoption rates are extrapolated by looking at contextual similarities per the Barrier Analysis (see section 3.4.5), and comparisons of geopolitical profiles using the Country Similarity Index (CSI). The CSI between Ukraine and Moldova is substantially higher, with the agricultural industry in these two countries being considered nearly identical. What is more, the CSI between Moldova, Ukraine and Romania is also high. Moldova and Ukraine present very similar social, cultural, and institutional barriers to regenerative agriculture diffusion to those in Romania (i.e., land fragmentation, prevalent subsistence farming, low farmer cooperation), further suggesting that the predominant agricultural practices and farming approaches would also be alike in these three countries. Consequently, it is reasonable to assume that the adoption rates of Project Activities in Moldova and Ukraine are similar to those of Romania (e.g., 3% for reduced tillage) if not lower, given that Romania is a more developed, EU-member country.

A full assessment of the countries in the EU is provided as a separate document and will be referenced for future verifications. Table 3-9 shows the percentage rates for all Project Activities in the Project, derived from information provided by Eurostat (for tillage, residue and cover crops) and the FAO (for fertiliser).

Table 3-9. Results from common practice assessment across initial project instances [213].

Country	Tillage		Cover Crops	Residue Management	Organic Fertiliser
	Reduced Tillage	No Tillage			
Bulgaria	41.21%	0.15%	0.21%	4.28%	9.88%
Denmark	10.70%	1.35%	15.94%	3.75%	45.27%
Estonia	26.59%	10.76%	3.54%	18.90%	18.51%
Spain	17.62%	6.45%	8.02%	8.57%	38.47%

[213] The raw data extracted from the FAO and Eurostat, along with calculations for the variables in Tables 3-12 and 3-13, are included in the appendix and supplementary material.

Latvia	5.32%	1.00%	4.38%	8.51%	14.90%
Lithuania	9.46%	1.21%	2.58%	2.17%	14.97%
Romania	2.78%	9.45%	1.47%	10.37%	22.13%
United Kingdom	35.49%	5.09%	4.18%	17.29%	34.69%
Ukraine	2.78%	9.45%	1.47%	10.37%	11.93%
Moldova	2.78%	9.45%	1.47%	10.37%	30.76%

3.5.3.1 Common Practice Calculation

The common practice calculation carried out, as guided by Section 7 Additionality of the VM0042 v2.0 methodology, uses the input taxonomy from Eurostat and FAO stat tables (outlined in Appendix 9). The Project Activities referenced in the example are aligned with those highlighted in Section 1.11, and for this example Denmark is used as the country for the calculations.

The first equation represents the general formula used, with names from the raw datasets on the right-hand side of the equation and the Project references on the left; this is followed by the numbers for Denmark (as the example country) applied to the formula.

Tillage:

$$Reduced\ tillage\ \% = \frac{conservational\ tillage}{Arable\ land} * 100$$

$$\frac{252660}{2361200} * 100 \ = \ 10.7\%$$

$$No\ tillage\ \% = \frac{zero\ tillage}{Arable\ land} * 100$$

$$\frac{31860}{2361200} * 100 \ = \ 1.35\%$$

Cover crops:

$$Cover\ crops\ \% = \frac{Cover\ crop\ or\ intermediate\ crop}{Arable\ land} * 100$$

$$\frac{376450}{2361200} * 100 \ = \ 15.94\%$$

Residue management:

$$Residue\ management\ \% = \frac{Plant\ residues}{Arable\ land} * 100$$

$$\frac{88520}{2361200} * 100 = 3.75\%$$

Organic fertiliser:

$$Organic\ fertiliser\ \% = \frac{m}{m+s}$$

$$\frac{70.49}{70.49+85.21} * 100 = 45.27\%$$

where : $m = Cropland\ nitrogen\ per\ unit\ area\ from\ manure\ applied\ to\ soils\ (kg/ha) s = Cropland\ nitrogen\ per\ unit\ area\ from\ Mineral\ fertilisers\ (kg/ha)$

The results in table 3-9 show that a majority of the Project Activities in the Project are additional for the initial project instances. Bulgaria, Estonia and the United Kingdom are not considered additional for 'reducing tillage', as described in Section 7 of VM0042 v2.0. Consequently, the weighted average adoption rates of a combination of tillage reduction with the other Project Activities included in the AgreenaCarbon Project are assessed and calculated using Equation 1 of VM0042 v2.0:

$$AR = ((EA_{a1} \times PA_{a1}) + (EA_{a2} \times PA_{a2}) + \cdots + (EA_{ay} \times PA_{ay}) \quad (1)$$

The PA values represent the proportion within each country that has implemented the different combinations of practice sets. The PA value is multiplied by the corresponding EA value, and these values are then summed to obtain the average adoption rate. Table 3-10 shows the average adoption rates calculated according to Equation 1 in the rightmost column. All values are below 20% and are therefore considered additional (2022).

The three leftmost columns in Table 3-10 describe the combined adoption rate of two practices, in VM0042 v2.0 it is called stacking activities. As an example, for Denmark, the adoption rate for reduced tillage combined with organic fertiliser is calculated as 10.7% * 45.27% = 4.84%.

Table 3-10. Results from Equation 1 VM0042 v2.0 of adoption rate of suite of at least two practices in the AgreenaCarbon Project.

Country	EA Reduced Tillage + Organic Fertilisers	EA Reduced Tillage + Cover Crop	EA Reduced Tillage + Residue Management	AR Reduced Tillage + Residue management + Cover crops + Organic Fertilisers
Bulgaria	4.07%	0.09%	1.76%	0.33%
Denmark	4.84%	1.71%	0.40%	0.86%
Estonia	4.92%	0.94%	5.03%	4.24%
Spain	6.78%	1.41%	1.51%	8.67%
Latvia	0.79%	0.23%	0.45%	0.29%
Lithuania	1.42%	0.24%	0.21%	0.53%
Romania	0.62%	0.04%	0.29%	0.80%
United Kingdom	12.31%	1.48%	6.13%	1.45%
Ukraine	0.33%	0.04%	0.29%	0.46%
Moldova	0.86%	0.04%	0.29%	0.43%

Thus, Table 3-10 shows that any combination of reduced tillage plus an additional Project Activity will be considered additional. According to the Project eligibility criteria, farmers in geographic areas where 'reduced tillage' is above 20% and is the sole Project Activity then the PAI not considered additional. As a result, project participants in these countries need to implement at minimum two Project Activities for a PAI to be eligible. UK, Bulgarian, and Estonian PAIs are further assessed in the initial instances to determine eligibility.

For the initial project instances in the UK, Bulgaria and Estonia 199 PAIs were deemed non-additional and ineligible for the Project as per VCS 4.5 and VM0042 2.0 requirements.

Monitoring of the Common Practice Test

The Project will continue to monitor current and check future Project Activities under the Common Practice Test Currently, the Common Practice Test includes the European market with the most recent data.

Based on the results presented, all countries (except Cyprus) fall within the 20% threshold, and therefore are additional in the common practice test (CPT) for reduced tillage and no tillage practices.

Available data is monitored regularly to provide a full picture of the state of regenerative agricultural practices in the markets in which the Project operates. Eurostat data is checked annually for updates and the ground-truthing data collected by Agreena for remote-sensing and Project purposes is utilised also. The most relevant and up to date data on farm practice uptake across Europe is in the Eurostat database, which is therefore used as a guide as described in the sections above.

3.6 Methodology Deviations

There is only one methodology deviation that occurs with the AgreenaCarbon Project from what is set out in VM0042 v2.0. According to VM0042 v2.0 guidance, project data must be quantified using one of the three accepted Quantification Approaches and must be sourced directly from project participants. Box 1 in VM0042 v2.0 outlines sources of qualitative and quantitative data that can be utilised for the Project baseline parameters. For the carbon dioxide emissions from liming, the Project utilises Box 1 for both the baseline and the Project Activity data, as a methodology deviation.

The Project has not collected data for the project emissions for the estimation of carbon dioxide emissions for liming for the verification of harvest year 2022, in the absence of such requirements in the draft version of VM0042 v2.0. In the absence of farmer reported data for the project emissions, the Project Activity emissions are quantified based on the regional data provided by countries for the National Inventory Reports submitted to the United Nations Convention on Climate Change (UNFCCC). The UNFCCC requires that all countries submit their GHG emission inventories in a common reporting format framework utilising the most up-to-date methodologies from the IPCC National Inventory Guidelines and Good Practice Guidelines. The standardisation of reporting amongst different nations ensures greater compatibility of emissions and transparency on calculation estimates.

For the National Inventory Reports, countries submit data on the quantity of lime (MLimestone,bsl,i, MDolomite,bsl,i as well as MLimestone,wp,i, MDolomite,wp,i, t/yr), the emission factors (t CO2-C/t) and the total emissions (kt CO2e) from liming activity for the agricultural sector (Table 3.G-1). The CO2 emissions from liming (CO2_limebsl,i,t as well as CO2_limewp,i,t; equation 9 in VM0042 v2.0) are calculated by dividing the total emissions (kt CO2e) by the the actual agricultural land area (k ha; Table 4.B) to obtain the CO2 emissions per unit area for each country (t CO2e/ha). Thus, all of the data under agriculture are validated. Additionally, this approach for determining the baseline scenario avoids gaps in the data and

includes all emissions associated with the activity. This method for calculating an activity's emission is therefore more robust and accurate, in comparison to an alternative method of estimating lime CO2 emissions under hypothetical scenarios. Furthermore, following the above-mentioned quantification approach, the project does not take into consideration any potential improved management practices for the reduction of emissions by reduction of liming application, but considered that all project instances are applying a "Business as usual" application rate. The principles of conservativeness and accuracy are therefore ensured, to avoid the risk of overestimation of GHG emission reductions.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

This section introduces all the necessary equations for the quantification of GHG emission reductions and removals in the AgreenaCarbon Project. The equations applied throughout the Project are consistent with VM0042 v2.0.

This section is accompanied by an ERR calculation spreadsheet and four calculation supplementary materials to display the detailed calculation process of the GHG emission reductions and removals. The ERR calculation spreadsheet and each supplementary material provides data inputs and a tutorial for the calculations using R or Excel.

1. Supplementary_Material_1_RothC: Tutorial for estimating soil carbon stock using the RothC model
2. Supplementary_Material_2_IPCC: Tutorial for calculating CO2 emissions from fuel combustion and liming and N2O emissions from soil
3. Supplementary_Material_3_Leakage: Leakage calculation.xlsx
4. Supplementary_Material_4_Uncertainty: Tutorial for the uncertainty calculation

The ERR calculation spreadsheet and Supplementary Material 3 show the detailed calculation processes using Excel files that include data inputs, formulas, results and definitions of each column. Supplementary Material 1, 2 & 4 provide R Markdown files (RMD files) and PDF files to show the data inputs, calculation R codes and results. R Markdown provides an interactive way to import data inputs, run the R codes and show the calculation results, which allows all the calculations to be reproducible. The same texts, codes and results are also shown in the corresponding PDF files. (An additional file "Getting Started with R and R Markdown" provides some instructions to easily use R Markdown).

In addition, an example calculation for one PAI (field id = 7627) is presented in each subsection for illustration purposes only to intuitively show the detailed calculation process of a PAI. Tables with input parameters and outputs for each step are shown in a logical stepwise approach. More detailed information about all parameters, sources, justifications, and monitoring plans is shown in Section 5.

4.1 Baseline Scenario Emissions

To estimate emissions under the baseline scenario for each PAI within the project area, the baseline SoA created as described in Section 3.4 is used to represent pre-project ALM practices for each PAI.

The estimation of baseline SOC stocks is performed using Quantification Approach 1, while CO_2 and N_2O emissions related to fertiliser use, fossil fuel burning and lime application are calculated using Quantification Approach 3, by applying the equations provided in VM0042 v2.0. These estimations are carried out at the PAI level, and the results are aggregated to derive the overall baseline SOC stocks and emissions for the project.

Wherever possible, data for these calculations—including ALM practices, climate drivers, and soil characteristics—was obtained at the PAI level. For the estimation of SOC stocks, PAIs within the project area are subdivided into homogeneous strata according to the stratification strategy outlined in Section 5.3.2. Soil Sampling Plan. Within these homogeneous groups, PAIs are selected for soil property measurements of initial SOC levels and bulk density, which are used to initialize the SOC estimation models for baseline and project scenario simulations, adhering to the requirements of Quantification Approach 1: Measure and Model. For emissions calculations under Quantification Approach 3, regional-level emission factors provided by the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories are applied, as detailed in Chapter 5 of this document.

4.1.1 Soil Organic Carbon

In accordance with VM0042 v2.0, Section 8.1 (Table 5) and Section 8.2.1.6, soil organic carbon (SOC) stocks will be calculated using the "Quantification Approach 1: Measure and Model" method, as specified in Equations 5 and 6. Equation 5 will be applied to derive the SOC model inputs for the ex-post calculations, while Equation 6 represents the application of a validated process-based model to determine SOC stocks under the baseline scenario.

$$SOC_{model} = 100 \times BD_{corr} \times d \times OC_{n,dl} \quad (5)$$

Where:

SOC_{model}	=	SOC stock as model input data (t/ha)
BD_{corr}	=	Corrected bulk density of the fine soil fraction, after subtracting the mass proportion of the coarse fragments (g/cm^3)
d	=	Soil depth (cm)
100	=	Conversion factor from g/cm^2 to t/ha

$$SOC_{bsl,i,t} = f(SOC_{bsl,i,t}) \quad (6)$$

Where:

$SOC_{bsl,i,t}$	=	Estimated carbon stocks in the SOC pool in the baseline scenario for sample unit *i* at the end of year *t* (t CO_2e/ha)
$f(SOC_{bsl,i,t})$	=	Modeled SOC stocks in the baseline scenario for sample unit *i* in year *t*, calculated by modeling SOC stock changes over the course of the preceding year (t CO_2e/ha)
i	=	Sample unit

Changes in soil organic carbon (SOC) stocks will be modelled by the Project using SoilR, a widely used R implementation of RothC. This model is recognized and frequently utilised for estimating carbon stock changes in agricultural soils. This implementation of the model was calibrated and validated in the MVR following the guidance in VMD0053 v2.0 and approved by an Independent Model Expert for the project area.

RothC is a first-order, process-based model for the turnover of organic carbon in non-waterlogged topsoils that accounts for the effects of soil type, temperature, moisture content, and plant cover on the carbon turnover process. As indicated in Table 4-1, RothC is initialized with inputs from multiple data sources. Climate inputs at the PAI level (temperature (ºC), precipitation (mm), and evapotranspiration (mm)) are sourced from NASAPOWER. Soil properties (clay content (%) and SOC for ex-ante estimations) are sourced from SoilGrids. Farm management data (tillage regime, cover crop adoption, fertilization, and residue mulching) is obtained from the baseline SoA and processed into model inputs as detailed in Chapter 5.

In compliance with the requirements of Approach 1, SOC stock changes will be modelled using measured SOC as the initial SOC in the RothC simulations. For ex-ante evaluations, we will use SoilGrids SOC stock values at the PAI level, available at a resolution of 250 m^2. For ex-post

calculations, SOC measured according to the stratification strategy outlined in Section 5.3.2 will be mapped to individual PAIs and used for model initialization.

The model initialization consists of a least squares optimization of the five carbon pools in the model with respect to the reference SOC stocks (SoilGrids SOC for ex-ante and measured SOC for ex-post calculations). This spin-up provides the starting point for a trend-setting run using the ALM practices described in the baseline SoA over the five years preceding the start of project activities (t -5 to t -1). After this run, the SOC change trend for the baseline period is established. At t0, SOC values are rescaled to match the measured data, and baseline scenario runs are performed by repeating the baseline SoA over the first 10 years of the crediting period, after which the project will undergo re-baselining.

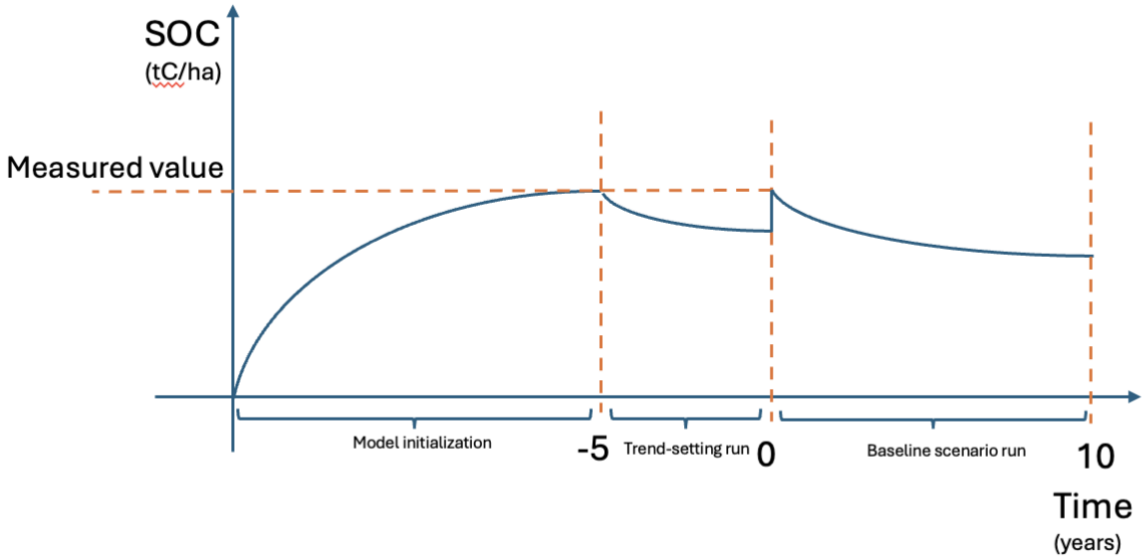


Figure 4-1. Schematic representation of the initialization, trend setting, and baseline scenario run processes with RothC.

Table 4-1. Collection of biophysical model inputs for the baseline scenarios.

Model Input Category	Timing	Approach
SOC content and bulk density to calculate SOC	Determined *ex-ante* at project start and	For ex ante estimations the model is initiated using existing soil maps (e.g.,

stocks (initial)	validated within +/- 5 years from the project start	SoilGrids). The input parameters of the model will be reviewed before the first verification, using direct soil measurements collected within ±5 years of the project start date. See parameter table for $SOC_{bsl,i,t}$.
Soil properties (other than bulk density and SOC)	Determined *ex-ante*	Clay content is determined from published soil maps (e.g., SoilGrids). See parameter table $Clay_i$.
Climate variables (e.g., precipitation, temperature)	Determined *ex-ante*	Climate variables are collected daily, and a climate normal is determined for each project PAI over the last 30 years using data from a synthetic weather station located no more than 50 km from the PAI. See the parameter tables for temperature, precipitation, and evapotranspiration.

Table 4-2 below, shows how the model is parameterized for the calculation of baseline scenario SOC values ($SOC_{bsl,i,t}$) for a sample PAI.

Table 4-2-a. Baseline Schedule of Activities (SoA) for *i = PAI ID 7627*

Year	Green cover (months)	Tilling	Fertiliser	Crop name	Crop yields ($P_{bsl,p}$; t/ha)	Crop residue management
2017	4 months	Conventional tillage	only synthetic	Oat, winter	20.85	Removed
2018	4 months	Conventional tillage	only synthetic	Oat, winter	20.85	Removed
2019	4 months	Conventional tillage	only synthetic	Buckwheat	2.65	Removed
2020	4 months	Reduced tillage	only organic	Rye, Winter	20.85	Removed

2021	4 months	Reduced tillage	only synthetic	Triticale, spring	20.85	Removed

Table 4-2b. Model input values utilised to calculate 0_t for *i = PAI ID 7627, and t = 0*

Parameter	Value	Unit	Description	Source
Time step	1	years	Project time	Project description
DPM	0.006	t C/ha	Decomposible plant material	Calculated based on Soilgrids values for each PAI
RPM	2.20	t C/ha	Resistant Plant Material	Calculated based on Soilgrids values for each PAI
BIO	0.50	t C/ha	Microbial Biomass	Calculated based on Soilgrids values for each PAI
HUM	57.36	t C/ha	Humified Organic Matter	Calculated based on Soilgrids values for each PAI
IOM	6.94	t C/ha	Inert Organic Matter	Calculated based on Soilgrids values for each PAI
Green cover adoption	4	months / year	Monthly soil green cover based on periods of cash and cover crop growth	Baseline SoA
ks	k.DPM = 10 k.RPM = 0.3 k.BIO= 0.66 k.HUM= 0.02 k.IOM = 0	-	A vector of length 5 containing the values of the decomposition rates for the different carbon pools	Standard values described in reference [214]

[214] Coleman, Kevin, and D. S. Jenkinson. "RothC-26.3-A Model for the turnover of carbon in soil." In *Evaluation of soil organic matter models: Using existing long-term datasets*, pp. 237-246. Berlin, Heidelberg: Springer Berlin Heidelberg, 1996.

In	0.094	t C/ha	A scalar specifying the amount of mulched litter inputs per year for the PAI baseline scenarios	Baseline SoA
FYM	0	t C/ha	A scalar specifying the amount of Farm Yard Manure inputs per year.	Baseline SoA
clay	40.65	%	Percent clay in mineral soil	Estimated Soilgrids average value collected at PAI level
DR	1.44	-	Decomposable plant material to resistant plant material ratio	Standard values described in reference [215]
Temp	11.17	°C	Monthly mean temperature	Synthetic weather station average PAI value from NASAPOWER
Precip	63.81	mm	Monthly mean precipitation	Synthetic weather station average value at PAI level from NASAPOWER
Evap	29.05	mm	Monthly mean evapotranspiration	Synthetic weather station average value at PAI level from NASAPOWER
TRM	1	-	Tillage rate modifier	Value extracted from reference[216]

The output of the model is described in table 4-3.

Table 4-3. Model output values for *i = PAI ID 7627, and t = 1*

Parameter	Value	Unit	Description

[215] Coleman, Kevin, and D. S. Jenkinson. "RothC-26.3-A Model for the turnover of carbon in soil." In *Evaluation of soil organic matter models: Using existing long-term datasets*, pp. 237-246. Berlin, Heidelberg: Springer Berlin Heidelberg, 1996.
[216] Jordon, Matthew W., and Pete Smith. "Modelling soil carbon stocks following reduced tillage intensity: A framework to estimate decomposition rate constant modifiers for RothC-26.3, demonstrated in north-west Europe." *Soil and Tillage Research* 222 (2022): 105428.

DPM	0.005	t C/ha	Final decomposible plant material
RPM	1.55	t C/ha	Final resistant Plant Material
BIO	0.41	t C/ha	Final microbial Biomass
HUM	56.28	t C/ha	Final humified Organic Matter
IOM	6.94	t C/ha	Final inert Organic Matter

4.1.2 Carbon Dioxide Emissions From Fossil Fuel Combustion

Carbon dioxide emissions from fossil fuel combustion are calculated using the "Quantification approach 3: Default Factors" method following Equation 7 and Equation 8 in VM0042 v2.0 . The emission factors (EFs) are retrieved from the Table 3.3.1 [217] and reported in the parameter table in section 5.2 in the PD.

[217] 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; vol 2. Ch. 3.3.1.2 (https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/2_Volume2/19R_V2_2_Ch02_Stationary_Combustion.pdf).

$$\overline{CO_{2\_}ff_{bsl,i,t}} = (\sum_{j=1}^{J} EFF_{bsl,j,i,t})/A_i \quad (7)$$

Where:

$\overline{CO_{2\_}ff_{bsl,i,t}}$	=	Areal mean carbon dioxide emissions from fossil fuel combustion in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)
$EFF_{bsl,j,i,t}$	=	Carbon dioxide emissions from fossil fuel combustion in the baseline scenario in vehicle/equipment type *j* for sample unit *i* in year *t* (t CO_2e)
A_i	=	Area of sample unit *i* (ha)
j	=	Type of fossil fuel (gasoline or diesel)

The parameter $EFF_{bsl,j,i,t}$ is estimated using the following equation:

$$EFF_{bsl,j,i,t} = FFC_{bsl,j,i,t} \times EF_{CO2,j} \quad (8)$$

Where:

$FFC_{bsl,j,i,t}$	=	Consumption of fossil fuel type *j* for sample unit *i* in year *t* (liters)
$EF_{CO2,j}$	=	Emission factor for combustion of fossil fuel type *j* (t CO_2e/liter)

Table 4-4. Data inputs and outputs for calculating CO2 emissions from fossil fuel combustion for i = PAI id 7627

Parameter	Value	Unit	Description	Source
j_{bsl}	Diesel	-	Fossil fuel type	Farm attestation
$FFC_{bsl,j}$ (L/ha)	100	litre/ha	Consumption of fossil fuel type j	Literature and reports (Details in Section 5.1)

$EF_{CO2,j,bsl}$	0.002886	tCO2e/litre	Emission factor for combustion of fossil fuel type j	VM0042 v 2.0 and 2019 IPCC Refinement[218]
$CO2\_ff_{bsl}$	0.2886	tCO2e/ha	CO_2 emissions due to fuel consumption	Equation 7 and 8 (VM0042 v 2.0)

4.1.3 Carbon Dioxide Emissions From Liming

Carbon dioxide emissions caused by limiting application are included in the AgreenaCarbon Project. CO_2 emissions from liming are calculated using the "Quantification approach 3: Default Factors" method following Equations 9 in VM0042 v2.0.

$$\overline{CO2\_lime_{bsl,i,t}} = EL_{bsl,i,t} / A_i \quad (9)$$

Where:

$\overline{CO2\_lime_{bsl,i,t}}$ = Areal mean carbon dioxide emissions from liming in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$EL_{bsl,i,t}$ = Carbon dioxide emissions from liming in the baseline scenario for sample unit *i* in year *t* (t CO_2e)

[218] 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; vol 2. Ch. 3.3.1.2 (https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/2_Volume2/19R_V2_2_Ch02_Stationary_Combustion.pdf).

$$EL_{bsl,i,t} = ((M_{Limestone,bsl,i} \times EF_{Limestone}) + (M_{Dolomite,,bsl,i} \times EF_{Dolomite})) \times \frac{44}{12} \quad (10)$$

Where:

$M_{Limestone,bsl,i}$	=	Amount of calcitic limestone ($CaCO_3$) applied to sample unit *i* in year *t* (tonnes)
$EF_{Limestone}$	=	Emission factor for calcitic limestone (0.12) (t C per t of limestone)
$M_{Dolomite,bsl,i}$	=	Amount of dolomite ($CaMg(CO_3)_2$) applied to sample unit *i* in year *t* (tonnes)
$EF_{Dolomite}$	=	Emission factor for dolomite (0.13) (t C per t of dolomite)
44/12	=	Molar mass ratio of CO_2 to C applied to convert CO_2-C emissions to CO_2 emissions

The current AgreenaCarbon Project utilizes regional data[219] to quantify CO2 emissions from liming (see further details in Section 3.6, 5.1 and 5.2 in the PD).

Table 4-5. Data inputs and outputs for calculating CO2 emissions from liming for the baseline emissions for i = PAI id 7627

Parameter	Value	Unit	Description	Source
Country	United Kingdom	-	Country of the PAI	Farm attestation
A	3601	k ha	Country actual agricultural land area	Table 4.B in 2023 National Inventory Report[220]
$M_{Limestone, bsl}$	1980635	t/y	Limestone application amount in the baseline	Table 3.G-I in 2023 National Inventory Report
$M_{Dolomite,bsl}$	338074	t/y	Dolomite application amount in the baseline	Table 3.G-I in 2023 National Inventory Report
$EF_{Limestone,bsl}$	0.12	t C/t	Emission factor for the application of calcitic limestone	2019 IPCC Refinement

[219] UNFCCC National Inventory Reports: https://unfccc.int/ghg-inventories-annex-i-parties/2023

[220] UNFCCC National Inventory Reports: https://unfccc.int/ghg-inventories-annex-i-parties/2023

$EF_{Dolomite,bsl}$	0.13	t C/t	Emission factor for the application of dolomite	2019 IPCC Refinement
EL_{bsl}	5163	kt CO2e	CO_2 emissions from liming in the five-year baseline (2016-2020)	Equation 10 (VM0042 v2.0); Table 3.G-I in 2023 National Inventory Report[221]
$CO2\_lime_{bsl}$	1.43	t CO2e/ha	Areal mean CO_2 emissions from liming in the baseline	Equation 9 (VM0042 v2.0)

Note: 2019 IPCC Refinement refers to 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

4.1.4 Nitrous Oxide Emissions From Nitrogen fertilisers And Nitrogen-Fixing Species

Nitrous oxide (N2O) is a potent greenhouse gas that is emitted from agricultural activities such as fertiliser application and livestock management. As a result, it is important to accurately quantify N2O emissions in order to assess and mitigate their impact on the environment. N2O emissions from use of nitrogen fertilisers and nitrogen-fixing (N-fixing) species within the project boundaries are quantified using the "Quantification approach 3: Default Factors" method following Equations 17 to 26 in VM0042 v2.0 .

In VM0042 v2.0 , N2O emissions due to nitrogen inputs to soils in the baseline scenario are estimated by applying Equation 17:

$$N2O\_soil_{bsl,i,t} = N2O\_fert_{bsl,i.t} + N2O\_md_{bsl,i,t} + N2O\_Nfix_{bsl,i,t} \quad (17)$$

Where:

$N2O\_soil_{bsl,i,t}$ = Nitrous oxide emissions due to nitrogen inputs to soils in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$N2O\_fert_{bsl,i,t}$ = Nitrous oxide emissions due to fertilizer use in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$N2O\_md_{bsl,i,t}$ = Nitrous oxide emissions due to manure deposition in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$N2O\_Nfix_{bsl,i,t}$ = Nitrous oxide emissions from crop residues due to the use of N-fixing species in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

[221] UNFCCC National Inventory Reports: https://unfccc.int/ghg-inventories-annex-i-parties/2023

Each component of N2O emissions due to N inputs to soils is broken down into emissions from fertiliser and N-fixing species. N2O emissions from manure deposition are currently not included in the AgreenaCarbon Project.

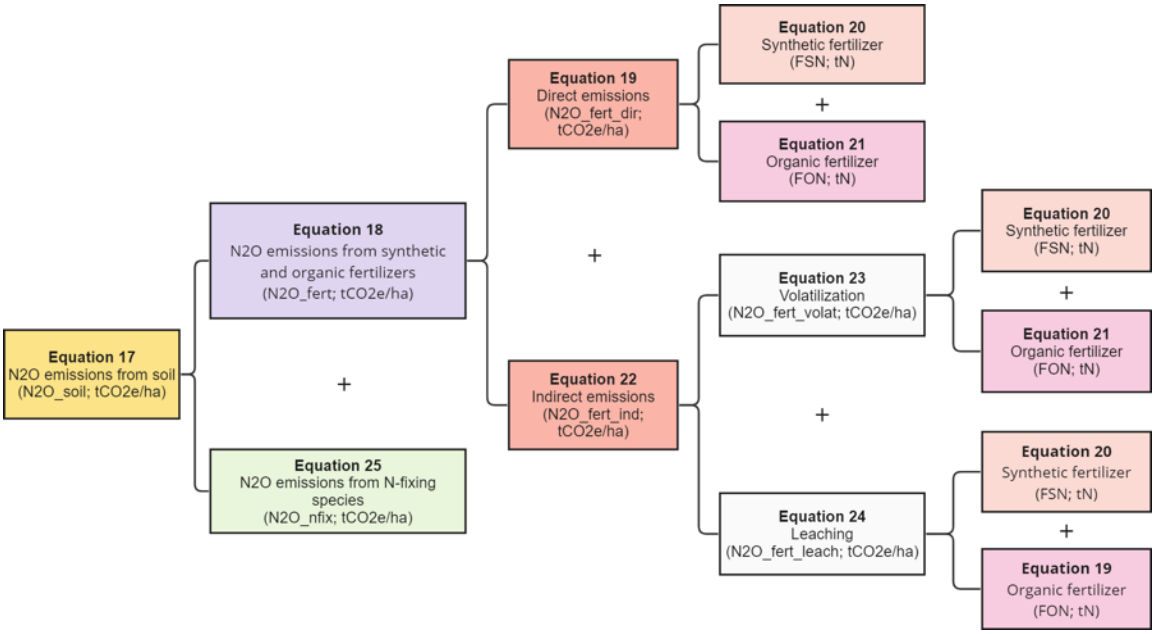


Figure 4-2. Flowchart of the calculations of N2O emissions due to nitrogen inputs to soils in the AgreenaCarbon Project according to Verra's Methodology for Improved Agricultural Land Management (VM0042 v2.0). All equations in the flowchart are from VM0042 v2.0.

4.1.4.1 Nitrous Oxide emissions due to fertiliser use

Total N2O emissions due to fertiliser use consist of direct and indirect N2O emissions.

Total N2O emissions due to fertiliser use:

$$N2O\_fert_{bsl,i,t} = N2O\_fert_{bsl,direct,i,t} + N2O\_fert_{bsl,indirect,i,t} \quad (18)$$

Where:

$N2O\_fert_{bsl,direct,i,t}$ = Direct nitrous oxide emissions due to fertilizer use in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$N2O\_fert_{bsl,indirect,i,t}$ = Indirect nitrous oxide emissions due to fertilizer use in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

Direct emissions due to fertiliser use

Direct N_2O-N is emitted from applied synthetic and organic fertiliser and released into the atmosphere. Direct emissions arise from the conversion of fertiliser N (ammonium or nitrate) by microbial nitrification/denitrification processes in the soil, its conversion to N_2O and emission to the atmosphere. N_2O emissions from fertiliser use are quantified in Equations 19–21.

$$\overline{N2O\_fert_{bsl,direct,i,t}} = \left(\left(FSN_{bsl,i,t} + FON_{bsl,i,t}\right) \times EF_{Ndirect} \times 44/28 \times GWP_{N2O}\right)/A_i \quad (19)$$

$$FSN_{bsl,i,t} = \sum_{SF} M_{bsl,SF,i,t} \times NC_{SF} \quad (20)$$

$$FON_{bsl,i,t} = \sum_{OF} M_{bsl,OF,i,t} \times NC_{OF} \quad (21)$$

Where:

$\overline{N2O\_fert_{bsl,direct,i,t}}$ = Areal mean direct nitrous oxide emissions due to fertilizer use in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$FSN_{bsl,i,t}$ = Synthetic N fertilizer applied to sample unit *i* in year *t* in the baseline scenario (t N)

$FON_{bsl,i,t}$ = Organic N fertilizer applied to sample unit *i* in year *t* in the baseline scenario (t N)

$EF_{Ndirect}$ = Emission factor for nitrous oxide emissions from N additions from synthetic fertilizers, organic amendments and crop residues (t N_2O-N/t N applied)

$M_{bsl,SF,i,t}$	=	Mass of N-containing synthetic fertilizer type *SF* applied to sample unit *i* in year *t* in the baseline scenario (t fertilizer)
NC_{SF}	=	N content of synthetic fertilizer type *SF* (t N/t fertilizer)
$M_{bsl,OF,i,t}$	=	Mass of N-containing organic fertilizer type *OF* applied to sample unit *i* in year *t* in the baseline scenario (t fertilizer)
NC_{OF}	=	N content of organic fertilizer type *OF* (t N/t fertilizer)
SF	=	Synthetic N fertilizer type
OF	=	Organic N fertilizer type
44/28	=	Molar mass ratio of N_2O to N applied to convert N_2O-N emissions to N_2O emissions

Indirect emissions due to fertiliser use

Fertiliser application also results in indirect N_2O emissions from volatilisation and leaching, which are quantified using Equations 22–24:

$$\overline{N2O\_fert_{bsl,indirect,i,t}} = (N2O\_fert_{bsl,volat,i,t} + N2O\_fert_{bsl,leach,i,t})/A_i \quad (22)$$

$$N2O\_fert_{bsl,volat,i,t} = \begin{bmatrix} (FSN_{bsl,i,t} \times Frac_{GASF,l,S}) + \\ (FON_{bsl,i,t} \times Frac_{GASM,l,S}) \end{bmatrix} \times EF_{Nvolat} \times 44/28 \times GWP_{N2O} \quad (23)$$

$$N2O\_fert_{bsl,leach,i,t} = \begin{pmatrix} FSN_{bsl,i,t} + \\ FON_{bsl,i,t} \end{pmatrix} \times Frac_{LEACH,l,S} \times EF_{Nleach} \times \frac{44}{28} \times GWP_{N2O} \quad (24)$$

Where:

$\overline{N2O\_fert_{bsl,indirect,i,t}}$	=	Areal mean indirect nitrous oxide emissions due to fertilizer use in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)
$N2O\_fert_{bsl,volat,i,t}$	=	Indirect nitrous oxide emissions produced from atmospheric deposition of N volatilized due to fertilizer use in the baseline scenario in sample unit *i* in year *t* (t CO_2e)
$N2O\_fert_{bsl,leach,i,t}$	=	Indirect nitrous oxide emissions produced from leaching and runoff of N, in regions where leaching and runoff occurs, due to fertilizer use in the baseline scenario in sample unit *i* in year *t* (t CO_2e)
$Frac_{GASF,l,S}$	=	Fraction of all synthetic N added to soils that volatilizes as NH_3 and NO_x for manure management system S and livestock type *l* (dimensionless)
$Frac_{GASM,l,S}$	=	Fraction of all organic N added to soils and N in manure and urine deposited on soils that volatilizes as NH_3 and NO_x for manure management system S and livestock type *l* (dimensionless)
EF_{Nvolat}	=	Emission factor for nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces (t N_2O-N/(t NH_3-N + NO_x-N volatilized))
$Frac_{LEACH,l,S}$	=	Fraction of N (synthetic or organic) added to soils and in manure and urine deposited on soils that is lost through leaching and runoff, in regions where leaching and runoff occurs, for manure management system S and livestock type *l* (dimensionless)
EF_{Nleach}	=	Emission factor for nitrous oxide emissions from leaching and runoff (t N_2O-N/t N leached and runoff)

4.1.4.2 Nitrous Oxide emissions due to use of nitrogen-fixing species

N-fixing species (e.g. legumes) develop symbiotic relationships with bacteria that carry out biological nitrogen fixation (BNF), converting atmospheric N_2 gas into ammonia that can be subsequently utilised by plants. Soil N originating from the BNF process that is not utilised by plants or microorganisms can become an additional source of N_2O emissions that needs to be quantified.

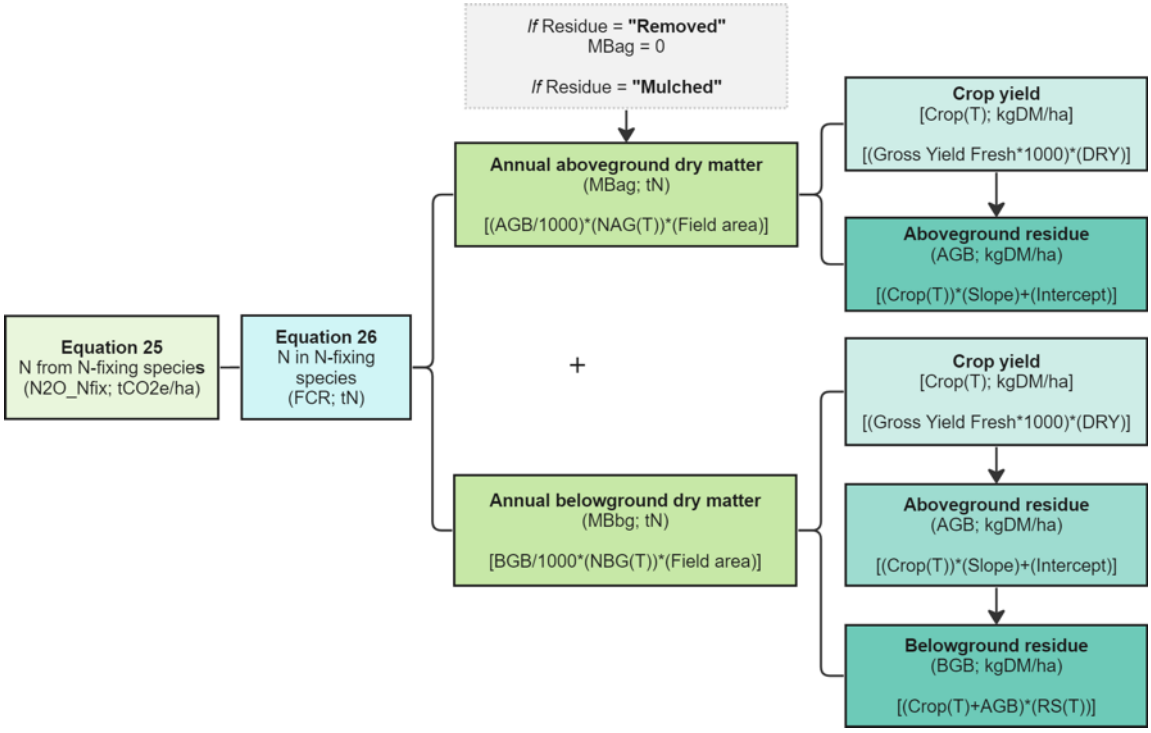


Figure 4-3. Flowchart for calculating N_2O emissions from nitrogen-fixing (N-fixing) species illustrating the additional steps for calculating dry crop yield [Crop(T)], above-ground crop residue (AGB), below-ground crop residue (BGB), above-ground (MBag_N) and below-ground (MBbg_N) N in dry matter returned to the soil. Equations 25 and 26 are from Methodology for Improved Agricultural Land Management (VM0042 v 2.0). The equations and default values used for calculating Crop(T), AGB, BGB, MBag_N and MBbg_N are derived from Equations 11.6 and 11.7 and Table 11.1A and Table 11.2 in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories[222]. Notes: IPCC represents the Intergovernmental Panel on Climate Change; N2O_Nfix represents areal mean nitrous oxide emissions from crop residues due to the use of N-fixing species; FCR represents amount of N in N-fixing species (above- and belowground) returned to soils; NAG(T) represents N fraction of above-ground residues; NBG(T) represents N fraction of below-ground residues; RS(T) represents ratio of below-ground biomass to above-ground biomass; Gross Yield Fresh represents harvested fresh yield for crop; DRY represents dry matter fraction of harvested product.

[222] 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; vol 4. Ch. 11.2.1.3. (https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf)

$$\overline{N2O\_Nfix_{bsl,i,t}} = (F_{CR,bsl,i,t} \times EF_{Ndirect} \times \frac{44}{28} \times GWP_{N2O})/A_i \quad (25)$$

Where:

$\overline{N2O\_Nfix_{bsl,i,t}}$ = Areal mean nitrous oxide emissions from crop residues due to the use of N-fixing species in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$F_{CR,bsl,i,t}$ = Amount of N in N-fixing species (above- and belowground) returned to soils in the baseline scenario for sample unit *i* in year *t* (t N)

$$F_{CR,bsl,i,t} = \sum_{g=1}^{G} MB_{g,bsl,i,t} \times N_{content,g} \quad (26)$$

Where:

$MB_{g,bsl,i,t}$ = Annual dry matter (above- and belowground) of N-fixing species *g* returned to soils for sample unit *i* in year *t* (t dm)

$N_{content,g}$ = Fraction of N in dry matter for N-fixing species *g* (t N/t dm)

g = Type of N-fixing species

To estimate the total N amount in N-fixing species (F_{CR}), the N amounts of aboveground (MBag_N) and belowground (MBag_N), is calculated respectively, and then summed up (Figure 4-2). The detailed calculation steps are as follows.

MBag_N:

1. Calculate the areal mean dry matter crop yield [Crop(T)]
2. Calculate the areal mean dry matter above-ground residues (AGB)
3. Apply logic
    1) IF residue is Removed from the soil surface:

        $MB_{ag,wp,i,t} = 0$

    2) IF residue is Mulched:

Multiply AGB by the PAI area to get the annual dry matter above-ground residues ($MB_{ag,wp,i,t}$) returned to the soil

4. Multiply $MB_{ag,wp,i,t}$ by the aboveground tissue N fraction [NAG(T)] to get the N inputs from the above-ground residues (MBag_N) returned to the soil (Equation 26)

MBbg_N:

1. Multiply the sum of [Crop(T)] and AGB with the root-shoot ratio (RS(T)) to get the areal mean dry matter belowground biomass (BGB)
2. Multiply BGB by the field area to get the annual dry matter below-ground residues ($MB_{bg,wp,i,t}$) returned to the soil
3. Multiply $MB_{bg,wp,i,t}$ by the below-ground tissue N fraction [NBG(T)] to get the N inputs from the below-ground residues (MBbg_N) returned to the soil (Equation 26)

$F_{CR,bsl}$ = MBag_N + MBbg_N (Equation 26)

Table 4-6. Data inputs and outputs for calculating N2O emissions from nitrogen fertilisers and nitrogen-fixing species for the baseline scenarios for i = PAI id 7627.

Parameter	Value	Unit	Description	Source
A_i	13.86	ha	PAI size in hectares	Farm attestation
FSN_{bsl}	3.20	t N	N inputs from synthetic fertiliser	EuropeAgriDB v1.0[223] and Eurostat (*lan_lcv_ovw*)[224]
$M_{bsl,OF}$	0	t	Mass of organic fertiliser OF	Farm attestation
OF	None	-	Organic fertiliser name	Farm attestation
$NC_{OF,bsl}$	-	-	N content of organic fertiliser OF	-

[223] https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772
[224] https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw__custom_12738492/default/table

FON_{bsl}	0	t N	N inputs from organic fertiliser	Equation 21 in VM0042 v 2.0
GWP_{N2O}	265	t CO2e/t N2O	Global warming potential for N_2O	Page 84 in VM0042 v 2.0
$EF_{Ndirect}$	0.01	t N2O-N/t N	Emission factor for nitrous oxide emissions from N additions from synthetic fertilisers, organic amendments and crop residues	Table 11.1 in 2019 IPCC Refinement*
$Frac_{GASF}$	0.11	-	Fraction of all synthetic N added to soils that volatilizes	Table 11.1 in 2019 IPCC Refinement*
$Frac_{GASM}$	0.21	-	Fraction of all organic N added to soils that volatilizes	Table 11.3 in 2019 IPCC Refinement*
EF_{Nvolat}	0.01	t N2O-N/t N	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces	Table 11.3 in 2019 IPCC Refinement*
$Frac_{LEACH}$	0.24	-	Fraction of N that is lost through leaching and runoff	Table 11.3 in 2019 IPCC Refinement*
EF_{Nleach}	0.011	t N2O-N/t N	Emission factor for N_2O emissions from leaching and runoff	Table 11.3 in 2019 IPCC Refinement*
$N2O\_fert_{bsl,direct}$	0.96	t CO2e/ha	Areal mean direct N_2O emissions due to fertiliser use	Equation 19 in VM0042 v 2.0
$N2O\_fert_{bsl,volat}$	1.46	t CO2e	Indirect N_2O emissions produced from atmospheric deposition of N volatilized	Equation 23 in VM0042 v 2.0

$N2O\_fert_{bsl,leach}$	3.52	t CO2e	Indirect N_2O emissions produced from leaching and runoff of N	Equation 24 in VM0042 v 2.0
$N2O\_fert_{bsl,indirect}$	0.36	t CO2e/ha	Areal mean indirect N_2O emissions due to fertiliser use	Equation 22 in VM0042 v 2.0
$N2O\_fert_{bsl}$	1.32	t CO2e/ha	Areal mean N_2O emissions due to fertiliser use	Equation 18 in VM0042 v 2.0
g_{wp}	None	-	Name of N-fixing species	Farm attestation
MBg,bsl ($MBag_{bsl}$)	0	t dm	Annual dry matter above-ground residues returned to the soil	Equations 11.6 and 11.7 and Table 11.2 in 2019 IPCC Refinement*
MBg,bsl ($MBbg_{bsl}$)	0	t dm	Annual dry matter below-ground residues returned to the soil	Equations 11.6 and 11.7 and Table 11.2 in 2019 IPCC Refinement*
$N2O\_Nfix_{bsl}$	0	t CO2e/ha	Areal mean N_2O emissions due to use of N-fixing species	No N-fixing species are applied in the baseline scenarios.
$N2O\_soil_{bsl}$	1.32	t CO2e/ha	Areal mean N_2O emissions from soil	Equation 17 in VM0042 v 2.0

*Note: 2019 IPCC Refinement refers to 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories[225].

4.1.5 Other Emissions

CO2 from woody biomass:

Woody biomass is not included in the project boundary.

CH4 from soil methanogenesis:

[225] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Ch.11 (https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf).

Soil methanogenesis is not included in the project boundaries as the Project does not operate on water-logged or temporarily water-logged soils.

CH4 from enteric fermentation:

Methane (CH4) from enteric fermentation is not included in the project boundaries as the Project does not operate in grasslands or permanent pasture lands.

CH4 from manure deposition:

Methane (CH4) from manure deposition is not included in the project boundaries as the Project does not operate in grasslands or permanent pasture lands.

CH4 from biomass burning:

Methane (CH4) from biomass burning is not included in the project boundaries as the Project does not allow for such practice.

N2O from manure deposition:

Nitrous oxide (N2O) from manure deposition is not included in the project boundaries as the Project does not operate in grasslands or permanent pasture lands.

N2O from biomass burning:

Nitrous oxide (N2O) from biomass burning is not included in the project boundaries as the Project does not allow for such practice.

4.2 Project Emissions

The quantification of GHG emissions and removals for each project will be conducted in accordance with Section 8 of VM0042 v2.0. The same GHG quantification approaches applied to baseline emissions (as outlined in Section 4.1) will also be used for project emissions. However, unlike the baseline emissions, which are modeled using the SoA, the project emissions will be calculated based on the actual reported and verified practices implemented at the PAI throughout the project period.

To distinguish between baseline and project emission calculations, the subscript 'bsl' (for baseline scenario) will be replaced with 'wp' (for with project scenario) in the equations.

4.2.1 Soil Organic Carbon

As in the baseline scenario, SOC stocks for the project scenario will be quantified using the "Quantification Approach 1: Measure and Model" method (VM0042 v2.0, Section 8.1, Table 5), applying the same models, data sources, and methodology. The key difference lies in the inputs,

which will reflect the actual practices reported and verified at the PAI during the project period. These practices will be used in SoilR (RothC implementation), with inputs such as climate data from NASAPOWER, soil properties from SoilGrids, and project-specific management practices.

Table 4-7. Collection of model inputs for the project scenario.

Model Input Category	Timing	Approach
SOC content and bulk density to calculate SOC stocks (initial)	Determined *ex-ante* at project start and validated within +/- 5 years from the project start	For *ex-ante* estimations the model is initiated using existing soil maps (e.g., SoilGrids). The input parameters of the model will be reviewed before the first verification, using direct soil measurements collected within ±5 years of the project start date. See parameter table for $SOC_{wp,i,t}$.
Soil properties (other than bulk density and SOC)	Determined *ex-ante*	Clay content is determined from published soil maps (e.g., SoilGrids). See parameter table $Clay_i$.
Climate variables (e.g., precipitation, temperature)	Continuously monitored *ex-post*	Climate variables are collected daily, and a climate normal is determined for each project PAI over the last 30 years using data from a synthetic weather station located no more than 50 km from the PAI. See the parameter tables for temperature, precipitation, and evapotranspiration.
ALM activities (as identified following procedures in VMD0053, referencing categories of practices outlined in Applicability Condition 1)	Continuously monitored *ex-post*	Required model inputs related to ALM practices will be monitored and recorded for each project year *t*. These inputs are verified using an MRV procedure that combines satellite imagery analysis and documentation auditing.

Table 4.8 below, shows how the model is parameterized for the calculation of project scenario SOC values ($SOC_{wp,i,t}$) for a sample PAI.

Table 4-8 - Model input values utilised to calculate $SOC_{wp,i,t}$ for PAI *i* = 7627, t = 1

Parameter	Value	Unit	Description	Source
time step	1	years	Project time	Project description
DPM	0.006	t C/ha	Initial decomposible plant material	Calculated from Soilgrids values for each PAI
RPM	2.20	t C/ha	Initial resistant Plant Material	Calculated from Soilgrids values for each PAI
BIO	0.50	t C/ha	Initial microbial Biomass	Calculated from Soilgrids values for each PAI.
HUM	57.36	t C/ha	Initial humified Organic Matter	Calculated from Soilgrids values for each PAI
IOM	6.94	t C/ha	Initial inert Organic Matter	Calculated from Soilgrids values for each PAI
Green cover adoption	5	months / year	Monthly soil green cover based on periods of cash and cover crop growth	Farmer attestation
ks	k.DPM = 10 k.RPM = 0.3 k.BIO= 0.66 k.HUM= 0.02 k.IOM = 0	-	A vector of length 5 containing the values of the decomposition rates for the different carbon pools	Standard values described in reference[226]

[226] Coleman, Kevin, and D. S. Jenkinson. "RothC-26.3-A Model for the turnover of carbon in soil." In *Evaluation of soil organic matter models: Using existing long-term datasets*, pp. 237-246. Berlin, Heidelberg: Springer Berlin Heidelberg, 1996.

In	0.16	t C/ha	A scalar specifying the amount of litter inputs per year for the PAI baseline scenarios	Farmer attestation
FYM	0.57	t C/ha	A scalar specifying the amount of Farm Yard Manure inputs per year.	Farmer attestation
clay	40.65	%	Percent clay in mineral soil	Estimated Soilgrids average value collected at PAI level
DR	1.44	-	Decomposable plant material to resistant plant material ratio	Standard values described in reference[227]
Temp	11.17	°C	Monthly mean temperature	Synthetic weather station average PAI value from NASAPOWER
Precip	63.81	mm	Monthly mean precipitation	Synthetic weather station average PAI value from NASAPOWER
Evap	29.05	mm	Monthly mean evapotranspiration	Synthetic weather station average PAI value from NASAPOWER
TRM	0.95	-	Tillage rate modifier	Value extracted from reference[228]

Table 4-9. Model output values for *i = PAI ID 7627, and t = 1*

Parameter	Value	Unit	Description

[227] Coleman, Kevin, and D. S. Jenkinson. "RothC-26.3-A Model for the turnover of carbon in soil." In *Evaluation of soil organic matter models: Using existing long-term datasets*, pp. 237-246. Berlin, Heidelberg: Springer Berlin Heidelberg, 1996.
[228] Jordon, Matthew W., and Pete Smith. "Modelling soil carbon stocks following reduced tillage intensity: A framework to estimate decomposition rate constant modifiers for RothC-26.3, demonstrated in north-west Europe." *Soil and Tillage Research* 222 (2022): 105428.

DPM	0.033	t C/ha	Final decomposible plant material
RPM	1.83	t C/ha	Final resistant Plant Material
BIO	0.43	t C/ha	Final microbial Biomass
HUM	56.17	t C/ha	Final humified Organic Matter
IOM	6.94	t C/ha	Final inert Organic Matter

4.2.2 Carbon Dioxide Emissions From Fossil Fuel Combustion

The sole difference between the project and baseline emission calculations is that we apply the data for fuel consumption amount per hectare reported by farmers in the project emission calculation. All the EFs and equations for the baseline emissions (see Section 4.1.2) are applied for the project emissions.

Table 4-10. Data inputs and outputs for calculating CO_2 emissions from fossil fuel combustion for the project emissions in the PAI *i = PAI ID 7627*

Parameter	Value	Unit	Description	Source
j_{wp}	Diesel	-	Implementation status of energy sources	Farm attestation
$FFC_{wp,j}$ (L/ha)	100	litre/ha	Fuel consumption amount per hectare	Literature and reports (Details in Section 5.1)

$EF_{CO2,j,wp}$	0.002886	tCO2eq/litre	Emission factor for combustion of fossil fuel type j	VM0042 v 2.0 and 2019 IPCC Refinement[229]
$CO2\_ff_{wp}$	0.2886	tCO2eq/ha	CO_2 emissions due to fuel consumption	Equation 7 and 8 (VM0042 v 2.0)

4.2.3 Carbon Dioxide Emissions From Liming

The data[230] of the lime application amounts and agricultural areas for each country in 2021 are applied to calculate CO_2 emissions from liming using the same calculation method for the baseline emissions (Section 4.1.3). Five times the CO_2 emissions (t CO2e/ha) in 2021 for each country are considered as the project emissions to ensure the conservativeness of the emission calculation and the consistency with the five-year baseline data.

Table 4-11. Data inputs and outputs for calculating CO_2 emissions from liming for the project emissions in the sample unit *i* = *PAI ID 7627*

Parameter	Value	Unit	Description	Source
Country	United Kingdom	-	Country of the PAI	Farm attestation
A	3550	K ha	Country actual agricultural land area	Table 4.B-I in 2023 National Inventory Report [231]
$M_{Limestone, wp}$	2392724	t/y	Limestone application amount in the project scenario	Table 3.G-I in 2023 National Inventory Report
$M_{Dolomite,wp}$	257385	t/y	Dolomite application amount in the project scenario	Table 3.G-I in 2023 National Inventory Report

[229] 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; vol 2. Ch. 3.3.1.2 (https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/2_Volume2/19R_V2_2_Ch02_Stationary_Combustion.pdf).

[230] UNFCCC National Inventory Reports: https://unfccc.int/ghg-inventories-annex-i-parties/2023

UNFCCC National Inventory Reports: https://unfccc.int/ghg-inventories-annex-i-parties/2023

$EF_{Limestone,wp}$	0.12	t C/t	Emission factor for the application of calcitic limestone	2019 IPCC Refinement
$EF_{Dolomite,wp}$	0.13	t C/t	Emission factor for the application of dolomite	2019 IPCC Refinement
EL_{wp}	5877	kt CO2e	CO2 emissions from liming in the project scenario (five times emissions in 2021)	Equation 10 (VM0042 v 2.0); Table 3.G-I in 2023 National Inventory Report
$CO2\_lime_{wp}$	1.655	t CO2e/ha	Areal mean CO_2 emissions from liming for project emissions	Equation 9 (VM0042 v 2.0)

Note: 2019 IPCC Refinement refers to 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

4.2.4 Nitrous Oxide Emissions From Nitrogen Fertilisers And Nitrogen-Fixing Species

The project emission calculations are following the same quantification methods applied for the baseline emissions. The synthetic fertiliser application amount and organic fertiliser mass as well as the yields of N-fixing species are described in section 5.1 in the PD. All the EFs and equations for N_2O emissions from soil due to use of fertiliser and N-fixing species in the baseline emission calculations (see Section 4.1.4) are applied for the project emission calculations.

Table 4-12. Data inputs and outputs for calculating N_2O emissions from nitrogen fertilisers and nitrogen-fixing species for the project emissions in the PAI i = *PAI ID 7627*

Parameter	Value	Unit	Description	Source
Ai	13.86	ha	PAI size in hectares	Farm attestation
Organic N fertiliser name	Poultry layer manure	-	Organic fertiliser name, if any	Farm attestation
$M_{wp,OF}$	69.3	t fertiliser	Mass of organic fertiliser, if any	Farm attestation

NC_{OF}	0.019	-	N content of organic fertiliser	Based on literature[232]
FON_{wp}	1.32	t N	N inputs from organic fertiliser	Equation 21 (VM0042 v 2.0)
FSN_{wp}	0	t N	N inputs from synthetic fertiliser	Farm attestation
GWP_{N2O}	265	t CO2e/t N2O	Global warming potential for N_2O	Page 84 in VM0042 v 2.0
$EF_{Ndirect}$	0.01	t N2O-N/t N	Emission factor for nitrous oxide emissions from N additions from synthetic fertilisers, organic amendments and crop residues	Table 11.1 in 2019 IPCC Refinement*
$Frac_{GASF}$	0.11	-	Fraction of all synthetic N added to soils that volatilizes	Table 11.3 in 2019 IPCC Refinement*
$Frac_{GASM}$	0.21	-	Fraction of all organic N added to soils that volatilizes	Table 11.3 in 2019 IPCC Refinement*
EF_{Nvolat}	0.01	t N2O-N/t N	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces	Table 11.3 in 2019 IPCC Refinement*
$Frac_{LEACH}$	0.24	-	Fraction of N that is lost through leaching and runoff	Table 11.3 in 2019 IPCC Refinement*

[232] Delin, S., Stenberg, B., Nyberg, A., & Brohede, L. (2012). Potential methods for estimating nitrogen fertiliser value of organic residues. Soil Use and Management, 28(3), 283-291.

Aboutayeb, Rachid & Elgharous, Mohamed & Abail, Zhor & Faouzi, Badr & Koulali, Yahya. (2014). Short term effects of chicken manure application on soil physicochemical properties cropped with silage maize. International Journal of Innovation and Applied Studies. 9. 2028-9324.

Cool Farm Institute (1013: Cool Farm Tool online guide: Crops. www.coolfarmtool.org

EF_{Nleach}	0.011	t N2O-N/t N	Emission factor for N2O emissions from leaching and runoff	Table 11.3 in 2019 IPCC Refinement*
g_{wp}	Horse Beans	-	Name of N-fixing species	Farm attestation
$P_{wp,p}$	3.27	t Biomass/ha	Average crop productivity	Farm attestation
Crop residue management	Mulched	-	Implementation status of residue management	Farm attestation
DRY	0.91	-	Dry matter fraction of harvested product	Table 11.1A in 2019 IPCC Refinement*
$Slope_{(T)}$	0.36	-	Default slope values in IPCC yield-to-residue equations	Table 11.2 in 2019 IPCC Refinement*
$Intercept_{(T)}$	0.68	-	Default intercept values in IPCC yield-to-residue equations	Table 11.2 in 2019 IPCC Refinement*
$RS_{(T)}$	0.19	-	Ratio of below-ground biomass to above-ground biomass	Table 11.1A in 2019 IPCC Refinement*
Ncontent,g ($N_{AG(T)}$)	0.008	-	N content of above-ground residues	Table 11.1A in 2019 IPCC Refinement*
Ncontent,g ($N_{BG(T)}$)	0.008	-	N content of below-ground residues	Table 11.1A in 2019 IPCC Refinement*
$N2O\_fert_{wp,direct}$	0.396	t CO2e/ha	Areal mean direct N_2O emissions due to fertiliser use	Equation 19 (VM0042 v 2.0)
$N2O\_fert_{wp,volat}$	1.151	t CO2e	Indirect N_2O emissions produced from atmospheric deposition of N volatilized	Equation 23 (VM0042 v 2.0)

$N2O\_fert_{wp,leach}$	1.448	t CO2e	Indirect N_2O emissions produced from leaching and runoff of N	Equation 24 (VM0042 v 2.0)
$N2O\_fert_{wp,indirect}$	0.188	t CO2e/ha	Areal mean indirect N_2O emissions due to fertiliser use	Equation 22 (VM0042 v 2.0)
$N2O\_fert_{wp}$	0.58	t CO2e/ha	Areal mean N_2O emissions due to fertiliser use	Equation 18 (VM0042 v 2.0)
MBg,wp ($MBag_{wp}$)	14.86	t dm	Annual dry matter above-ground residues returned to the soil	Equations 11.6 and 11.7 and Table 11.2 in 2019 IPCC Refinement*
MBg,wp ($MBbg_{wp}$)	10.66	t dm	Annual dry matter below-ground residues returned to the soil	Equations 11.6 and 11.7 and Table 11.2 in 2019 IPCC Refinement*
$MBag\_N_{wp}$	0.119	t N	Total N inputs from above-ground residues	Equation 26 (VM0042 v 2.0)
$MBbg\_N_{wp}$	0.085	t N	Total N inputs from below-ground residues	Equation 26 (VM0042 v 2.0)
$F_{CR,wp}$	0.204	t N	Amount of N in N-fixing species (above- and belowground) returned to soils	Sum of total N inputs from above-ground residues ($MBag\_N_{wp}$) and below-ground residues ($MBbg\_N_{wp}$)
$N2O\_Nfix_{wp}$	0.06	t CO2e/ha	Areal mean N2O emissions from crop residues of N-fixing species	Equation 25 (VM0042 v 2.0)
$N2O\_soil_{wp}$	0.64	t CO2e/ha	Total N2O emissions from soil	Equation 17 (VM0042 v 2.0)

Note: '2019 IPCC Refinement refers' to 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.[233]

4.2.5 Other emissions

CO_2 from woody biomass:

Woody biomass is not included in the project boundary.

CH_4 from soil methanogenesis:

Soil methanogenesis is not included in the project boundaries as the Project does not operate on water-logged or temporarily water-logged soils.

CH_4 from enteric fermentation:

Methane (CH4) from enteric fermentation is not included in the project boundaries as the Project does not operate in grasslands or permanent pasture lands.

CH_4 from manure deposition:

Methane (CH_4) from manure deposition is not included in the project boundaries as the Project does not operate in grasslands or permanent pasture lands.

CH_4 from biomass burning:

Methane (CH_4) from biomass burning is not included in the project boundaries as the Project does not allow for such practice.

N_2O from manure deposition:

Nitrous oxide (N_2O) from manure deposition is not included in the project boundaries as the Project does not operate in grasslands or permanent pasture lands.

N_2O from biomass burning:

Nitrous oxide (N_2O) from biomass burning is not included in the project boundaries as the Project does not allow for such practice.

4.3 Leakage

The project does not cause GHG emissions to change outside of the project boundary as a result of adopted practices or changes to existing practices. According to VM0042 v2.0, the

[233] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Ch.11 (https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf).

AgreenaCarbon Project will implement leakage management activities as outlined in the section on Leakage Management. The scenarios that will be tracked for leakage are as follows.

4.3.1 Accounting for Leakage from Organic Amendments Outside the Project Area

When carbon applications are obtained from outside the project area that were not in the historical baseline period, there are several cases in which a deduction must be applied. The AgreenaCarbon Project flags cases during the internal quality check process in which the manure or compost applied is not produced on-site, the manure is not from an uncontrolled anaerobic lagoon, pond, tank or pit, or when the manure or biosolid is documented to have been used as a soil amendment. In these cases, the deduction is then applied and is calculated based on Equation 34 in VM0042 v2.0 .

$$LE_{OA,t} = \sum_{l} \left(M\_manure_{wp,l,t} \times CC_{wp,l,t} \times 0.12 \times \frac{44}{12} \right) \quad (34)$$

Where:

$LE_{OA,t}$	=	Leakage from organic amendments in year *t* (t CO_2e)
$M\_OA_{wp,l,t}$	=	Mass of organic amendment applied as fertilizer in the project area in year *t* (tonnes)
$CC_{wp,l,t}$	=	Carbon content of organic amendment applied as fertilizer in the project area in year *t* (t C/t manure)
0.12	=	Fraction of manure (i.e., organic amendment) carbon expected to remain in project area soils (unitless)
$\frac{44}{12}$	=	Ratio of molecular weight of carbon dioxide to carbon

Table 4-13. Data inputs and outputs for calculating leakage due to organic amendments for the sample unit i = PAI ID 7627

Parameter	Value	Unit	Description	Source
$M\_manure_{wp,l,t}$	69.3	t	Tons of manure applied to PAI	Farm attestation
$CC_{wp,l,t}$	0.114	t C/t manure	Carbon content (wet)	Based on literature[234]
$LE_{OA,t}$	3.48	t CO2e	Leakage from organic amendments in year t	Equation 34 (VM0042 v 2.0)

4.3.2 Accounting for Leakage from Livestock Displacement

Livestock is not included in the project boundary.

4.3.3 Accounting for Leakage from Productivity Declines

As is stated in VM0042 v2.0 , market leakage is likely to be negligible yet VM0042 v2.0 requires that the productivity calculations need to be completed every ten years. The AgreenaCarbon Project has not run for ten years, so we do not calculate the leakage from productivity declines at the current period. However, it will be calculated after ten-year of data have been collected. Here, we only provide the quantification methods based on the methodology VM0042 v2.0.

Step 1: Determine whether the productivity of each crop product has declined by over 5 percent in the project scenario:

1) Apply Equation 35 to calculate the change in the productivity of each crop product.

[234] Aboutayeb, Rachid & Elgharous, Mohamed & Abail, Zhor & Faouzi, Badr & Koulali, Yahya. (2014). Short term effects of chicken manure application on soil physicochemical properties cropped with silage maize. International Journal of Innovation and Applied Studies. 9. 2028-9324.

$$\Delta P = \left(\frac{P_{wp,p} - P_{bsl,p}}{P_{bsl,p}} \right) \times 100 \quad (35)$$

Where:

ΔP	=	Change in productivity (%)
$P_{wp,p}$	=	Average productivity for product *p* during the project period (output/ha)
$P_{bsl,p}$	=	Average productivity for product *p* during the historical look-back period (output/ha)
p	=	Crop/livestock product

2) Or apply Equation 36 to calculate the change in productivity ratio per hectare for each crop product. Regional data can be retrieved from government, industry, peer-reviewed research, academic or international organization (e.g., FAO) sources. A productivity decline of 10 percent in the project scenario would be acceptable if regional data show a 10 percent decline in the corresponding crop productivity.

$$\Delta PR = \left(\frac{P_{wp,p}}{RP_{wp,p}} - \frac{P_{bsl,p}}{RP_{bsl,p}} \right) \times 100 \quad (36)$$

Where:

ΔPR	=	Change in productivity ratio per hectare (%)
$P_{wp,p}$	=	Average productivity for crop/livestock product *p* during the project period (output/ha)
$P_{bsl,p}$	=	Average productivity for product *p* during the historical look-back period (output/ha)
$RP_{wp,p}$	=	Average regional productivity for product *p* during the project period (output/ha)
$RP_{bsl,p}$	=	Average regional productivity for product *p* during the historical look-back period (output/ha)
p	=	Crop/livestock product

When new crop products are adopted in the project that are not present in the baseline, the calculations of changes in crop productivity should apply Equation 36 and set $P_{bsl,p}$ equal to $RP_{bsl,p}$.

No further action is needed when a change in crop productivity is less than 5 percent. If a reduction in productivity of one or more crop products is more than 5 percent, Step 2 should be conducted.

Step 2: Determine whether the crop productivity decline by more than 5 percent results from a short-term productivity decrease. To do this, data inputs from the first three years of project implementation are removed and the following calculation is performed as described in Step 1. No further action is needed when the crop productivity decline without data inputs from the first three years is less than 5 percent; Otherwise, Step 3 should be conducted.

Step 3: Determine whether the result of a loss in productivity is due to a combination of factors such as different practice changes, crop type, soil type and climatic zone. If a certain combination of factors lead to the productivity decline, then the combination of factors must be removed for future crediting.

4.3.4 Accounting for Leakage from Diversion of Biomass Residues Used for Energy Applications in the Baseline Scenario

Crop residue management is a component of the project activity, and those crop residues could be diverted from energy applications in the baseline scenario, leading to a risk of leakage. This leakage will be calculated according to Equation S1 in CDM Methodological Tool: Project and leakage emissions from biomass[235].

$$LE_{BR,Div,y} = EF_{CO2,LE} \times \sum_{n} BR_{PJ,n,y} \times NCV_{n,y} \qquad \text{Equation (67)}$$

Where:

$LE_{BR,Div,y}$	=	Leakage emissions due to the diversion of biomass residues from other applications in year *y* (t CO_2e)
$EF_{CO2,LE}$	=	CO_2 emission factor of the most carbon intensive fossil fuel used in the country (t CO_2/GJ)
$BR_{PJ,n,y}$	=	Quantity of biomass residues of category *n* used in facilities which are located at the project site and included in the project boundary in year *y* (tonnes on dry-basis)
$NCV_{n,y}$	=	Net calorific value of the biomass residues of category *n* in year *y* (GJ/tonne of dry matter)
n	=	Categories of biomass residues for which B4 has been identified as the alternative scenario

[235] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-16-v5.0.pdf

Table 4-14. Data inputs and outputs for calculating the leakage from the diversion of biomass residues used for energy applications in the baseline scenario for i = PAI ID 7627

Parameter	Value	Unit	Description	Source
$EF_{CO2,LE}$	0.0946; 0.0741; 0.0561	t CO2 / GJ	Emission factor of coal, oil and natural gas, respectively	Table 2.2 in 2019 IPCC Refinement[236]; International Energy Agency[237]
$BR_{pj,n,y}$	0	t DMy	Quantity of residue	Farmer reported data
$NCV_{n,y}$	14.44	GJ / t	Net calorific value of residue	Teagasc Agriculture and Food Development Authority[238]; Danish Energy Agency[239]
LE_BR,y	0	t CO2e	Leakage emission[240]	Equation 67

4.4 Net GHG Emission Reductions and Removals

The forthcoming section outlines the calculations for emission reductions and removals, focusing on two types of emissions: carbon dioxide and nitrous oxide from various emission sources. It also elaborates on the computation of model uncertainty and its deduction from the total ERRs.

4.4.1 Carbon Dioxide Emission Reductions and Removals

[236] 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; vol 2. Ch. 2. (https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf)

[237] https://www.iea.org/regions/europe/energy-mix
[238] https://www.teagasc.ie/media/website/publications/2010/868_StrawForEnergy-1.pdf
[239] https://ens.dk/sites/ens.dk/files/Statistik/metode_halm.pdf
[240] Agricultural residue contributes ~3.3% of the EU's renewable energy. Based on this, it was estimated that 3.3% of residues left to mulch would have been used for energy production. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0650&amp%3Bqid=1708966429742#document2

The Change in Soil Organic Carbon (ΔCO2soil) is determined using a validated model, as specified in Equation 40 from VM0042 v2.0. ΔCO2soil is defined by establishing the differences in soil organic carbon concentrations between the project scenario and the baseline scenario.

$$\Delta CO2\_soil_t = \sum_{i=1}^{n} \left(\left(\left(\overline{SOC_{wp,i,t}} - \overline{SOC_{wp,i,t-1}} \right) - \left(\overline{SOC_{bsl,i,t}} - \overline{SOC_{bsl,i,t-1}} \right) \right) \times \frac{44}{12} \right) \times A_i \quad (40)$$

Where:

$\overline{SOC_{wp,i,t}}$	=	Areal mean carbon stocks in the SOC pool in the project scenario for sample unit *i* at the end of year *t* (t CO_2e /ha)
$\overline{SOC_{wp,i,t-1}}$	=	Areal mean carbon stocks in the SOC pool in the project scenario for sample unit *i* at the end of year *t* − 1 (t CO_2e/ha)
$\overline{SOC_{bsl,i,t}}$	=	Areal mean carbon stocks in the SOC pool in the baseline scenario for sample unit *i* at the end of year *t* (t CO_2e/ha)
$\overline{SOC_{bsl,i,t-1}}$	=	Areal mean carbon stocks in the SOC pool in the baseline scenario for sample unit *i* at the end of year *t* − 1 (t CO_2e/ha)

Carbon dioxide emission reductions from fossil fuel combustion are quantified as the differences in CO2 emissions from fossil fuel combustion between the project and the baseline scenario.

$$\Delta CO2\_ff_t = \sum_{i=1}^{n} \left(\overline{CO2\_ff_{wp,i,t}} - \overline{CO2\_ff_{bsl,i,t}} \right) \times A_i \quad (41)$$

Where:

$\overline{CO2\_ff_{wp,i,t}}$	=	Areal mean carbon dioxide emissions from fossil fuel combustion in the project scenario for sample unit *i* in year *t* (t CO_2e/ha)

Carbon dioxide emission reductions from liming are quantified as the differences in CO2 emissions from liming between the project and the baseline scenario.

$$\Delta CO2\_lime_t = \sum_{i=1}^{n} \left(\overline{CO2\_lime_{wp,i,t}} - \overline{CO2\_lime_{bsl,i,t}} \right) \times A_i \quad (44)$$

Where:

$\overline{CO2\_lime_{wp,i,t}}$ = Areal mean carbon dioxide emissions from liming in the project scenario for sample unit *i* in year *t* (t CO_2e/ha)

$\overline{CO2\_lime_{bsl,i,t}}$ = Areal mean carbon dioxide emissions from liming in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

It must be noted that carbon dioxide emission removals in tree biomass and shrub biomass are not included in the AgreenaCarbon project boundary.

Table 4-15. Data inputs and outputs for calculating carbon dioxide emission reductions and removals in the PAI *i* = 7627

Parameter	Value	Unit	Description	Source
Ai	13.86	ha	PAI size in hectares	Farm attestation
$SOC_{bsl, t}$	65.185	t C/ha	Areal mean SOC in the baseline scenario at the end of year t	Equation 6 (VM0042 v 2.0)
$SOC_{bsl, t-1}$	67	t C/ha	Areal mean SOC in the baseline scenario at the end of year t-1	Equation 6 (VM0042 v 2.0)
$SOC_{wp, t}$	65.403	t C/ha	Areal mean SOC in the project scenario at the end of year t	Equation 6 (VM0042 v 2.0)
$SOC_{wp, t-1}$	67	t C/ha	Areal mean SOC in the project scenario at the end of year t-1	Equation 6 (VM0042 v 2.0)
$\Delta CO2\_soil_t$	11.1	t CO2e	Change in soil organic carbon in year t	Equation 40 (VM0042 v 2.0)
$CO2\_ff_{wp}$	0.2886	t CO2e/ha	Areal mean CO_2 emissions from fossil fuel combustion in the project emissions	Calculation as discussed in Section 4.2.3 of PD
$CO2\_ff_{bsl}$	0.2886	t CO2e/ha	Areal mean CO_2 emissions from fossil fuel combustion in the baseline emissions	Calculation as discussed in Section 4.1.2 of PD

$\Delta CO2\_ff_t$	0	t CO2e	CO_2 emission reductions from fossil fuel combustion	Equation 41 (VM0042 v 2.0)
$CO2\_lime_{wp}$	1.655	t CO2e/ha	Areal mean CO_2 emissions from liming in the project emissions	Calculation as discussed in Section 4.2.4 of PD
$CO2\_lime_{bsl}$	1.43	t CO2e/ha	Areal mean CO_2 emissions from liming in the baseline emissions	Calculation as discussed in Section 4.1.3 of PD
$\Delta CO2\_lime_t$	-3.12	t CO2e	CO_2 emission reductions from liming	Equation 44 (VM0042 v 2.0)

4.4.2 Nitrous Oxide Emission Reductions (ΔN2Ot)

Nitrous oxide emission reductions from nitrification/denitrification are quantified as the differences in N2O emission from soil between the project and the baseline scenario.

$$\Delta N2O\_soil_t = \sum_{i=1}^{n} \left(\overline{N2O\_soil_{bsl,i,t}} - \overline{N2O\_soil_{wp,i,t}}\right) \times A_i \quad (49)$$

Where:

$\overline{N2O\_soil_{bsl,i,t}}$ = Areal mean nitrous oxide emissions from nitrogen inputs to soils in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$\overline{N2O\_soil_{wp,i,t}}$ = Areal mean nitrous oxide emissions from nitrogen inputs to soils in the project scenario for sample unit *i* in year *t* (t CO_2e/ha)

Nitrous oxide emission reductions from biomass burning are not included in the AgreenaCarbon project boundary.

Table 4-16. Data inputs and outputs for calculating nitrous oxide emission reductions in the PAI *i* = 7627

Parameter	Value	Unit	Description	Source
Ai	13.86	ha	PAI size in hectares	Farm attestation
$N2O\_soil_{bsl}$	1.32	t CO2e/ha	Areal mean N_2O emissions from soil in the baseline emissions	Calculation as discussed in Section 4.1.4 of PD
$N2O\_soil_{wp}$	0.64	t CO2e/ha	Areal mean N_2O emissions from soil in the project emissions	Calculation as discussed in Section 4.2.5 of PD
$\Delta N2O\_soil_t$	9.4	t CO2e	N_2O emission reductions from nitrification/ denitrification in soil	Equation 49 (VM0042 v 2.0)

4.4.3 Methane Emission Reductions (ΔCH4t)

Methane emission is not included in the project boundary.

4.4.4 Uncertainty

This PD adopts Quantification Approach 1 (Measure and Model) to quantify changes in SOC stocks. All other emissions sources are quantified using Approach 3 (Default factors). Management data are collected across every PAI; as such these sources are not subject to measurement error, and thus do not factor into the calculation of the uncertainty deduction (see 8.6.3 of VM0042 v2.0).

Model prediction error and sampling error are computed via the "Analytical Calculation of Error Propagation" as described in Section 8.6.1.1, which we will subsequently detail. Other model inputs (e.g. project area, management data) are subject to QA/QC procedures detailed elsewhere in the PD; uncertainty in these quantities is not within the scope of Section 8.6. For model prediction error, the "Variance of the estimate of mean emission reductions" is computed as

described in sections 8.6.1.1.4 and 8.6.4. All equations are reproduced here for clarity. The term "Emission reduction in gas or pool" in Equations 51-54 and 65 here used refers to emission removal (i.e. change in SOC stocks).

Model prediction error

Computing model prediction error proceeds using data from the calibration and validation data (CVD) used to satisfy requirements in VMD0053 v2.0, as well as model predictions for PAIs. Equation 51 in VM0042 v 2.0 is used to compute model prediction errors.

$$s^2_{model,\Delta\bullet} = s^2\left(\widehat{\Delta\bullet}_{bsl} - \widehat{\Delta\bullet}_{pr}\right) = 2\left[s^2_{model,\bullet} - cov(\widehat{\Delta\bullet}_{pr}, \widehat{\Delta\bullet}_{bsl})\right] \quad (51)$$

Where:

$s^2_{model,\Delta\bullet}$	=	Variance of modeled estimates of emission reductions in gas or pool • (t CO_2e/ha)^2
$\widehat{\Delta\bullet}_{bsl}$	=	Modeled estimate of change in emissions reductions in gas or pool • in the baseline scenario (t CO_2e)
$\widehat{\Delta\bullet}_{pr}$	=	Modeled estimate of change in emissions reductions in gas or pool • in the project scenario (t CO_2e)
$s^2_{model,\bullet}$	=	Estimated variance of errors made by model prediction of emissions in gas or pool • (estimated from measurements in fields that need not be side-by-side trials with baseline and project scenarios) (t CO_2e/ha)^2

$$\rho = \frac{cov(\widehat{\Delta\bullet}_{pr}, \widehat{\Delta\bullet}_{bsl})}{\sqrt{(s^2_{model,\bullet\,pr})(s^2_{model,\bullet\,bsl})}} \quad (52)$$

Then:

$$s^2_{model,\Delta\bullet} = 2\, s^2_{model,\bullet}\,(1-\rho)$$

Where:

ρ	=	Correlation of errors in project and baseline scenario pairs (estimated from side-by-side field trials of baseline and project scenarios)

The CVD has insufficient paired fields to estimate $Cov\left[\widehat{\Delta\bullet}_{pr}, \widehat{\Delta\bullet}_{bsl}\right]$ across all our management practice changes, so this quantity is conservatively set to zero (i.e we set $\rho = 0$ in Equation 52 VM0042 v2.0). This choice is conservative because if we were to overestimate the change in SOC in the baseline, then we would be likely to overestimate change in SOC under the practice

change, leading to a positive value for $Cov[\widehat{\Delta \bullet}_{pr}, \widehat{\Delta \bullet}_{bsl}]$. A positive value for $Cov[\widehat{\Delta \bullet}_{pr}, \widehat{\Delta \bullet}_{bsl}]$ results in smaller model prediction error and thus smaller uncertainty deduction; setting this quantity to zero thus increases the uncertainty deduction.

Sampling error

Sampling error is estimated using soil sampling data, model runs and Equation 53 in VM0042 v2.0 . The SOC stocks of the model are initialised using each soil sample.

$$s^2_{sampling,\Delta\bullet,t} = \sum_{h=1}^{H} s^2_{sampling,\Delta\bullet,h,t} \quad (53)$$

Where:

$$s^2_{sampling,\Delta\bullet,h,t} = \frac{A_h^2}{n_h(n_h-1)} \sum_{ip=1}^{n_h} \left(\Delta\bullet_{h,ip,t} - \overline{\Delta\bullet_{h,t}}\right)^2$$

and:

$s^2_{sampling,\Delta\bullet,t}$	=	Variance of emission reductions in gas or pool • due to sampling error at time *t* across the entire project area (t CO_2e)^2
$s^2_{sampling,\Delta\bullet,h,t}$	=	Variance of emission reductions in gas or pool • within stratum *h* due to sampling error at time *t* (t CO_2e)^2
$\overline{\Delta\bullet_{h,t}}$	=	Areal mean emissions reduction in gas or pool • in stratum *h* at time *t*, computed as the average across the sample points in stratum *h* (t CO_2e/ha)
$\Delta\bullet_{h,ip,t}$	=	Estimated emissions reduction of gas or pool • on an area basis in year *t* in stratum *h* at point *ip* (t CO_2e/ha)
h	=	1, ..., *H* strata across the entire project area
ip	=	1, ..., n_h sample points within stratum *h*
A_h	=	Area of stratum *h*

Combined model prediction and sampling error

Combined model prediction and sampling error $s^2_{\underline{\Delta\bullet},t}$ is computed for the mean emissions reductions/removals estimate as it relates to Equation 54 in VM0042 v2.0.

$$s^2_{\overline{\Delta\bullet},t} = \frac{s^2_{sampling,\Delta\bullet,t}}{A^2} + s^2_{model} \quad (54)$$

Where:

$s^2_{\overline{\Delta\bullet},t}$	=	Variance of the estimate of mean emission reductions from gas or pool • at time *t* (t CO_2e/ha)^2
s^2_{model}	=	Variance of the estimate of emission reductions in gas or pool • due to model prediction error (t CO_2e/ha)^2
A	=	Total project area

Final uncertainty deduction

Given the estimate of combined model prediction and sampling error, we compute the uncertainty deduction $UNC_{\underline{\Delta\bullet},t}$ using Equation 65 in VM0042 v2.0.

$$UNC_{\overline{\Delta\cdot},t} = Uncertainty \times t_{\alpha=0.666} \quad (65)$$

$$Uncertainty = \frac{\sqrt{s^2_{\overline{\Delta\cdot},t}}}{\overline{\Delta\cdot}_t} \times 100$$

Where:

$UNC_{\overline{\Delta\cdot},t}$	=	Uncertainty deduction for gas or pool • to be applied in verification period *t* (%)
Uncertainty	=	Half-width of the one standard deviation interval as a percentage of the mean of the ERR estimate for gas or pool • in verification period *t* (%)
$\overline{\Delta\cdot}_t$	=	Mean estimated emissions reduction for gas or pool • across the entire project area in year *t* (t CO_2e/ha)
$s^2_{\overline{\Delta\cdot},t}$	=	Variance of the estimate of mean emission reductions from gas or pool • at time *t*. See Figure 3 to determine how this is estimated based on the methods employed in the project (t CO2e/ha)^2
$t_{\alpha=0.666}$	=	Critical value of a one-sided student's t-distribution at significance level α = 0.666 (66.6%) with degrees of freedom appropriate to the sampling design used. Equal to approximately 0.4307 at large sample sizes (dimensionless)

As this calculation depends on the value of $\overline{\Delta\cdot}_t$, the precise uncertainty deduction is verification period-specific and will thus be reported in future monitoring reports. Indicatively, suppose a future monitoring report estimates a $\overline{\Delta\cdot}_t = 0.828$ (t CO2e/ha) over a 1-year period, with a

corresponding $s^2_{\overline{\Delta}_t} = 0.36$ (t CO2e/ha)^2 combined model and sampling error. Applying equation 65 in VM0042 v2.0 yields an uncertainty deduction of 31.35%.

Results and table of computed quantities

List of quantities and indicative values as required to compute the uncertainty deduction. All values are indicative, as they depend on ERR calculations that will be contained in the monitoring report, and the specific verification period. Quantities that are strata-specific (i.e. subscripted with h) have specific values shown for soil sampling strata h=18.

Table 4-17. Data inputs and outputs for calculating the uncertainty deduction

Parameter	Value	Unit	Source	Notes
$cov(\widehat{\Delta}\bullet_{pr}, \widehat{\Delta}\bullet_{bsl})$	0	-	Conservative estimate	Implies ρ=0 in Equation 52 (VM0042 v 2.0)
$s^2_{model,\Delta\bullet}$	0.359713	$(t\ CO_2e/ha)^2$	Equation 51 (VM0042 v2.0) and the MVR following VMD0053 v2.0	
A_h	104829	ha	Post QA/QC field boundaries	Note that, in line with the text of 8.6.1.1.3, these strata and areas are specific to each verification report/period, and will be fully reported at such a time.
A	479834	ha	Post QA/QC field boundaries	
n_h	4111	# fields	Post QA/QC field boundaries	

$\Delta \bullet_{h,ip,t}$	0.404	$t\ CO_2e/ha$	Model runs from soil sampling initial values, $ip = 1$	
$\overline{\Delta \cdot}_{h,t}$	0.387	$t\ CO_2e/ha$	Mean of ip points within strata h	
$s^2_{sampling,\Delta\bullet,h,t}$	1153858	$(t\ CO_2e/ha)^2$	Equation 53 (VM0042 v2.0) – not yet normalised by total project area	This is the unnumbered equation just after Equation 53 (VM0042 v2.0 .0)
$s^2_{sampling,\Delta\bullet,t}$	87042144	$(t\ CO_2e/ha)^2$	Equation 53 (VM0042 v2.0) – not yet normalised by total project area	
$s^2_{\overline{\Delta \cdot}_t}$	0.363343	$(t\ CO_2e/ha)^2$	Equation 54 (VM0042 v2.0)	
$\overline{\Delta \cdot}_t$	0.828	$t\ CO_2e/ha$	Monitoring report/ERR sheet – average SOC stock increase for the period	
$t_{\alpha=0.666}$	0.4307	-	Sample size, thus degrees-of-freedom for the t-distribution, is sufficiently large for this approximation	
$UNC_{\overline{\Delta \cdot}_t}$	31.35	%	Equation 65 (VM0042 v2.0)	Uncertainty deduction applied to SOC stock removals, used in

				Equation 38 (VM0042 v2.0)

4.4.5 Summary calculations of emission reduction and removals

Net GHG emissions are calculated based on Equations 37, 38, and 39 from VM0042 v2.0, that describe the process of quantifying both the reductions in emissions from various anthropogenic sources and the enhancements in carbon sequestration that lead to carbon reductions. Equation 37 outlines the methodology for calculating emission reductions from sources such as fossil fuels, livestock, and biomass burning, including adjustments for uncertainty factors. Equation 38 details the calculation of carbon removals, taking into account increases in soil organic carbon pools, tree biomass, and shrub biomass, while also accounting for potential leakage emissions that might offset these gains. Finally, Equation 39 combines these reductions and removals to provide a measure of net GHG emissions impact for a given year.

$$E_{red,t} = \Delta CO2\_ff_t + \Delta CO2\_lime_t + \Delta CH4\_ent_t + \Delta CH4\_md_t + \Delta CH4\_bb_t + \left(\Delta CH4\_soil_t \times \left(1 - UNC_{t,CH4\_soil}\right)\right) + \left(\Delta N2O\_soil_t \times \left(1 - UNC_{t,N2O\_soil}\right)\right) + \Delta N2O\_bb_t \quad (37)$$

Where:

$E_{red,t}$	=	Estimated net GHG emissions reductions in year t (t CO_2e)
$\Delta CO2\_ff_t$	=	Total carbon dioxide emission reductions from fossil fuel combustion in year t (t CO_2e)
$\Delta CO2\_lime_t$	=	Total carbon dioxide emission reductions from liming in year t (t CO_2e)
$\Delta CH4\_ent_t$	=	Total methane emission reductions from livestock enteric fermentation in year t (t CO_2e)
$\Delta CH4\_md_t$	=	Total methane emission reductions from manure deposition in year t (t CO_2e)
$\Delta CH4\_bb_t$	=	Total methane emission reductions from avoided or reduced biomass burning in year t (t CO_2e)
$\Delta CH4\_soil_t$	=	Total methane emission reductions from increasing uptake into the SOC pool in year t (t CO_2e)
$UNC_{t,CH4\_soil}$	=	Uncertainty deduction in year t when using Quantification Approach 1 to model methane emission reductions from increasing uptake into the SOC pool (fraction between 0 and 1)
$\Delta N2O\_soil_t$	=	Total nitrous oxide emission reductions from nitrification/denitrification in year t (t CO_2e)

$UNC_{t,N2O\_soil}$ = Uncertainty deduction in year *t* when using Quantification Approach 1 to model nitrous oxide emission reductions from nitrification/denitrification (fraction between 0 and 1)

$\Delta N2O\_bb_t$ = Total nitrous oxide emission reductions from avoided or reduced biomass burning in year *t* (t CO_2e)

$$E_{rem,t} = \left(\left(\Delta CO2_{soil_t} - LE_{OA,t} - LE_{BR,t}\right) \times \left(1 - UNC_{t,CO2}\right)\right) + \Delta C_{TREE,t} + \Delta C_{SHRUB,t} \quad (38)$$

Where:

$E_{rem,t}$ = Estimated net GHG emissions removals in year *t* (t CO_2e)

$\Delta CO2\_soil_t$ = Total carbon dioxide emission removals from increasing the SOC pool in year *t* (t CO_2e)

$LE_{BR,t}$ = Leakage emissions from the diversion of manure or crop residues from baseline energy applications in year *t* (t CO_2e)

$\Delta C_{TREE,t}$ = Total carbon dioxide emission removals from increasing tree biomass in year *t* (t CO_2e)

$\Delta C_{SHRUB,t}$ = Total carbon dioxide emission removals from increasing shrub biomass in year *t* (t CO_2e)

$UNC_{t,CO2}$ = Uncertainty deduction in year *t* associated with modeling or measuring SOC stock changes (fraction between 0 and 1)

$$ERR_t = E_{red,t} + E_{rem,t} \quad (39)$$

Where:

$ERR_{n,t}$ = Estimated net GHG emissions reductions and removals in year *t* (t CO_2e)

Table 4-18. Data inputs and outputs for calculating net GHG emission reductions and removals in the sample unit *i* = *PAI ID 7627*

Parameter	Value	Unit	Description	Source
$\Delta CO2\_ff_t$	0	t CO2e	CO2 emission reductions from fossil fuel combustion	Calculation as discussed in Section 4.4.1 of PD

$\Delta CO2\_lime_t$	-3.12	t CO2e	CO2 emission reductions from liming	Calculation as discussed in Section 4.4.1 of PD
$\Delta N2O\_soil_t$	9.4	t CO2e	N2O emission reductions from nitrification/ denitrification in soil	Calculation as discussed in Section co2_lime of PD
$\Delta CO2\_soil_t$	11.1	t CO2e	CO2 emission removals from increasing the SOC pool in year t	Calculation as discussed in Section 4.4.1 of PD
$LE_{BR,t}$	3.48	t CO2e	Leakage emissions	Leakage calculations as discussed in Section 4.3
$UNC_{t,\ CO2}$	31.35	%	Uncertainty deduction in year t associated modelling SOC stock changes	Uncertainty calculations as discussed in Section 4.4.4
$E_{red,\ t}$	6.24	t CO2e	Estimated net GHG emissions reductions	Equation 37 (VM0042 v 2.0)
$E_{rem,\ t}$	5.23	t CO2e	Estimated net GHG emissions removals	Equation 38 (VM0042 v 2.0)
ERR_t	11.48	t CO2e	Estimated net GHG emissions reductions and removals	Equation 39 (VM0042 v 2.0)

4.4.6 Calculation of Verified Carbon Units

Verified Carbon Units (VCUs) are calculated using Equation 66 from VM0042 v2.0 , which integrates the values of Ered, Erem, and the Buffer. The buffer acts as a reserve of credits to account for potential reversals in the project's ERRs according to the latest version of the VCS AFOLU Non-Permanence Risk Tool. VCUs represent the verified emissions reductions and removals achieved by the project and are issued as units of carbon credits.

$$VCU_t = E_{red,t} + (E_{rem,t} - Buffer_t) \quad (66)$$

Where:

VCU_t = Number of VCUs in year t (t CO_2e)
$Buffer_t$ = Number of buffer credits to be contributed to the AFOLU pooled buffer account in year t (t CO_2e)

Table 4-19. Data inputs and outputs for calculating verified carbon units for the sample unit *i* = *PAI ID 7627*

Parameter	Value	Unit	Description	Source
$E_{red,\,t}$	6.24	t CO2e	Estimated net GHG emissions reductions	Calculations as discussed in section 4.4.5
$E_{rem,\,t}$	5.23	t CO2e	Estimated net GHG emissions removals	Calculations as discussed in section 4.4.5
$Buffer_t$	1.09	t CO2e	Number of buffer credits to be contributed to the AFOLU pooled buffer account	The VCS AFOLU Non-Permanence Risk Tool

VCU_t	10.38	t CO2e	Number of VCUs	Equation 6 (VM0042 v 2.0)

Table 4-20. Net GHG Emission Reductions and Removals.

Vintage	Estimated baseline emissions or removals (t CO_2e)	Estimated project emissions or removals (t CO_2e)	Estimated leakage emissions (t CO_2e)	Estimated uncertainty deduction (t CO_2e)	Estimated Net GHG Emission Reductions and Removals (t CO_2e)	Buffer Pool Allocation [241]	Estimated VCUs for Issuance
15/09/21 - 31/12/21	26,040.82	-778.16	0.00	5,587.20	21,231.79	2,569.33	18,662.46
01/01/22 – 31/12/22	636,548.54	-37,095.28	2,350.87	123,836.04	547,456.91	56,947.40	490,509.51
01/01/23 - 31/12/23	634,414.75	-37,116.40	4,958.17	123,018.66	543,554.32	56,571.52	486,982.81
01/01/24 - 31/12/24	632,755.43	-37,100.32	4,626.25	123,122.71	542,106.78	56,619.37	485,487.41
01/01/25 - 31/12/25	632,647.04	-37,106.20	4,786.39	123,072.51	541,894.34	56,596.28	485,298.06
01/01/26 - 31/12/26	632,963.89	-37,110.63	5,121.31	122,967.51	541,985.70	56,548.00	485,437.70
01/01/27 - 31/12/27	636,548.54	-37,095.28	2,350.87	123,836.04	547,456.91	56,947.40	490,509.51
01/01/28 - 31/12/28	634,414.75	-37,116.40	4,958.17	123,018.66	543,554.32	56,571.52	486,982.81

[241] The buffer pool allocation is equal to 21%. More information is available in the AFOLU Non-Permanence Risk Tool.

01/01/29 - 31/12/29	632,755.43	-37,100.32	4,626.25	123,122.71	542,106.78	56,619.37	485,487.41
01/01/30 - 31/12/30	632,647.04	-37,106.20	4,786.39	123,072.51	541,894.34	56,596.28	485,298.06
01/01/31 - 31/12/31	632,963.89	-37,110.63	5,121.31	122,967.51	541,985.70	56,548.00	485,437.70
01/01/32 - 31/12/32	636,548.54	-37,095.28	2,350.87	123,836.04	547,456.91	56,947.40	490,509.51
01/01/33 - 31/12/33	634,414.75	-37,116.40	4,958.17	123,018.66	543,554.32	56,571.52	486,982.81
01/01/34 - 31/12/34	632,755.43	-37,100.32	4,626.25	123,122.71	542,106.78	56,619.37	485,487.41
01/01/35 - 31/12/35	632,647.04	-37,106.20	4,786.39	123,072.51	541,894.34	56,596.28	485,298.06
01/01/36 - 31/12/36	632,963.89	-37,110.63	5,121.31	122,967.51	541,985.70	56,548.00	485,437.70
01/01/37 - 31/12/37	636,548.54	-37,095.28	2,350.87	123,836.04	547,456.91	56,947.40	490,509.51
01/01/38 - 31/12/38	634,414.75	-37,116.40	4,958.17	123,018.66	543,554.32	56,571.52	486,982.81
01/01/39 - 31/12/39	632,755.43	-37,100.32	4,626.25	123,122.71	542,106.78	56,619.37	485,487.41
01/01/40 - 31/12/40	632,647.04	-37,106.20	4,786.39	123,072.51	541,894.34	56,596.28	485,298.06
01/01/41 - 09/14/41	606,245.68	-36,333.25	4,999.94	117,418.37	520,160.62	53,996.16	466,164.46

Crediting Period	Total Estimated VCUs	Yearly Average Estimated VCUs
20 Years	9,734,251.15	486,712.56

5 MONITORING

5.1 Data and Parameters Available at Validation

The VM0042 v2.0 parameters that are relevant to the AgreenaCarbon Project are listed in the section below. The data for these parameters are collected during the validation stage and used for ex-ante estimations. The parameters that are not relevant to the AgreenaCarbon Project yet are included in the VM0042 v2.0 methodology are listed in the Table 5-1. All parameters that are monitored as part of the AgreenaCarbon Project are represented in the text below, and no additional parameters are included as data collected outside of the necessary criteria laid out by VM0042 v2.0.

Data / Parameter	*AR*
Data unit	Percent
Description	Weighted mean adoption rate
Equations	Equation 1
Source of data	Calculated for the Project across the group or all activity instances
Value applied	

Country	(EA) RT + OF	(EA) RT + CC	(EA) RT + M	(AR) Tilling + OF + CC + M
Bulgaria	4.07%	0.09%	1.76%	0.33%
Denmark	4.84%	1.71%	0.40%	0.86%
Estonia	4.92%	0.94%	5.03%	4.24%
Spain	6.78%	1.41%	1.51%	8.67%

	Latvia	0.79%	0.23%	0.45%	0.29%
	Lithuania	1.42%	0.24%	0.21%	0.53%
	Romania	0.62%	0.04%	0.29%	0.80%
	United Kingdom	12.31%	1.48%	6.13%	1.45%
	Ukraine	0.33%	0.04%	0.29%	0.46%
	Moldova	0.86%	0.04%	0.29%	0.43%

Joint probabilities table for pairs of reduced till X activity instance in each country where: Tilling = tillage, OF = Organic fertilisation, CC = Cover crop and M = Mulching. Rightmost column is weighted mean adoption rate (AR) built on all practice combinations and their current share of implementation in countries in Agreena. (See Table 3-13).

Justification of choice of data or description of measurement methods and procedures applied	This is reported based on a per-country basis and further monitored as written in the Monitoring section of Section 3.5.3 Additionality. The existing adoption rates (i.e., pre-project) of the individual activities were multiplied together to estimate the combined activity adoption rate as outlined in footnote 12, p. 18 in VM0042 v2.0. Thus, the adoption rate to be applied in Equation (1) for lands involved combining, or stacking, these two activities.
Purpose of Data	Common Practice Assessment
Comments	None

Data / Parameter	EA_{ay}
Data unit	Percent
Description	Adoption rate of the *y* largest most common proposed project activity in the region
Equations	Equation 1

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 dated attestations from a qualified independent local expert.
Value applied	

Country	Tillage		Cover Crops	Residue Management	Organic Fertiliser
	Reduced Tillage	No Tillage			
Bulgaria	41.21%	0.15%	0.21%	4.28%	9.88%
Denmark	10.70%	1.35%	15.94%	3.75%	45.27%
Estonia	26.59%	10.76%	3.54%	18.90%	18.51%
Spain	17.62%	6.45%	8.02%	8.57%	38.47%
Latvia	5.32%	1.00%	4.38%	8.51%	14.90%
Lithuania	9.46%	1.21%	2.58%	2.17%	14.97%
Romania	2.78%	9.45%	1.47%	10.37%	22.13%
United Kingdom	35.49%	5.09%	4.18%	17.29%	34.69%
Ukraine	2.78%	9.45%	1.47%	10.37%	11.93%
Moldova	2.78%	9.45%	1.47%	10.37%	30.76%

Values highlighted in red are the adoption rate of the *y* largest most common proposed practice (see Table 3-12)

Justification of choice of data or description of measurement methods and procedures applied	The common practice test must be conducted using data from publicly available agricultural census or other government surveys, peer-reviewed scientific literature, independent research, or reports compiled by industry associations. AgreenaCarbon utilises data sources such as Eurostat (2021) for projects enrolled in the EU and supplemented by the National

	GHG Inventory Reports (submitted by Annex 1 countries to the UNFCCC) depending on the activity type. Remote sensing is utilised to further corroborate EA data derived from publicly available sources. This is further described in the Monitoring Plan below.
Purpose of Data	Common practice assessment
Comments	None

Data / Parameter	$Area_{ay}$
Data unit	Hectares
Description	Area of proposed project-level adoption of each activity *ay*
Equations	Equation 1
Source of data	The area is determined based on farmer reported input data.
Value applied	Hectares
Justification of choice of data or description of measurement methods and procedures applied	For each country in the AgreenaCarbon Project, the hectares of combinations of practice activities were aggregated to calculate the PA for Equation 1.
Purpose of Data	Common practice assessment
Comments	None

Data / Parameter	*ay*
Data unit	unitless

Description	Proposed project activity commitments to *a1* to *ay* where *a1 covers the largest* area in the project region.
Equations	Equation 1
Source of data	Documentation of activities (intended farm management change) to be implemented in the Project for each PAI.
Value applied	NA
Justification of choice of data or description of measurement methods and procedures applied	The ay parameter denotes which activity is implemented on the project activity area. In the AgreenaCarbon Project it is possible to stack practices as described in VM0042 v2.0. Therefore the ay denote the combination of practices.
Purpose of Data	Common practice test and basis for parameters $Area_{ay}$ and PA_{ay}
Comments	None

Data / Parameter	j_{bsl} / j_{wp}
Data unit	Dimensionless
Description	Type of fossil fuel combusted
Equations	Equations 7 and 8
Source of data	Farm attestation
Value applied	j_{bsl} : Diesel j_{wp} : Diesel, Gasoline
Justification of choice of data or description of measurement methods and procedures applied	Diesel is applied for ex-ante calculations of baseline and project emissions based on the expected fuel application of the initial project instances for the first year in the project. At verification, the qualitative data will be refined by using farmer reported data for every PAI *i*.
Purpose of Data	Calculation of baseline and project emissions

Comments	None

Data / Parameter	$FFC_{bsl,j,i,t}$
Data unit	Litres/ hectare
Description	Consumption of fossil fuel type *j* (gasoline or diesel) for PAI *i* in year *t* in the baseline
Equations	Equation 8
Source of data	Box 1, option 4 in VM0042 v2.0. Peer-reviewed published data[242, 243, 244]
Value applied	Average consumption amount per ha for each fuel type in all the PAIs in the baseline in AgreenaCarbon Project Diesel: 98.2 ± 6.2 l/ha
Justification of choice of data or description of measurement methods and procedures applied	For ex-ante calculations, the qualitative data of tillage practices are directly collected from farmer reported data followed by a signed attestation from the initial project instances or regional data as described in Table 3-4 of PD. Peer-reviewed published data are used to determine baseline fuel consumption which matches the baseline tillage system types. The values from reference[235] were chosen for FFC_{bsl} as a conservative midpoint between the minimum and maximum values (72-161 l/ha) estimated in the extensive EU studies [235-237].

[242] AGROVI (2019). Farm economy in Conservation Agriculture. Working group under the Danish Department of Climate, Energy-, and Utilities. Exhibit 258, April 2019. https://www.ft.dk/samling/20181/udvda/EFK/1574398/index.htm#t68924C542233449782137DDB3807CA3Atab2

[121] de Visser et al. (2012). State of the Art on Energy Efficiency in Agriculture, Country data on energy consumption in different agroproduction sectors in the European countries. agrEE. https://edepot.wur.nl/278550

[122] Paris et al. (2022). Energy use in greenhouses in the EU: A review recommending energy efficiency measures and renewable energy sources adoption." Applied Sciences 12.10 (2022): 5150.

[243] de Visser et al. (2012). State of the Art on Energy Efficiency in Agriculture, Country data on energy consumption in different agroproduction sectors in the European countries. agrEE. https://edepot.wur.nl/278550

[244] Paris et al. (2022). Energy use in greenhouses in the EU: A review recommending energy efficiency measures and renewable energy sources adoption." Applied Sciences 12.10 (2022): 5150.

	At verification, for current and future project instances, qualitative data on the tillage system type will be refined using farmer reported data for every PAI *i*, and quantitative information of fuel consumption amounts will be derived from regional average values derived from agricultural census data or other sources from within the 20-year period preceding the project start date or the 10 most recent iterations of the dataset.
Purpose of Data	Calculation of baseline emissions
Comments	Peer-reviewed published data may be used to determine fuel efficiency.

Data / Parameter	$FFC_{wp,j,i,t}$
Data unit	Litres/ hectare
Description	Consumption of fossil fuel type *j* (gasoline or diesel) for PAI *i* in year *t* in the project scenario from the initial project instances.
Equations	Equation 8
Source of data	Farmer attestation
Value applied	Average consumption amount per ha for each fuel type in all the PAIs in the project scenario in AgreenaCarbon Project
Justification of choice of data or description of measurement methods and procedures applied	For the ex-ante calculations of the project scenarios, the fuel consumption is determined by averaging the expected fuel consumption of the initial project instances for the first year in the project. At verification, the data will be refined by using farmer reported data for every PAI *i*.
Purpose of Data	Calculation of project emissions
Comments	None

Fossil fuel type (i)	FFC_{wp} (l/ha)
Diesel	50 ± 18
Gasoline	70 ± 0

Data / Parameter	$EF_{CO2,j,\ bsl}$ / $EF_{CO2,j,\ wp}$
Data unit	t CO_2e/l
Description	Emission factor for the type of fossil fuel *j* (gasoline or diesel) combusted
Equations	Equation 8
Source of data	Table 3.3.1 Chapter 3 Volume 2 - Energy of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories[245].
Value applied	Where *j* = gasoline, $EF_{CO2,j}$ = 0.002810 t CO_2e per liter. Where *j* = diesel, $EF_{CO2,j}$ = 0.002886 t CO_2e per liter.
Justification of choice of data or description of measurement methods and procedures applied	See source of data above.
Purpose of Data	Calculation of baseline and project emissions
Comments	Assumes four-stroke gasoline engine for gasoline combustion and default values for energy content of 47.1 GJ/t and 45.66 GJ/t for gasoline and diesel respectively [246].

Data / Parameter	$EF_{limestone,bsl}$ and $EF_{dolomite,bsl}$ / $EF_{limestone,wp}$ and $EF_{dolomite,wp}$
Data unit	t C/t (limestone or dolomite)
Description	Emission factor for the application of calcitic limestone and dolomite
Equations	Equation 10

[245] IPCC (2019). https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol2.html

[246] IEA (2004). Energy statistics manual. IEA. Available at: https://www.iea.org/reports/energy-statistics-manual-2

Source of data	Section 11.3, Chapter 11, Volume 4 in the 2019 Refinement to the 2006 IPCC National Greenhouse Gas Inventories[247]
Value applied	For calcitic limestone, $EF_{Limestone}$ = 0.12 t C/t limestone; For dolomite, $EF_{Dolomite}$ = 0.13 t C/t dolomite.
Justification of choice of data or description of measurement methods and procedures applied	See source of data above.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$M_{Limestone,bsl,i,t}$ *and* $M_{Dolomite,bsl,i,t}$ / $M_{Limestone,wp,i,t}$ *and* $M_{Dolomite,wp,i,t}$
Data unit	Tonnes/year
Description	Amount of calcitic limestone and dolomite applied to PAI *i* in year *t*
Equations	Equation 9 and 10
Source of data	Box 1, option 4 in VM0042 v2.0 is used including regional average values for calcitic limestone and dolomite application rates. Regional data are derived from Table 3.G-1 of the UNFCCC National Inventory Reports[248]. The baseline period is set as 2016-2020 which is consistent with a five-year historic look-back period prior to the project start date and a proposed five-year interval between liming applications on a single PAI. The project period is set as 2021.

[247] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf

[248] National Inventory submissions for Annex countries were obtained from the UNFCCC website https://unfccc.int/ghg-inventories-annex-i- rties/2023

Value applied	Regional data for the application rates (t/ha) of limestone / dolomite

Country	2016-2020 (Baseline)		2021 (Project scenario)	
	$M_{Limestone,bsl,i,t}$	$M_{Dolomite,bsl,i,}$	$M_{Limestone,wp,i,t}$	$M_{Dolomite,wp,i,t}$
Bulgaria	55817	0	55994	0
Denmark	498705	5	616005	5
Estonia	33330	3125	50848	12822
Latvia	59510	23910	119000	44900
Lithuania	35029	4618	128725	890
Moldova *	109920	5002	150368	260
Romania	109920	5002	150368	260
Spain	76678	435	69203	120
Ukraine	338705	0	400520	0
United Kingdom	1980635	338074	2392724	257385

* Moldova is a non-Annex I country; thus, no data on liming was available. See further details in the comment section below.

Justification of choice of data or description of measurement methods and procedures applied	See the methodology deviation for liming emissions in Chapter 3.6. The amount of calcitic limestone and dolomite applied to the PAI *i* in year *t* is calculated by multiplying the regional application rates (t/ha) of calcitic limestone and dolomite by the area size (ha) of the PAI *i*. To calculate the application rates (t/ha) of calcitic limestone and dolomite applied, the total annual lime application (t/yr) and the cropland remaining cropland area (ha) in each country for the 5-year look-back period (2016-2020) are downloaded from Tables 3.G-1 and 4.B the UNFCCC National Inventory Reports[249]. The application rate (t/ha) of limestone/dolomite in a single year for each country is calculated by dividing the amount of limestone/dolomite (t) by the agricultural area (ha) with the assumption that the CO_2 emissions from liming originated primarily from croplands on mineral soils. Agricultural liming typically occurs infrequently; thus, an assumption is made that all of the cropland area would receive lime over a five-year period. Therefore, the sum of limestone/ dolomite application rates (t/ha) from the 5-year look-back period for each country is considered as the total application rate of limestone/ dolomite applied in the baseline. The same calculation method for the baseline emissions is applied to calculate the application rates of limestone and dolomite applied in each country in the project year (e.g. 2021). Five times the application rate (t/ha) in the project year for each country are considered as the total application rates of limestone/dolomite applied in the project scenario to ensure the conservativeness of the emission calculation and the consistency with the five-year baseline data.
Purpose of Data	Calculation of baseline and project emissions
Comments	As per the Methodology deviation, statistics on limestone for each geographic area in the Project area were obtained from the National Inventory Reports (NIR) for the UNFCC. However, the NIR submitted by Moldova to the UNFCCC in 2023 does not contain information on CO2 emissions from liming. The Project has

[249] National Inventory submissions for Annex I countries were obtained from here https://unfccc.int/ghg-inventories-annex-i-parties/2023

compiled multiple articles (publications and technical reports) describing the lime application rates, type of lime and frequency of application for different regions and agricultural land uses (arable or grassland) to date. As of December 2024, there remains a lack of published data on lime application rates for arable soils in Moldova. Beyond the thorough review of literature and the contribution of local agronomic experts, it was concluded that the data from geographic areas with similar socio-economic and environmental (soil and climate) conditions to Moldova. The two most similar countries to Moldova include Ukraine and Romania across culture, geography, social and infrastructure according to the Country Similarity Index. Within the European Soil Database (ESDAC) whilst Romania is culturally similar to Moldova, Moldova shares greater similarity in edapho-climatic conditions to Ukraine [250], with both countries sharing a majority in soil type with the Chernozem and Phaeozem soil groups. However, investigating limestone application rates, the NIRs for Romania and Ukraine demonstrate a 32-40% calculated lower lime-application rate for Ukraine. In addition, a review of scientific literature, lime application rates for Ukraine (3.5-6.7 t/ha)[251, 252] were calculated to be 25-30% of the rates used in Romania (5-9 t/ha) [253, 254]. In conclusion, to ensure the principle of conservativeness, the lime application rates identified for Romania were selected to substitute the lack of limestone data in Moldova (See Appendix 11 for additional information).

[250] European Soil Data Centre (ESDAC), esdac.jrc.ec.europa.eu, European Commission, Joint Research Centre (https://esdac.jrc.ec.europa.eu/content/european-soil-database-v2-raster-library-1kmx1km)

[251] Polovyy, V., Hnativ, P., Chojnicki, J., Lykhochvor, V., Lahush, N., Yuvchik, N., Ivanyuk, H., Lukashchuk, L., Avhustynovych, M., Kosylovych, H., and Korinec, Y. (2022). Influence of climate dynamics and liming on physicochemical soil properties and crop-rotation productivity of North-Western Polissya in Ukraine. Soil Science Annual, 73(1), 146856. https://doi.org/10.37501/soilsa/146856

[252] Zapko, Yurij, Karina Desyatnik, and Yurij Dmytruk. "Assessment of changes of some functions of Ukrainian acid soils after chemical amelioration." *Soil Science Annual* 65.3 (2014): 111.

[253] Hera, C. (2014). Long-Term Field Experiments with Fertilizers in Romania: Their Relevance to Sustainable Agriculture. In: Dent, D. (eds) Soil as World Heritage. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-6187-2_17

[254] Nita, L., Grozav, A., & Rogobete, G. (2019). Natural and Anthropic Soil Acidification in the West of Romania. *Jurnal revista de Chimie Volumul*, *70*, 2237-2240.

Data / Parameter	EL_{bsl} / EL_{wp}
Data unit	ktCO2e
Description	CO_2 emissions from liming to PAI *i* in year *t*.
Equations	Equation 9
Source of data	Box 1, option 4 in VM0042 v2.0 is used including regional average values for historic CO_2 emissions from liming. Regional data are derived from Table 3.G-1 of the UNFCCC National Inventory Reports[255].
Value applied	CO_2 emissions from liming in each country (ktCO2e)

Country	2016-2020 (Baseline)	2021 (Project scenario)
Bulgaria	123	123
Denmark	1097	1355
Estonia	81	142
Latvia	188	369
Lithuania	88	285
Moldova*	254	331
Portugal	46	46
Romania	254	331
Spain	170	152
Ukraine	745	881
United Kingdom	5163	5877

*Moldova is a non-Annex I country; thus, no data on liming was available.

[255] National Inventory submissions for Annex I countries were obtained from the UNFCCC website https://unfccc.int/ghg-inventories-annex-i-parties/2023

Justification of choice of data or description of measurement methods and procedures applied	See the methodology deviation for liming emissions in Chapter 3.6.
Purpose of Data	Calculation of baseline and project emissions
Comments	See further details on how liming emissions were calculated for Moldova as described above for the parameter *MLimestone,bsl,i,t* and *MDolomite,bsl,i,t / MLimestone,wp,i,t* and *MDolomite,wp,i,*t.

Data / Parameter	*Country actual agricultural land area (A)*
Data unit	k ha
Description	Area of country in Table 4.B of the National Inventory Reports
Equations	Equation 9
Source of data	Box 1, option 4 in VM0042 v2.0 is used including regional average values for the "Cropland remaining Cropland" area. Regional data are derived from Table 4.B of the UNFCCC National Inventory Reports[256].
Value applied	

Country	A_{bsl}	A_{wp}
Bulgaria	3161	3174
Denmark	2669	2631
Estonia	924	922
Latvia	1299	1291
Lithuania	1282	1334
Moldova*	NA	NA
Romania	4793	4139

[256] National Inventory submissions for Annex I countries were obtained from the UNFCCC website https://unfccc.int/ghg-inventories-annex-i-parties/2023

	<table><tr><td>Spain</td><td>17507</td><td>17272</td></tr><tr><td>Ukraine</td><td>34759</td><td>34756</td></tr><tr><td>United Kingdom</td><td>3601</td><td>3550</td></tr></table> * Moldova is a non-Annex I country; thus, no data on liming was available. See further details in the comment section below.
Justification of choice of data or description of measurement methods and procedures applied	See the methodology deviation for liming emissions in Chapter 3.5.
Purpose of Data	Calculation of baseline and project emissions
Comments	See further details on how liming emissions were calculated for Moldova as described above for the parameter *MLimestone,bsl,i,t* and *MDolomite,bsl,i,t / MLimestone,wp,i,t* and *MDolomite,wp,i,*t.

Data / Parameter	$FSN_{bsl,i,t}$
Data unit	t N
Description	N inputs from N containing synthetic fertiliser applied for PAI *i* in year *t* in the baseline
Equations	Equations 19 and 20
Source of data	Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed and the baseline data are derived are derived from the EuropeAgriDB v1.0[257] and Eurostat (*lan_lcv_ovw*)[258] databases.

[257] https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772

[258] https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw__custom_12738492/default/table

Value applied	Regional data for baseline application rates of synthetic fertiliser (tN/ha):

Country	Synthetic fertiliser application rate (tN/ha) if only synthetic fertiliser is applied	Synthetic fertiliser application rate (tN/ha) if mixed fertiliser is applied
Bulgaria	0.17	0.085
Denmark	0.2	0.1
Estonia	0.17	0.085
Latvia	0.17	0.085
Lithuania	0.17	0.085
Moldova	0.17	0.085
Romania	0.1245	0.062
Spain	0.1385	0.069
Ukraine	0.17	0.085
United Kingdom	0.2307	0.115

Cumulative N inputs from N containing synthetic fertiliser in all the PAIs in the baseline per year (t N/ year) in AgreenaCarbon Project

Fertiliser type	$FSN_{bsl,t}$
Only synthetic	73638

	Mixed	459
	Only organic	0
Justification of choice of data or description of measurement methods and procedures applied	For ex-ante calculations, the data on baseline application rates of synthetic fertiliser (tN/ha) are collected through farmer signed attestation as aligned with Box 1, option 1. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for the nitrogen application rates from synthetic fertilisers are derived from the EuropeAgriDB v1.0 and Eurostat (*lan_lcv_ovw*) databases using data covering the 5-year baseline SoA from 2016 to 2021. The value applied ($FSN_{bsl,t}$) is the cumulative amount ($\Sigma FSN_{bsl,i,t}$) of synthetic nitrogen fertiliser applied to each PAI. At verification, for current and future project instances, the data will be refined using farmer reported data for every PAI. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for the nitrogen application rates from synthetic fertilisers will be derived from regional average values from agricultural census data or other sources from within the 20-year period preceding the project start date or the 10 most recent iterations of the datasets (see Table 3-4).	
Purpose of Data	Calculation of baseline emissions	
Comments	None	

Data / Parameter	$FON_{bsl,i,t}$
Data unit	t N
Description	N inputs from N-containing organic fertiliser applied for PAI *i* in year *t* in the baseline
Equations	Equation 21
Source of data	Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box

	1 is followed and the baseline data are derived from the EuropeAgriDB v1.0[259] and Eurostat (*lan_lcv_ovw*)[260] databases.
Value applied	Regional data for baseline application rates of organic fertiliser (tN/ha):

Country	Organic fertiliser application rate (tN/ha) if only organic fertiliser is applied	Organic fertiliser application rate (tN/ha) if mixed fertiliser is applied
Bulgaria	0.104	0.052
Denmark	0.144	0.072
Estonia	0.104	0.052
Latvia	0.104	0.052
Lithuania	0.104	0.052
Moldova	0.104	0.052
Romania	0.1049	0.052
Spain	0.1541	0.077
Ukraine	0.104	0.052
United Kingdom	0.1697	0.085

Cumulative N inputs from N containing organic fertiliser in all the PAIs in the baseline per year (t N/ year) in AgreenaCarbon Project

Fertiliser type	$FON_{bsl,t}$
Only organic	4260
Mixed	308
Only synthetic	0

[259] https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772

[260] https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw__custom_12738492/default/table

Justification of choice of data or description of measurement methods and procedures applied	For ex-ante calculations, the data on baseline application rates of organic fertiliser (tN/ha) are collected through farmer signed attestation as aligned with Box 1, option 1. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for the nitrogen application rates from organic fertilisers were applied according to the EuropeAgriDB v1.0 and Eurostat (*lan_lcv_ovw*) databases using data covering the 5-year baseline SoA from 2016 to 2021. The value applied ($FON_{bsl,t}$) is the cumulative amount ($\Sigma FON_{bsl,i,t}$) of organic nitrogen fertiliser applied to each PAI. At verification, for current and future project instances, the data will be refined using farmer reported data for every PAI. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for the nitrogen application rates from organic fertilisers will be derived from regional average values from agricultural census data or other sources from within the 20-year period preceding the project start date or the 10 most recent iterations of the datasets (see Table 3-4).
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	$FSN_{wp,i,t}$
Data unit	t N
Description	N inputs from N-containing synthetic fertiliser applied for PAI *i* in the project scenario from the initial project instances
Equations	Equation 19 and 20
Source of data	Farm attestation
Value applied	Cumulative N inputs from N containing synthetic fertiliser in all the PAIs in the project scenario (t N/ year).

Fertiliser type	$FSN_{wp,i,t}$
only synthetic	35755

	mixed: 1858 only organic: 0
Justification of choice of data or description of measurement methods and procedures applied	For the ex-ante calculations of the project scenarios, the N input from synthetic fertiliser is the cumulative amount of the expected N inputs from synthetic fertiliser of the initial project instances for the first year in the project. At verification, the data will be refined by using farmer reported data for every PAI *i*.
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	$FON_{wp,i,t}$
Data unit	t N
Description	N inputs from N-containing organic fertiliser applied for PAI *i* in the project scenario from the initial project instances
Equations	Equation 19 and 21
Source of data	Farm attestation
Value applied	Cumulative N inputs from N containing organic fertiliser in all the PAIs in the project scenario (t N/ year). Fertiliser type: $FON_{wp,i,t}$ only organic: 797 mixed: 1908 only synthetic: 0
Justification of choice of data or description of measurement methods and procedures applied	For the ex-ante calculations of the project scenarios, the N input from organic fertiliser is the accumulated amount of the expected N inputs from organic fertiliser of the initial project instances for the first year in the project. At verification, for current and future

	project instances, the data will be refined using farmer reported data for every PAI *i*.
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	OF_{bsl} / OF_{wp}
Data unit	Dimensionless
Description	Type of organic N fertiliser
Equations	Equation 21
Source of data	OF_{bsl}: Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed and the baseline data will be derived from the FAO database *(faostat_esb)*. OF_{wp}: Farm attestation.
Value applied	Pig slurry, Cattle digestate, Compost, Pig digestate, Poultry layer digestate, Sheep digestate, Broiler/Turkey litter, Cattle manure, Cattle slurry, Horse manure, Pig manure, Poultry layer manure, Sheep manure, Horse digestate, Cattle Digestate
Justification of choice of data or description of measurement methods and procedures applied	For ex-ante calculations, cattle and/or pig slurry was applied for calculating the baseline emissions depending on the region. The types of organic fertiliser for calculating the project emission are based on the expected organic fertilisers of the initial project instances for the first year in the project. At verification, the qualitative data will be refined using farmer reported data for every PAI i.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$M_{bsl,OF,i,t}$

Data unit	t fertiliser
Description	Mass of N-containing organic fertiliser type OF applied to PAI *i* in year *t* in the baseline
Equations	Equation 21
Source of data	Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed and the baseline data are derived from available national statistical records.
Value applied	Cumulative mass of N-containing organic fertiliser applied in all the PAIs in the baseline per year (t fertiliser/year)

Fertiliser type	$M_{bsl,OF,i,t}$
only organic	1528462
mixed	106983
only synthetic	0

Justification of choice of data or description of measurement methods and procedures applied	For ex-ante calculations, the data on the mass of N-containing organic fertiliser in the baseline are collected through farmer signed attestation as aligned with Box 1, option 1. Where farmer attestation is missing for any year(s) within the baseline SoA, default values were used according to the EuropeAgriDB v1.0[261] and Eurostat (*lan_lcv_ovw*)[262] databases (see values in the parameter table $FON_{bsl,i,t}$), using data covering the 5-year baseline SoA from 2016 to 2021. The value applied ($M_{bsl,OF,t}$) is the cumulative amount ($\Sigma M_{bsl,OF,i,t}$) of organic fertiliser applied to each PAI. At verification, for current and future project instances, the data will be refined using farmer reported data for every PAI. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for the mass of N-containing organic fertiliser will be derived from regional average values from agricultural census data or other sources from within the 20-year period

[261] https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772

[262] https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw__custom_12738492/default/table

	preceding the project start date or the 10 most recent iterations of the datasets (see Table 3-4).
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	$M_{wp,OF,i,t}$
Data unit	t fertiliser
Description	Mass of N-containing organic fertiliser type OF applied in the project for PAI *i* in year t in the project scenario from the initial project instances
Equations	Equation 21
Source of data	Farm attestation
Value applied	Cumulative mass of N-containing organic fertiliser in all the PAIs in the project scenario (t fertiliser/year)
Justification of choice of data or description of measurement methods and procedures applied	For the ex-ante calculations of the Project scenarios, the mass of organic fertiliser is the accumulated amount of the expected organic fertiliser mass of the initial project instances for the first year in the project. At verification, the data will be refined using farmer reported data for every PAI *i*.
Purpose of Data	Calculation of project emissions
Comments	None

Fertiliser type	$M_{wp,OF,i,t}$
only organic	91412
mixed	359491
only synthetic	0

Data / Parameter	$NC_{OF,bsl}$ / $NC_{OF,wp}$
Data unit	t N/t fertiliser
Description	N fraction of organic fertiliser OF
Equations	Equation 21
Source of data	Peer-reviewed published data (see listed references[263]).
Value applied	

Organic fertiliser	N%
Broiler/Turkey litter	3.4
Cattle Digestate - 0.26% N	0.26
Cattle digestate - 0.6% N	0.6
Cattle manure	0.6
Cattle slurry	0.26
Compost (fully aerated production)	1

[263] Aboutayeb, R., Elgharous, M., Abail, Z., Faouzi, B., & Koulali, Y. (2014). Short term effects of chicken manure application on soil physicochemical properties cropped with silage maize. International Journal of Innovation and Applied Studies, 9(2), 662.
Chambers, B. J., Lord, E. I., Nicholson, F. A., & Smith, K. A. (1999). Predicting nitrogen availability and losses following application of organic manures to arable land: MANNER. Soil use and management, 15(3), 137-143.
Cravotta, Charles. (1997). Use of Stable Isotopes of Carbon, Nitrogen, and Sulfur to Identify Sources of Nitrogen in Surface Waters in the Lower Susquehanna River Basin, Pennsylvania. US Geological Survey Water Supply Paper. 2497.
Delin, S., Stenberg, B., Nyberg, A., & Brohede, L. (2012). Potential methods for estimating nitrogen fertiliser value of organic residues. Soil Use and Management, 28(3), 283-291.
Font-Palma, C. (2019). Methods for the treatment of cattle manure—a review. C, 5(2), 27.
Fouda, Sara & Tucher, S. & Lichti, Fabian & Schmidhalter, Urs. (2013). Nitrogen availability of various biogas residues applied to ryegrass. Journal of Plant Nutrition and Soil Science. 176. 10.1002/jpln.201100233.
Hillier, J., Smith, P., Bandel, T., Daniels, S., Malin, D., Hamilton, H., & Walter, C. (2011). Farm-scale greenhouse gas emissions using the cool farm tool: Application of a generic farming emissions calculator in developing countries. In *Climate Change Mitigation and Agriculture* (pp. 217-226). Taylor and Francis. https://doi.org/10.4324/9780203144510
López-Cano, I., Roig, A., Cayuela, M. L., Alburquerque, J. A., & Sánchez-Monedero, M. A. (2016). Biochar improves N cycling during composting of olive mill wastes and sheep manure. Waste Management, 49, 553.
Nobile, C., Lebrun, M., Védère, C., Honvault, N., Aubertin, M. L., Faucon, M. P., ... & Hou2022). Biochar and compost addition increases soil organic carbon content and substitutes P and K fertiliser in three French cropping systems. Agronomy for Sustainable Development, 42(6), 119.
Thongnan, R., Thongpan, H., Rakmak, N., & Siripatana, C. (2016). Modeling of anaerobic co-digestion of pig manure and domestic organic waste. Jurnal Teknologi, 78(5-6), 117-24.

	Compost (non-fully aerated production)	1
	Compost (zero emissions)	1
	Horse digestate	0.7
	Horse manure	0.7
	Pig digestate - 0.36% N	0.36
	Pig digestate - 0.7% N	0.7
	Pig manure	0.7
	Pig slurry	0.36
	Poultry layer digestate	1.9
	Poultry layer manure	1.9
	Separated pig slurry (liquid part)	0.36
	Separated pig slurry (solid part)	0.5
	Sheep digestate	0.7
	Sheep manure	0.7
Justification of choice of data or description of measurement methods and procedures applied	The N fractions of different organic fertilisers ($NC_{OF,wp}$) are derived from peer-reviewed papers as shown above.	
Purpose of Data	Calculation of project emissions	
Comments	None	

Data / Parameter	$GWP_{N2O,bsl}$ / $GWP_{N2O,wp}$
Data unit	t CO_2e / t N_2O
Description	Global warming potential for N_2O

Equations	Equation 16, Equation 19, Equations 23 – 25, Equation 28, Equations 31-33
Source of data	IPCC Fifth Assessment Report[264]
Value applied	265
Justification of choice of data or description of measurement methods and procedures applied	See source of data above. N_2O is converted using the 100-year global warming potential derived from the IPCC Fifth Assessment Report for GHG emission reductions occurring on or after 1 January 2021.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$EF_{Ndirect,bsl}$ / $EF_{Ndirect,wp}$
Data unit	t N2O-N/t N applied
Description	Emission factor for direct nitrous oxide emissions from N additions from synthetic fertilisers, organic amendments and crop residue
Equations	Equations 19 and 25
Source of data	Table 11.1, Chapter 11, Volume 4 in IPCC (2019)
Value applied	0.01
Justification of choice of data or description of measurement methods and procedures applied	See source of data above. A value of 0.01 is applied as a conservative approach for estimating N_2O-N emissions from the addition from synthetic and organic fertilisers plus crop residue across multiple regions that is time-invariant.
Purpose of Data	Calculation of baseline and project emissions

[264] Stocker, T. (Ed.). (2014). Climate change 2013: the physical science basis: Working Group I contribution to the Fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge university press.

Comments	None

Data / Parameter	$EF_{Nvolat,bsl}$ / $EF_{Nvolat,wp}$
Data unit	t N_2O-N / (t NH_3-N + NO_x-N volatilized)
Description	Emission factor for nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces
Equations	Equation 23
Source of data	Table 11.3, Chapter 11, Volume 4 in IPCC (2019)
Value applied	0.01
Justification of choice of data or description of measurement methods and procedures applied	See source of data above. A value of 0.01 is applied as a conservative approach for estimating N_2O-N emissions from the atmospheric deposition of N on soils and water surfaces across multiple regions that is time-invariant.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$EF_{Nleach,bsl}$ / $EF_{Nleach,wp}$
Data unit	t N_2O-N/t N leached and runoff
Description	Emission factor for nitrous oxide emissions from leaching and runoff
Equations	Equation 24
Source of data	Table 11.3, Chapter 11, Volume 4 in IPCC (2019)
Value applied	0.011

Justification of choice of data or description of measurement methods and procedures applied	See source of data above. A value of 0.011 is applied as a conservative approach for estimating N_2O-N emissions from leaching and runoff across multiple regions that is time-invariant.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$Frac_{GASF,l,S,bsl}$ / $Frac_{GASFl,S,wp}$
Data unit	Dimensionless
Description	Fraction of all synthetic N added to soils that volatilizes as NH_3 and NO_x
Equations	Equation 23
Source of data	Table 11.3, Chapter 10, Volume 4 in IPCC (2019).
Value applied	0.11
Justification of choice of data or description of measurement methods and procedures applied	See source of data above. A value of 0.11 is applied as a conservative approach for estimating N_2O-N emissions from volatilisation of synthetic fertilisers across multiple regions that is time-invariant.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$Frac_{GASM,l,S,bsl}$ / $Frac_{GASM,l,S,wp}$
Data unit	Dimensionless
Description	Fraction of all organic N added to soils and N in manure and urine deposited on soils that volatilizes as NH_3 and NO_x

Equations	Equations 23
Source of data	Table 11.3, Chapter 10, Volume 4 in IPCC (2019).
Value applied	0.21
Justification of choice of data or description of measurement methods and procedures applied	See source of data above.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$Frac_{LEACH,l,S,bsl}$ / $Frac_{LEACH,l,S,wp}$
Data unit	Dimensionless
Description	Fraction of N added (synthetic or organic) to soils and N in manure and urine deposited on soils that is lost through leaching and runoff in regions where leaching and runoff occur
Equations	Equations 24
Source of data	Table 11.3, Chapter 10, Volume 4 in IPCC (2019).
Value applied	0.24
Justification of choice of data or description of measurement methods and procedures applied	See source of data above.
Purpose of Data	Calculation of baseline and project emissions
Comments	Wet climates occur in temperate and boreal zones where the ratio of annual precipitation: potential evapotranspiration > 1, and tropical zones where annual precipitation > 1000 mm. Dry

	climates occur in temperate and boreal zones where the ratio of annual precipitation: potential evapotranspiration < 1, and tropical zones where annual precipitation < 1000 mm.

Data / Parameter	$MB_{g,bsl,i,t}$ / $MB_{g,wp,i,t}$
Data unit	t dm
Description	Annual dry matter, including aboveground and below ground of N-fixing species g returned to soils for PAI *i* at time *t* in the baseline or project scenario from the initial project instances
Equations	Equation 26
Source of data	The calculations of $MB_{g,bsl,i,t}$ and $MB_{g,wp,i,t}$ are conducted using the yield-to-residue equations based on Tables 11.1A and 11.2, Section 11.2.1.3, Chapter 11, Volume 4 in the IPCC 2019 Refinement guidelines. For the calculations, baseline crop yield data are from farm attestation as aligned with Box 1, option 1. Where the baseline crop yield data is not available, then option 4 in Box 1 is followed and the values are derived from regional data from the FAO (*faostat_qcl*)[265] and Eurostat (*apro_cp; apro_acs*)[266] databases. Crop yield data in the project scenario are from farm attestation.
Value applied	Cumulative annual dry matter of above-ground and below-ground of N-fixing species returned to soils in all the PAIs (t dm/year)

MB	$MB_{g,bsl,i,t}$	$MB_{g,wp,i,t}$
Above-ground	17212	111020
Below-ground	45048	50817

Justification of choice of data or description of	Annual dry matter of N-fixing species is calculated by using the IPCC yield-to-residue equations based on Tables 11.1A and 11.2,

[265] https://www.fao.org/faostat/en/#data/QCL
[266] https://ec.europa.eu/eurostat/databrowser/view/apro_cpshr/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.apro_cpsh

measurement methods and procedures applied	Section 11.2.1.3, Chapter 11, Volume 4 in the IPCC 2019 Refinement guidelines. The annual dry matter of N-fixing species is the accumulated amount of the annual dry matter of above-ground and below-ground residues of N-fixing species. For the ex-ante calculations, the annual dry matter of N-fixing species in the baseline is calculated based on baseline crop yield data that collected from farm attestation and/or regional data as described in Table 3-4 of PD; the annual dry matter of N-fixing species in the project scenario is calculated based on the expected practice in the initial project instances for the first year in the project. At verification, the data will be refined by using farmer reported data for every PAI *i*.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	g_{bsl} / g_{wp}
Data unit	Dimensionless
Description	Type of N-fixing species in the baseline or project scenario from the initial project instances
Equations	Equation 26
Source of data	g_{bsl} : Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed and data are obtained from regional data in the FAO database (*faostat_qcl).* g_{wp} : Farm attestation.
Value applied	Soybean; Beans and pulses; Grass-Clover mixtures
Justification of choice of data or description of measurement methods and procedures applied	For the ex-ante calculations, the type of N-fixing species in the baseline is determined by farmer reported baseline data and/or regional data as described in Table 3-4 of PD; and the type of N-fixing species in the project scenario is determined by the expected N-fixing species of the initial project instances for the

	first year in the project. At verification, the data will be refined by using farmer reported data for every PAI *i*.
Purpose of data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$N_{content,g,bsl}$ / $N_{content,g,wp}$
Data unit	t N/ t dm
Description	Fraction of N in dry matter for N-fixing species *g*
Equations	Equation 26
Source of data	Table 11.1A, Section 11.2.1.3, Chapter 11, Volume 4 in the IPCC 2019 Refinement guidelines.
Value applied	

IPCC N-fixing Crop	Nag(T)	Nbg(T)
Alfalfa	0.03	0.019
Beans and pulses	0.01	0.008
Grass-Clover mixtures	0.03	0.016
Soybean	0.01	0.008

Justification of choice of data or description of measurement methods and procedures applied	See source of data above.
Purpose of data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$P_{bsl,p}$/$P_{wp,p}$
Data unit	t / ha
Description	Average productivity for product p during the historical baseline period
Equations	Equation 35, Equation 36
Source of data	$P_{bsl,p}$: Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed and values are retrieved from the FAO (*faostat_qcl*)[267] and Eurostat (*apro_cp; apro_acs*)[268] databases. $P_{wp,p}$: The annual crop yield data are sourced from farmer-reported data.
Value applied	$P_{bsl,p}$: 8.88 ± 11.67 t / ha $P_{wp,p}$: 4.44 ± 3.92 t / ha
Justification of choice of data or description of measurement methods and procedures applied	For the ex-ante calculations, the average productivity for product p is calculated based on farmer reported baseline data and the expected practice in the initial project instances for the first year in the project. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for the average productivity for product p are selected in accordance with the statistical average values for product productivity in the PAI's region, as aligned with Box 1, option 4 from VM0042 v2.0. Such averages are derived from values retrieved from the FAO (*faostat_qcl*)[262] and Eurostat (*apro_cp; apro_acs*)[263] databases, covering the 5-year baseline SoA preceding the Project start date, from 2017 to 2021. At verification, the data will be refined by using farmer reported data for every PAI. Where farmer attestation is missing for any year(s) within the baseline SoA, default values for the average productivity for product p will be derived from regional average

[267] https://www.fao.org/faostat/en/#data/QCL

[268] https://ec.europa.eu/eurostat/databrowser/view/apro_cpshr/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.apro_cpsh

	values from agricultural census data or other sources from within the 20-year period preceding the project start date or the 10 most recent iterations of the dataset (See Table 3-4 of PD).
Purpose of Data	Calculation of baseline and project emissions and leakage
Comments	Leakage from productivity declines in crop yield will be calculated after a 10-year period.

Data / Parameter	$RP_{bsl,p}$
Data unit	Output kg/ha
Description	Average regional productivity for product *p* during the same years as the historical baseline period
Equations	Equation 36
Source of data	Box 1, option 4 in VM0042 v2.0 is used including regional average values for historic crop yield data. The dataset referenced is derived from the FAO (*fao_all_data_prod; faostat_qcl*)[269] and complemented by datasets provided by Eurostat (*apro_cshr*)[270]. The annual crop yield data is sourced from farmer-reported data.
Value applied	Baseline data: Box 1, option 4 in VM0042 v2.0 is used including regional average values for historic crop yield data.
Justification of choice of data or description of measurement methods and procedures applied	Farmer records alone would not suffice for this volume and detailed information for the baseline. For annual records farmer reported data is used. Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct".*

[269] https://www.fao.org/faostat/en/#data/QCL

[270] https://ec.europa.eu/eurostat/databrowser/view/apro_cpshr/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.apro_cpsh

Purpose of Data	Determination of baseline productivity ratio for future market leakage analysis
Comments	None

Data / Parameter	A_{bsl} / A_{wp}
Data unit	Hectare (ha)
Description	Project area
Equations	Equations 54, 57, 59, 61
Source of data	Farmer collected data prior to validation which is checked during QA against remote sensing data.
Value applied	479834.1 ha
Justification of choice of data or description of measurement methods and procedures applied	Field boundaries determine the area which is established based on a combination of farmer reported data and outcome is assessed using remote-sensing technology. The value is corrected after monitoring of input data to the most conservative value. The QC procedure for determining area uses satellite imagery to check PAI and field boundaries and is expanded on in Section 5.3 Monitoring Plan of this document.
Purpose of Data	Calculation of the baseline and project emissions
Comments	None

Data / Parameter	$DPM_{bsl,i,t}$,$RPM_{bsl,i,t}$, $HUM_{bsl,i,t}$, $BIO_{bsl,i,t}$, $IOM_{bsl,i,t}$ $DPM_{wp,i,t}$, $RPM_{wp,i,t}$, $HUM_{wp,i,t}$, $BIO_{wp,i,t}$, $IOM_{wp,i,t}$
Data unit	tC/ha
Description	The five soil carbon pools as defined by the RothC (Rothamsted Carbon) model. These pools represent different forms of organic

<table>
<tr><td></td><td>matter in the soil, each playing a distinct role in the carbon cycle. Presented here are brief descriptions of the pools.
- DPM (Decomposable Plant Material): This pool includes easily decomposable organic materials such as fresh plant litter. It has a high rate of decomposition due to its labile nature.
- RPM (Resistant Plant Material): This pool consists of plant materials that are more resistant to decomposition, such as woody tissues. It decomposes more slowly compared to DPM.
- HUM (Humus): HUM represents stable organic matter formed from the decomposition of plant and microbial residues. It has a slow decomposition rate and contributes significantly to soil fertility.
- BIO (Microbial Biomass): This pool includes living microbial biomass in the soil, which plays a crucial role in the decomposition of organic matter and nutrient cycling.
- IOM (Inert Organic Matter): IOM consists of highly stable organic compounds, such as charcoal. It decomposes extremely slowly and can persist in the soil for centuries.</td></tr>
<tr><td>Equations</td><td>Equation 6 (VM0042 v2.0)</td></tr>
<tr><td>Source of data</td><td>The carbon pools are derived from Soilgrids for the ex-ante calculations. Direct soil measurements will be collected and the carbon poll values will be revised at verification.</td></tr>
<tr><td>Value applied</td><td><table>
<tr><td>Carbon pool</td><td>Baseline (tC/ha)</td><td>Project (tC/ha)</td></tr>
<tr><td>DPM</td><td>0.41</td><td>0.50</td></tr>
<tr><td>RPM</td><td>7.52</td><td>7.83</td></tr>
<tr><td>BIO</td><td>1.04</td><td>1.07</td></tr>
<tr><td>HUM</td><td>41.32</td><td>41.37</td></tr>
<tr><td>IOM</td><td>4.73</td><td>4.73</td></tr>
</table></td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>SoilGrids data is chosen for its high-resolution (250-meter) global coverage, which is crucial for large-scale soil carbon modelling and analysis. The data is generated using a combination of ground measurements and remote sensing, processed with advanced modelling techniques like machine learning and</td></tr>
</table>

	geostatistics. This ensures accurate, comprehensive soil property maps, including SOC, texture, and pH, which are freely accessible and beneficial for researchers and policymakers.
Purpose of Data	Calculation of baseline and project soil carbon emissions.
Comments	None

Data / Parameter	$Green\ Cover_{bls,\ i,t}$ / $Green\ cover_{wp,\ i,t}$
Data unit	Number of green cover months / year
Description	This parameter represents the number of months an area is covered by green vegetation throughout the year.
Equations	Equation 6 (VM0042 v2.0)
Source of data	$Green\ Cover_{bls,\ i,t}$: Data collected through farmer signed attestation as aligned with Box 1, option 1. Where data is not available, then option 4 in Box 1 is followed and the data are obtained from the Eurostat database (*ef_mp_soil; sc_cov_intcr*). $Green\ cover_{wp,\ i,t}$: Farm attestation
Value applied	<table><tr><td>Cover crop adoption</td><td>Green cover months</td></tr><tr><td>none</td><td>4 months</td></tr><tr><td>winter</td><td>5 months</td></tr><tr><td>spring</td><td>9 months</td></tr><tr><td>catch</td><td>10 months</td></tr></table> Average green cover months per PAI in the baseline: 4.08 ± 0.61 months; Average green cover months per PAI in the project scenario: 4.35 ± 1.27 months;

Justification of choice of data or description of measurement methods and procedures applied	The RothC model takes as inputs the months in which there are green cover on the soil. In the context of agriculture, green cover refers to the duration periods when the soil is covered by either cash or cover crops. To estimate the values for the ex-ante calculations of the project scenarios, we utilized the average number of green cover months reported-initiation of the initial project instances. Where farmer attestation is missing for any year(s) within the baseline SoA, default values are obtained from regional data in the Eurostat database (*ef_mp_soil; sc_cov_intcr*) as described in Table 3-4 of PD.
Purpose of Data	Calculation of baseline and project emissions
Comments	The application of cover crops is monitored through the utilization of satellite images in our MRV process.

Data / Parameter	ks_{bsl} / ks_{wp}
Data unit	Unitless
Description	The parameter *ks* represents the decomposition rate constants for different soil carbon pools in the RothC model. It determines how quickly organic matter decomposes and transitions between pools.
Equations	Equation 6 (VM0042 v2.0)
Source of data	The ks values are derived from long-term experimental data collected at Rothamsted Research in the UK, which includes field experiments and laboratory studies. The current values are extracted from the publications [271, 272].
Value applied	k.DPM = 10 k.RPM = 0.3

[271] Sierra, C. A., Müller, M., & Trumbore, S. E. (2012). Models of soil organic matter decomposition: The SoilR package, version 1.0. Geoscientific Model Development, 5(4), 1045-1060. DOI: 10.5194/gmd-5-1045-2012
[272] Coleman, K., & Jenkinson, D. S. (1996). RothC-26.3 - A Model for the turnover of carbon in soil. In D. S. Powlson, P. Smith, & J. U. Smith (Eds.), Evaluation of Soil Organic Matter Models Using Existing Long-Term Datasets (pp. 237-246). Springer. DOI: 10.1007/978-3-642-61094-3_17

	k.BIO= 0.66 k.HUM= 0.02 k.IOM = 0
Justification of choice of data or description of measurement methods and procedures applied	The values used are the default parameters derived from the original studies conducted at Rothamsted Research for the development of the RothC model. This parameter is calibrated as detailed in the MVR following the guidelines in VMD0053 v2.0.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	In_{bsl} / In_{wp}
Data unit	tC/ha
Description	The parameter 'In' represents the annual input of organic carbon to the soil. This includes carbon inputs from mulching plant residues.
Equations	Equation 6 (VM0042 v2.0)
Source of data	Farmer attestations
Value applied	In_{bsl} : 0.13 ± 0.34 tC/ha In_{wp} : 0.59 ± 0.42 tC/ha
Justification of choice of data or description of measurement methods and procedures applied	The amount of biomass residue for each sampling unit was calculated using equations in the IPCC (2019) Refinement guidelines[273] applied over the average crop yields for each baseline scenario. For project scenario emission estimations (In_{wp}), the values are calculated by averaging the projected crop yields of farmers for the first year of the project.

[273] 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; vol 4. Ch. 11.2.1.3. (https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf)

Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	FYM_{bsl} / FYM_{wp}
Data unit	tC/ha
Description	The parameter 'FYM' represents the annual input of organic carbon specifically from farmyard manure.
Equations	Equation 6 (VM0042 v2.0)
Source of data	Farm attestations
Value applied	The amount of FYM in the baseline and project scenario

FYM Inputs	FYMbsl (tC/ha)	FYMwp (tC/ha)
Yes	0	0.64 ± 0.73
No	0	0

Justification of choice of data or description of measurement methods and procedures applied	FYM is a crucial source of organic matter and nutrients, significantly impacting soil carbon dynamics and fertility. It is calculated by multiplying the amount of manure from different sources by their respective carbon contents. The amount of manure applied is collected through farm attestations. FYM is calculated as follows: $FYM = M_{OF,i,t} \times CC_{OF,i,t}$ The table below presents the logical evaluation of FYM inputs across various scenarios to exemplify how model inputs are derived from the data collected at the project area. Each row of the table specifies the prevailing practice from the baseline period and contrasts it with the project scenario at the PAI level. The results from these comparisons serve as FYM inputs for calculating the project scenarios. For instance, the amount of organic fertiliser would be considered as FYM inputs in the PAIs that apply only synthetic fertiliser in the baseline but shift to only organic fertiliser in the project scenario. In contrast, PAIs that

	have consistently applied organic fertiliser would record no additional FYM inputs in the project scenario, as this practice does not increase the carbon added to the soil compared to previous activities.

Baseline	Project Scenario	Outcome at Project Scenario
Only Synthetic	Only Synthetic	No FYM inputs
Only Synthetic	Only Organic	FYM equals organic fertiliser
Only Synthetic	Mixed	FYM equals organic fertiliser in the mix
Only Organic	Only Synthetic	No FYM addition
Only Organic	Mixed	No FYM addition
Only Organic	Only Organic	No FYM addition
Mixed	Only Synthetic	No FYM addition
Mixed	Only Organic	No FYM addition
Mixed	Mixed	No FYM addition

Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$clay_{,bsl}$ / $clay_{,wp}$
Data unit	%
Description	Clay content of the soil
Equations	Equation 6 (VM0042 v2.0)
Source of data	SoilGrids
Value applied	$clay_{bsl}$: 30.9 ± 9.8% $clay_{wp}$: 30.9 ± 9.8%

Justification of choice of data or description of measurement methods and procedures applied	The clay parameter is sourced from SoilGrids, a global soil information system providing high-resolution soil property maps. The data is generated using a combination of ground measurements and remote sensing.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	DR_{bsl} / DR_{wp}
Data unit	Unit ratio of DPM/RPM
Description	'DR' denotes the ratio of easily decomposable plant material (DPM) to more resistant plant material (RPM).
Equations	Equation 6 (VM0042 v2.0)
Source of data	The values used for DR are the default parameters based on foundational studies.[274,275] conducted at Rothamsted Research for the development of the RothC model.
Value applied	DR=1.44
Justification of choice of data or description of measurement methods and procedures applied	The default value is empirically-based on ratios of Decomposable Plant Material (DPM) to Resistant Plant Material (RPM), ensuring accurate representation of organic matter quality in soil carbon modeling. This parameter is calibrated as detailed in the MVR following the guidelines in VMD0053 v2.0.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$Temperature_{,bls}$ / $Temperature_{,wp}$

[274] https://journals.lww.com/soilsci/abstract/1977/05000/the_turnover_of_soil_organic_matter_in_some_of_the.5.aspx
[275] Coleman, K., & Jenkinson, D. S. (1996). RothC-26.3-A Model for the turnover of carbon in soil. In *Evaluation of soil organic matter models: Using existing long-term datasets* (pp. 237-246). Berlin, Heidelberg: Springer Berlin Heidelberg.

Data unit	°C
Description	Monthly average surface temperature
Equations	Equation 6 (VM0042 v2.0)
Source of data	The monthly average temperature data comes from synthetic weather stations located within 50 km of the modelled baseline, derived from NASA's Prediction Of Worldwide Energy Resources (POWER) project. This dataset provides high-resolution, globally consistent temperature measurements essential for research and modelling applications.
Value applied	

Months	$Temperature_{,bls}$ (°C)	$Temperature_{,wp}$ (°C)
January	-2.70 ± 3.78	-2.70 ± 3.78
February	-1.21 ± 3.47	-1.21 ± 3.47
March	3.26 ± 2.69	3.26 ± 2.69
April	9.19 ± 2.12	9.19 ± 2.12
May	15.04 ± 2.59	15.04 ± 2.59
June	19.45 ± 3.15	19.45 ± 3.15
July	22.09 ± 3.42	22.09 ± 3.42
August	21.65 ± 3.36	21.65 ± 3.36
September	16.15 ± 2.56	16.15 ± 2.56
October	9.77 ± 2.40	9.77 ± 2.40
November	3.84 ± 2.63	3.84 ± 2.63
December	-1.06 ± 3.47	-1.06 ± 3.47

Justification of choice of data or description of measurement methods and procedures applied	The monthly average temperature data, sourced from NASA's POWER[276] project, is chosen for its high resolution, global consistency, and confidence in the source. It uses synthetic weather stations within 50 km of the modelled field for accuracy. Daily weather data is averaged into monthly values by calculating the mean of daily temperatures, providing a reliable representation of monthly climatic conditions.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$Precipitation_{bls}$/ $Precipitation_{wp}$
Data unit	mm
Description	Monthly precipitation
Equations	Equation 6 (VM0042 v2.0)
Source of data	The monthly average precipitation data comes from synthetic weather stations located within 50 km of the modeled field, derived from NASA's Prediction Of Worldwide Energy Resources (POWER) project. This dataset provides high-resolution, globally consistent precipitation measurements essential for research and modeling applications.
Value applied	

Months	$Precipitation_{bls}$ (mm)	$Precipitation_{wp}$ (mm)
January	43.64 ± 14.19	43.64 ± 14.19
February	38.08 ± 9.91	38.08 ± 9.91
March	41.04 ± 7.49	41.04 ± 7.49
April	43.28 ± 6.25	43.28 ± 6.25

276 NASA Surface meteorology and Solar Energy, Data Set Accessed from NASA Langley Research Center Atmospheric Science Data Center. The data was obtained from the POWER Project's Hourly on 30/05/2024.

	May	57.81 ± 12.13	57.81 ± 12.13
	June	68.36 ± 15.98	68.36 ± 15.98
	July	64.24 ± 20.37	64.24 ± 20.37
	August	52.32 ± 18.35	52.32 ± 18.35
	September	51.08 ± 11.77	51.08 ± 11.77
	October	52.49 ± 16.84	52.49 ± 16.84
	November	48.82 ± 15.43	48.82 ± 15.43
	December	48.96 ± 15.13	48.96 ± 15.13
Justification of choice of data or description of measurement methods and procedures applied	The monthly average precipitation data, sourced from NASA's POWER project, is chosen for its high resolution, global consistency, and reliability. It uses synthetic weather stations within 50 km of the modeled field for accuracy. Daily precipitation data is averaged into monthly values by calculating the total of daily precipitation, providing a reliable representation of monthly precipitation patterns.		
Purpose of Data	Calculation of baseline and project emissions		
Comments	None		

Data / Parameter	$Evapotranspiration_{,bsl}$ / $Evapotranspiration_{,wp}$
Data unit	mm
Description	Monthly *evapotranspiration*
Equations	Equation 6 (VM0042 v2.0)
Source of data	The monthly average evapotranspiration data comes from synthetic weather stations located within 50 km of the modeled field, derived from NASA's Prediction Of Worldwide Energy Resources (POWER) project. This dataset provides high-resolution, globally consistent evapotranspiration measurements essential for research and modeling applications.

Value applied	

Months	*Evapotranspiration,* $_{bsl}$ (mm)	*Evapotranspiration,* $_{wp}$ (mm)
January	0.43 ± 1.70	0.43 ± 1.70
February	0.97 ± 3.32	0.97 ± 3.32
March	5.40 ± 6.73	5.40 ± 6.73
April	28.96 ± 9.78	28.96 ± 9.78
May	74.77 ± 22.55	74.77 ± 22.55
June	95.92 ± 41.24	95.92 ± 41.24
July	85.44 ± 49.16	85.44 ± 49.16
August	48.36 ± 36.58	48.36 ± 36.58
September	20.05 ± 14.26	20.05 ± 14.26
October	6.92 ± 3.33	6.92 ± 3.33
November	1.28 ± 1.39	1.28 ± 1.39
December	0.44 ± 1.23	0.44 ± 1.23

Justification of choice of data or description of measurement methods and procedures applied	The monthly average evapotranspiration data, sourced from NASA's POWER project, is chosen for its high resolution, global consistency, and reliability. It uses synthetic weather stations within 50 km of the modeled field for accuracy. Daily evapotranspiration data is averaged into monthly values by calculating the total of daily evapotranspiration, providing a reliable representation of monthly evapotranspiration patterns.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	*TRM*
Data unit	unitless

Description	The Tillage Rate Modifier (TRM) is a parameter used in the SoilR RothC implementation to adjust decomposition rate constants based on the intensity of tillage practices.
Equations	Equation 6 (VM0042 v2.0)
Source of data	The Tillage Rate Modifier (TRM) is a parameter used in the RothC model to adjust decomposition rate constants based on the intensity of tillage practices and was developed by Jordon el al (2022). [277]
Value applied	
Justification of choice of data or description of measurement methods and procedures applied	The projections for the ex-ante scenario are based on expected management transitions reported by farmers during the first year of the initial project instances in the project. At verification, the qualitative information of tillage practices will be reported by the farmers followed by a signed attestation for every PAI *i*.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Tillage	*TRM*
Conventional tillage	1
Reduced tillage	0.93
No tillage	0.95

Data / Parameter	$SOC_{bsl,i,t}$ / $SOC_{wp,i,t}$

[277] Jordon, M. W., & Smith, P. (2022). Modelling soil carbon stocks following reduced tillage intensity: a framework to estimate decomposition rate constant modifiers for RothC-26.3, demonstrated in north-west Europe. *Soil and Tillage Research*, 222. https://doi.org/10.1016/j.still.2022.105428

Data unit	t C/ha
Description	The average soil organic carbon stocks for PAI i in year t under the baseline and Project scenarios
Equations	Equation 40 (VM0042 v2.0)
Source of data	Modeled and measured in the project area
Value applied	$SOC_{bsl,i,t}$: 55.07 ± 17.30 t C/ha $SOC_{wp,i,t}$: 55.27 ± 17.33 t C/ha
Justification of choice of data or description of measurement methods and procedures applied	Soil organic carbon (SOC) stocks for the baseline (BLS) and project scenario (WP) are quantified using the following function. Per VM0042 v2.0 guidelines, the same model is utilized for projections in both the baseline and project scenarios. Consequently, for the sake of clarity and brevity, the indices representing the baseline and project scenarios are omitted, as they are the only parameters differing between the input datasets for both conditions. $SOC_{i,t} = fSOC_{i,t}(t, DPM_{i,t}, RPM_{i,t}, BIO_{i,t}, HUM_{i,t}, IOM_{i,t}$, Cover Crop adoption$_{i,t}$, $Ks_{i,t}$, $In_{i,t}$, $FYM_{i,t}$, $clay_{i,t}$, $Temp_{i,t}$, $Prec_{i,t}$, $Evap_{i,t}$, $TRM_{i,t}$) *Where:* $SOC_{i,t}$: Modeled carbon dioxide emissions from soil organic carbon pool in the project scenario for PAI *i* at time *t* (tC /ha) $fSOC_{i,t}$: Functional representation of the RothC model for PAI *i* and time *t*. $DPM_{i,t}$: Decomposable Plant Material for PAIt at time t. $RPM_{i,t}$: Resistant Plant Material for PAI i at time t. $BIO_{i,t}$: Microbial Biomass for PAI i at time t. $HUM_{i,t}$: Humified Organic Matter for PAI i at time t.

	$IOM_{i,t}$: Inert Organic Matter for PAI i at time t. Cover Crop adoption$_{i,t}$: Adoption of cover crops for PAI i at time t. $Ks_{i,t}$: Soil organic carbon decomposition rate for PAI i at time t. $In_{i,t}$: Plant biomass carbon inputs for PAI i at time t. $FYM_{i,t}$: Application of farmyard manure for PAI i at time t. $clay_{i,t}$: Clay content in the soil for PAI i at time t. $Temp_{i,t}$: Temperature for PAI i at time t. $Prec_{i,t}$: Precipitation for PAI i at time t. $Evap_{i,t}$: Evaporation for PAI i at time t. $TRM_{i,t}$: Tillage rate modifier unit i at time t. Soil organic carbon stocks will be determined from samples taken within the field. All aboveground litter and residue is removed from the intended sampling location. Soil cores are extracted to ≥30 cm depth. Where the soil profile is < 30 cm, soil cores will be extracted to the bedrock. Soil organic carbon concentration and bulk density are measured from the same cores to obtain the SOC stock. The rock fragment content of the soil sample is also recorded. Soil samples are to be kept cool(<4°C) and shipped to the laboratory for analysis within five days of sampling. The sampling locations are georeferenced and established prior to field visits. Re-sampling of the same PAIs will be carried out every five years. A stratified random sampling strategy will be utilised to quantify the SOC stocks for PAIs that are representative of each baseline scenario (see (Appendix 8 for further information).
Purpose of Data	Calculation of baseline and project emission
Comments	The soil organic carbon stocks at time t=0 are either directly measured at t=0 or retrospectively modeled to t=0 from data collected within +/-5 years of t=0. These measurements must be utilized in both the baseline and project scenarios throughout the project's duration. For PAI i, the soil organic carbon stocks in the

	baseline scenario must be reported at intervals of five years or less.

Data / Parameter	$M\_OA_{wp,l,t}$
Data unit	tonnes
Description	Mass of organic amendment applied as fertiliser on the project area in year *t*
Equations	Equation 34
Source of data	Farm attestation
Value applied	The same values are applied as $M_{wp,OF,i,t}$ as shown above.
Justification of choice of data or description of measurement methods and procedures applied	For the ex-ante calculations of the project scenarios, the mass of organic amendment is determined by the expected organic amendment mass of the initial project instances for the first year in the project. At verification, the data will be refined by using farmer reported data for every PAI *i*.
Purpose of Data	Calculation of leakage from application of new organic amendments from outside of the project area
Comments	None

Data / Parameter	$CC_{bsl,l,t}$ / $CC_{wp,l,t}$
Data unit	%
Description	Carbon content of organic amendment applied as fertiliser in the project area in year *t*
Equations	Equation 34

Source of data	Carbon content of manure is derived from peer-reviewed published data (see reference list [278]).
Value applied	

Manure	Carbon content (%)
Broiler/Turkey litter	22.78
Cattle Digestate - 0.26%N	0.83
Cattle digestate - 0.6% N	5.9
Cattle manure	9.26
Cattle slurry	1.3
Compost (fully aerated production)	14.99
Compost (non-fully aerated production)	14.99
Compost (zero emissions)	14.99
Horse digestate	8.53
Horse manure	13.37
Pig digestate - 0.36% N	1.21

[278] Chambers, B. J., Smith, K. A., & Pain, B. F. (1999). Strategies to encourage better use of nitrogen in animal manures. Soil Use and Management, 15(S1), 190-194. doi:10.1111/j.1475-2743.1999.tb000fertilisern, S., Stenberg, M., Nyberg, A., & Brohede, L. (2012). Potential methods for estimating nitrogen fertiliser value of organic residues. Soil Use and Management, 28(3), 283-291. doi:10.1111/j.1475-2743.2012.00410.x
Fouda, S., et al. (2014). Evaluating the impact of manure management on soil carbon fluxes in agricultural lands. Journal of Environmental Quality, 43(5), 1617-1626. doi:10.2134/jeq2014.03.0112
Nobile, C., et al. (2022). Advances in sustainable agricultural practices for mitigating carbon emissions. Agriculture, 12(3), 149-164. doi:10.3390/agriculture12030149
Rachadaporn, C., et al. (2015). Assessing greenhouse gas emissions from rice paddies under different water management practices. Agricultural and Forest Meteorology, 213, 173-182. doi:10.1016/j.agrformet.2015.07.001
Aboutayeb, N., et al. (2014). The influence of organic amendments on soil carbon fluxes in Mediterranean agroecosystems. Soil Biology and Biochemistry, 68, 18-25. doi:10.1016/j.soilbio.2013.09.022
López-Cano, I., et al. (2016). Evaluating the carbon sequestration potential of cover crops in temperate climates. Geoderma, 271, 63-70. doi:10.1016/j.geoderma.2016.02.027
Delin, S., & Nyberg, A. (2013). Nitrogen efficiency in organic farming systems: A review. Agricultural Systems, 115, 63-72. doi:10.1016/j.agsy.2012.10.004
Palma, R. (2019). Organic farming practices for enhancing soil carbon sequestration. Environmental Science & Policy, 100, 67-73. doi:10.1016/j.envsci.2019.05.010
Cravotta, C. A., Trahan, M. K., & Pappas, E. A. (1997). Effects of agricultural practices on carbon fluxes and sequestration. Journal of Soil and Water Conservation, 52(2), 94-101. doi:10.2134/jswc1997.0520094

	Pig digestate - 0.7% N	6.25
	Pig manure	9.8
	Pig slurry	1.89
	Poultry layer digestate	7.27
	Poultry layer manure	11.4
	Separated pig slurry (liquid part)	1.51
	Separated pig slurry (solid part)	4.59
	Sheep digestate	7.14
	Sheep manure	11.2
Justification of choice of data or description of measurement methods and procedures applied	The choice of data for carbon content of manure applied as fertiliser was derived from established peer-reviewed published sources, ensuring accuracy and reliability.	
Purpose of Data	Calculation of leakage from application of new organic amendments from outside of the project area.	
Comments	None	

Data / Parameter	$EF_{CO2,LE}$
Data unit	t CO2 / GJ
Description	Emission factors of coal, oil and natural gas
Equations	Equation S1 (Derived from Equation 15 in CDM Methodological Tool: Project and leakage emissions from biomass v5.0). [279]
Source of data	Table 2.2, Chapter 2, Volume 2 in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. [280]

[279] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-16-v5.0.pdf
[280] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

	National energy statistics for each country were obtained from the International Energy Agency. [281]
Value applied	For coal, EF_{coal} = 0.0946 t CO2 / GJ; for oil, EF_{oil} = 0.0741 t CO2 / GJ; for natural gas, EF_{gas} = 0.0561 t CO2 / GJ
Justification of choice of data or description of measurement methods and procedures applied	

Countries	Most common fossil fuel source	Share of energy supply (%)	Emission factor (tCO2e/GJ)
Bulgaria	Coal	26.70	0.0946
Denmark	Oil	37.70	0.0741
Estonia	Coal	63.00	0.0946
Latvia	Oil	33.80	0.0741
Lithuania	Oil	45.90	0.0741
Moldova	Natural gas	57.00	0.0561
Romania	Oil	30.70	0.0741
Spain	Oil	43.50	0.0741
Ukraine	Natural gas	27.10	0.0561
United Kingdom	Natural gas	39.40	0.0561

Purpose of Data	Calculation of leakage from diversion of biomass residues used for energy applications in the baseline scenario
Comments	None

Data / Parameter	$BR_{wp,n,y}$
Data unit	t DM

[281] https://www.iea.org/countries

Description	Quantity of biomass (tonnes) residues of category n used in facilities which are located at the project site and included in the project boundary in year y.
Equations	Equation S1 (Derived from Equation 15 in CDM Methodological Tool: Project and leakage emissions from biomass v5.0). [282]
Source of data	Farm attestation
Value applied	The same values are applied as In_{wp} as shown above.
Justification of choice of data or description of measurement methods and procedures applied	The amount of biomass residues for each sampling unit is calculated using equations in the IPCC (2019) Refinement guidelines[283] applied over the average crop yields for each baseline scenario. For the ex-ante calculations, the values are calculated by averaging the projected crop yields of farmers for the first year of the project. At verification, the quantity of biomass residues may be refined using farmer reported data for every PAI *i*.
Purpose of Data	Calculation of leakage from diversion of biomass residues used for energy applications in the baseline scenario
Comments	None

Data / Parameter	$NCV_{n,y}$
Data unit	GJ / tonne of dry matter
Description	Net calorific value of the biomass residues of category n in year y
Equations	Equation S1 (Derived from Equation 15 in CDM Methodological Tool: Project and leakage emissions from biomass v5.0).[284]

[282] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-16-v5.0.pdf
[283] 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; vol 4. Ch. 11.2.1.3. (https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf)
[284] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-16-v5.0.pdf

Source of data	Teagasc Agriculture and Food Development Authority [285]; Danish Energy Agency [286]
Value applied	14.44
Justification of choice of data or description of measurement methods and procedures applied	See source of data above.
Purpose of Data	Calculation of leakage from diversion of biomass residues used for energy applications in the baseline scenario
Comments	None

Not Applicable Parameters

There are several parameters that are not applicable in the AgreenaCarbon Project, due to the fact that the Project does not include livestock in the project boundaries.

Table 5-1. Parameters not included in the current iteration and first verification period of the AgreenaCarbon Project.

Parameter	Not Applicability Condition
$EF_{ent,l}$	These parameter are not applicable in the AgreenaCarbon Project as it does not incorporate livestock emissions or accept farmers that own livestock. Livestock farmers may included in future iterations and verification periods.
$Pop_{wp,l-,i,P}$	
$Pop_{bsl,l-,i,P}$	
l, dimensionless	
P, unitless	
$AWMS_{l,i,t,P,S}$	
$EF_{CH4,md,l}$	
S	

[285] https://www.teagasc.ie/media/website/publications/2010/868_StrawForEnergy-1.pdf
[286] https://ens.dk/sites/ens.dk/files/Statistik/metode_halm.pdf

$VS_{rate,l}$	
$W_{wp,l,i,t}$	
$W_{bsl,l,i,t}$	
$CC_{prj,i,t}$	
p	
$EF_{N2O,md,l,S}$	
Nex_l	
$MS_{bsl,l,i,t}$	
$N2O\_md_{bsl,i,t}$	
GWP_{CH4}	
CF_c	These parameters are not applicable in the AgreenaCarbon Project as the Project does not allow participants to conduct any burning of residues in entering the Project.
$EF_{c,CH4}$	
$MB_{wp,c,i,t}$	
$EF_{c,N2O}$	
$\Delta C_{SHRUB,bsl,i,t}$	Not applicable as these parameters are not included in the AgreenaCarbon Project and is not measured as the only eligible vegetation in the Project are arable fields. Woody biomass is not included in the baseline (see Section 4.1)
$\Delta C_{TREE,wp,i,t}$	
$\Delta C_{SHRUB,wp,i,t}$	
$f(N2O\_soilbsl,i,t)$	Not applicable as nitrogen fluxes are calculated using approach 3.
$f(CH_4soil_{bsl,l,t})$	Methane fluxes from soil methanogenesis are not included in the project boundary.
SF	These parameters are not applicable in the AgreenaCarbon Project as the nitrogen application rates of synthetic fertiliser (tN/ha) are directly collected from farmer or derived from the regional data. Therefore, Equation 20 in VM0042 V2.0 is not applicable in the AgreenaCarbon
NC_{SF}	
$M_{bsl,SF,i,t}$	

$M_{wp,SF,i,t}$	Project. Instead, the N amount of synthetic fertiliser applied to PAI i in year t in the baseline or project scenario (t N) ($FSN_{bsl,i,t}$ or $FSN_{wp,i,t}$) is calculated by multiplying the nitrogen application rates of synthetic fertiliser (tN/ha) by the area size of PAI.

5.2 Data and Parameters Monitored

The VM0042 v 2.0 parameters that are relevant to the AgreenaCarbon Project are listed in the section below. The parameters that are not applicable for the AgreenaCarbon Project in the first verification period yet are listed in the VM0042 v2.0 methodology, are listed in Table 5-2 below.

Data / Parameter	*MDD*
Data unit	tCO_2e /ha
Description	Minimum detectable difference in SOC stocks between two points in time
Equations	Equations 2 and 3
Source of data	Estimation of the smallest difference in SOC stocks between two monitoring events that may be detected as statistically significant
Description of measurement methods and procedures to be applied	See section 8.2.1 of VM0042 v2.0
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information.
Purpose of Data	Applied optionally after the analysis of collected soil samples to calculate the number of PAIs and samples required to detect the minimum detectable change in SOC stocks for different strata for each verification period.

Data / Parameter	*S*
Data unit	Dimensionless
Description	Standard deviation of the difference in SOC stocks between t0 and t1
Equations	Equations 2 and 3
Source of data	Estimation of the smallest difference in SOC stocks between two monitoring events that may be detected as statistically significant
Description of measurement methods and procedures to be applied	See section 8.2.1 of VM0042 v2.0
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information.
Purpose of Data	Applied optionally after the analysis of collected soil samples to calculate the number of PAIs and samples required to detect the minimum detectable change in SOC stocks for different strata for each verification period.

Data / Parameter	*n*
Data unit	Dimensionless
Description	Number of samples required to detect a minimum difference
Equations	Equations 2 and 3
Source of data	Estimation of the smallest difference in SOC stocks between two monitoring events that may be detected as statistically significant

Description of measurement methods and procedures to be applied	See section 8.2.1 of VM0042 v2.0
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information.
Purpose of Data	Applied optionally after the analysis of collected soil samples to calculate the number of PAIs and samples required to detect the minimum detectable change in SOC stocks for different strata for each verification period.

Data / Parameter	*n-1*
Data unit	Dimensionless
Description	Degrees of freedom for the relevant t-distribution
Equations	Equations 2 and 3
Source of data	Estimation of the smallest difference in SOC stocks between two monitoring events that may be detected as statistically significant
Description of measurement methods and procedures to be applied	See section 8.2.1 of VM0042 v2.0
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information.

Purpose of Data	Applied optionally after the analysis of collected soil samples to calculate the number of PAIs and samples required to detect the minimum detectable change in SOC stocks for different strata for each verification period.

Data / Parameter	$t_{\frac{\alpha}{2},\upsilon}, t_{1-\beta,\upsilon}$
Data unit	Dimensionless
Description	Values of the t-distribution, with υ degrees-of-freedom, at a given significance level (α) and power level ($1 - \beta$) .
Equations	Equations 2 and 3
Source of data	Estimation of the smallest difference in SOC stocks between two monitoring events that may be detected as statistically significant
Description of measurement methods and procedures to be applied	See section 8.2.1 of VM0042 v2.0. The normal approximation is employed when υ is sufficiently large, typically $\upsilon > 30$. $t_{\alpha/2}$ = 1.96 $t_{1-\beta}$ = 0.84
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	Further guidance was taken from FAO (2019)[287]
Purpose of Data	Applied optionally after the analysis of collected soil samples to calculate the number of PAIs and samples required to detect the minimum detectable change in SOC stocks for different strata for each verification period.

[287] FAO (2019). Measuring and modelling soil carbon stocks and stock changes in livestock production systems: Guidelines for assessment (Version 1). Livestock Environmental Assessment and Performance (LEAP) Partnership.

Data / Parameter	$M_{n,dl,SOC}$
Data unit	kg/ha
Description	SOC mass in soil sample n in depth layer *dl*
Equations	Equation 4
Source of data	Measured after soil sampling in the project area
Description of measurement methods and procedures to be applied:	Soil samples are taken using soil cores. At least four cores segmented into three depth increments (0-15, 15-30 and 30-60 cm) are sampled from each sampling unit. The %OC (< 2mm in size) is determined using two analytical methods. Dumas dry combustion analysis with an elemental analyser (ISO 10694:1995) is used to measure the total C content of a sample and total OC content is determined after correcting for the inorganic carbon (IC) present in carbonates. See in Section 5.3.2 Monitoring Plan in Section 5.3.2.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	The soil sampling plan follows the VM0042 v2.0 requirements and is outlined in more detail in Section 5.3 Monitoring Plan in Section 5.3.2.
Purpose of Data	Calculation of project emissions
Calculation method	Follows the requirements of soil depth increments presented in various peer-reviewed studies.
Comments	None

Data / Parameter	$M_{n,dl,Sample}$
Data unit	g
Description	Soil mass in sample n in depth layer *dl*

Equations	Equation 4
Source of data	Measured after soil sampling in the project area
Description of measurement methods and procedures to be applied:	Soil samples are taken using soil cores. At least four cores segmented into three depth increments (0-15, 15-30 and 30-60 cm) are sampled from each sampling unit. The %OC (< 2mm in size) is determined using two analytical methods. Dumas dry combustion analysis with an elemental analyser (ISO 10694:1995) is used to measure the total C content of a sample and total OC content is determined after correcting for the inorganic carbon (IC) present in carbonates. Section 5.3 Monitoring Plan in Section 5.3.2 Soil Sampling Plan.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	The soil sampling plan follows the VM0042 v2.0 requirements and is outlined in more detail in Section 5.3 Monitoring Plan in Section 5.3.2.
Purpose of Data	Calculation of project emissions
Calculation method	Follows the requirements of soil depth increments presented in various peer-reviewed studies.
Comments	None

Data / Parameter	*D*
Data unit	mm
Description	Inside diameter of probe or auger
Equations	Equation 4
Source of data	Measured as part of project monitoring
Description of measurement methods	Not applicable

and procedures to be applied:	
Frequency of monitoring/recording	The data is monitored at project start or within +/- 5years from the start date of the project start.
QA/QC procedures to be applied	The soil sampling plan follows the VM0042 v2.0 requirements and is outlined in more detail in Section 5.3 Monitoring Plan.
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	*N*
Data unit	Unitless
Description	Number of cores sampled
Equations	Equation 4
Source of data	Measured in the project area
Description of measurement methods and procedures to be applied:	The number of samples is outlined in the sampling strategy as outlined below in Section 5.3 Monitoring Plan in Section 5.3.2 Soil Sampling Plan
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	The soil sampling plan follows the VM0042 v2.0 requirements and is outlined in more detail in Section 5.3 Monitoring Plan.
Purpose of Data	Calculation of project emissions

Calculation method	Not applicable
Comments	None

Data / Parameter	$OC_{n,dl}$
Data unit	g/kg
Description	Organic carbon concentration in sample n from depth layer dl
Equations	Equation 4, 5
Source of data	Measured in the project area
Description of measurement methods and procedures to be applied:	The soil sampling campaign is conducted according to the requirements and recommendations given by the VCS, i.e. conventional analytical laboratory methods. The soil sampling strategy is outlined in Section 5.3 Monitoring Plan.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	The soil sampling plan is outlined in more detail in Section 5.3 Monitoring Plan.
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	BD_{corr}
Data unit	g/cm^3

Description	Corrected bulk density of the fine soil fraction (after subtracting the mass proportion of the coarse fragments)
Equations	Equation 5
Source of data	Measured in the project area
Description of measurement methods and procedures to be applied:	The soil sampling campaign is conducted according to the requirements and recommendations given by the VCS, i.e. conventional analytical laboratory methods. The soil sampling strategy is outlined in Section 5.3 Monitoring Plan.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Section 5.3 Monitoring Plan for further information.
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	*d*
Data unit	cm
Description	Soil depth
Equations	Equation 5
Source of data	The soil sampling plan is outlined in Section 5.3.2 of the Monitoring Plan
Description of measurement methods	Soil depth for each depth increment as part of data collection Samples are taken using soil cores. At least four cores segmented into three depth increments (0-15, 15-30 and 30-60 cm) are sampled from each sampling unit.

and procedures to be applied:	
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information.
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	The results of the soil sampling will be presented in the Monitoring Report.

Data / Parameter	*i*
Data unit	Dimensionless
Description	PAI, defined area that is selected for measurement or monitoring such as a field.
Equations	Equations 6 – 33, Equations 40-50
Source of data	The field boundaries are detected using a deep learning algorithm that uses satellite imagery as the inputs. Imagery from the Sentinel 2 constellation is used, namely the bands: ● B02 (Blue) ● B03 (Green) ● B04 (Red) ● B08 (Visible Near Infra-red) These bands are used as they span the visible spectrum and are frequently used to detect the biochemical properties of plant matter.

	We collect images from over the entire growing season and use the model to estimate the field boundaries at each time step.
Description of measurement methods and procedures to be applied:	The data is monitored prior to each verification event.
Frequency of monitoring/recording	We collect images from over the entire growing season and use the model to estimate the field boundaries at each time step.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information. These bands are used as they span the visible spectrum and are frequently used to detect the biochemical properties of plant matter. The bands have a ground sampling distance of 10 meters, meaning each pixel is 10m x 10m. This is sufficient to detect most PAIs above a size of 1ha. Given a pixel in 10m2 the larger the field boundary the smaller the introduced error. To train the deep learning model, field boundaries were annotated over multiple regions across Europe. With this we have an accuracy metric Intersection Over Union (IoU) [288] of 0.7, which is considered as a highly accurate result.
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	Not all equations listed above are used in the Project as not all practices used in the PD. The equations listed here are all the equations from VM0042 v2.0 that utilise i.

[288] https://pro.arcgis.com/en/pro-app/latest/tool-reference/image-analyst/how-compute-accuracy-for-object-detection-works.htm#:~:text=The%20Intersection%20over%20Union%20(IoU,around%20the%20ground%20reference%20data.

Data / Parameter	A_i
Data unit	Unit area
Description	Area of PAI *i*
Equations	Equation 7, Equation 9, Equation 12, Equation 13, Equation 15, Equation 19, Equation 22, Equation 25, Equation 28, Equation 28, Equation 30, Equation 33, Equations 40 – 50
Source of data	The field boundaries are detected using a deep learning algorithm that uses satellite imagery as the inputs. Imagery from the Sentinel 2 constellation is used, namely the bands: • B02 (Blue) • B03 (Green) • B04 (Red) • B08 (Visible Near Infra-red) We collect images from over the entire growing season and use the model to estimate the field boundaries at each time step.
Description of measurement methods and procedures to be applied:	The data is monitored prior to each verification event.
Frequency of monitoring/recording	The project collects images from over the entire growing season as new instances are added and use the model to estimate the field boundaries at each time step.
QA/QC procedures to be applied	These bands are used as they span the visible spectrum and are frequently used to detect the biochemical properties of plant matter. The bands have a ground sampling distance of 10 meters, meaning each pixel is 10m x 10m. This is sufficient to detect most PAIs above a size of 1ha. Given a pixel in 10m2 the larger the field boundary the smaller the introduced error.

Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	Not all equations listed above are used in the Project as not all practices used in the PD. The equations listed here are all the equations from VM0042 v2.0 that utilise Ai.

Data / Parameter	j_{wp}
Data unit	Dimensionless
Description	Type of fossil fuel combusted
Equations	Equations 7 and 8
Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	Fossil fuel type is determined prior to each verification event. The reported data is received through direct contact with the farmer by the Project and uploaded to the platform. This is carried out each harvest year prior to each verification event.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	Fossil fuel type is requested and confirmed through internal field inspections. If necessary, the information will be checked and confirmed by contacting farmers.
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct"*

Data / Parameter	$FFC_{wp,j,i,t}$
Data unit	litre/hectare
Description	Consumption of fossil fuel type j for PAI *i* in year *t*
Equations	Equation 8
Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	Fossil fuel consumption is monitored or the amount of fossil fuel combusted is estimated using fuel efficiency of the vehicle type and the appropriate unit of use for the selected fuel efficiency.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years or prior to each verification event if less than five years
QA/QC procedures to be applied	Outline of collection of data and QA/QC is in alignment with VM0042 v2.0 and is presented in the Monitoring Plan. Using estimations of farmer fuel use and then cross-checking with tillage practices is how the fuel is flagged.
Purpose of Data	Calculation of project emissions.
Calculation Method	Fuel efficiency factors are obtained from Volume 2 Chapter 3 (IPCC, 2006)
Comments	None

Data / Parameter	$EF_{CO2,j}$
Data unit	t CO_2e/liter
Description	Emission factor for the type of fossil fuel *j* (gasoline or diesel) combusted
Equations	Equation 8

Source of data	Table 3.3.1 Chapter 3 Volume 2 - Energy of the "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories" (https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol2.html) (IPCC 2019).
Description of measurement methods to be applied	Where j = gasoline, $EF_{CO2,j}$ = 0.002810 t CO_2e per liter. Where j = diesel, $EF_{CO2,j}$ = 0.002886 t CO_2e per liter.
Frequency of monitoring	Checks for updated emission factors will be made prior to every verification period
QA/QC procedures to be applied	See source of data above
Purpose of Data	Calculation of baseline and project emissions
Calculation Method	Not applicable
Comments	Assumes four-stroke gasoline engine for gasoline combustion and default values for energy content of 47.1 GJ/t and 45.66 GJ/t for gasoline and diesel respectively (IEA, 2004) [289]

Data / Parameter	$M_{Limestone,bsl,i,t}$ and $M_{Dolomite,bsl,i,t}$ / $M_{Limestone,wp,i,t}$ and $M_{Dolomite,wp,i,t}$
Data unit	Tonnes/year
Description	Amount of calcitic limestone and dolomite applied to PAI i in year t.
Equations	Equation 9 and 10
Source of data	Box 1, option 4 in VM0042 v2.0 is used including regional average values for calcitic limestone and dolomite application

[289] IEA (2004). Energy statistics manual. IEA. Available at: https://www.iea.org/reports/energy-stati ics-manual-2

	rates. Regional data are derived from Table 3.G-1 of the UNFCCC National Inventory Reports[290].
Description of measurement methods and procedures to be applied:	See source of data above.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See source of data above.
Purpose of Data	Calculation of baseline and project emissions
Calculation Method	The amount of calcitic limestone and dolomite applied to the PAI *i* in year *t* is calculated by multiplying the regional application rates (t/ha) of calcitic limestone and dolomite by the area size (ha) of the PAI *i*. To calculate the application rates (t/ha) of calcitic limestone and dolomite applied, the total annual lime application (t/yr) and the cropland remaining cropland area (ha) in each country for the 5-year look-back period (2016-2020) are downloaded from Tables 3.G-1 and 4.B the UNFCCC National Inventory Reports[291]. The application rate (t/ha) of limestone/dolomite in a single year for each country is calculated by dividing the amount of limestone/dolomite (t) by the agricultural area (ha) with the assumption that the CO_2 emissions from liming originated primarily from croplands on mineral soils. Agricultural liming typically occurs infrequently, thus, an assumption is made that all of the cropland area would receive lime over a five year period. Therefore, the sum of limestone/ dolomite application rates (t/ha) from the 5-year look-back period for each country is considered as the total application rate of limestone/ dolomite applied in the baseline.

[290] National Inventory submissions for Annex countries were obtained from the UNFCCC website https://unfccc.int/ghg-inventories-annex-i-parties/2023

[291] National Inventory submissions for Annex I countries were obtained from here https://unfccc.int/ghg-inventories-annex-i-parties/2023

	The same calculation method for the baseline emissions is applied to calculate the application rates of limestone and dolomite applied in each country in the project year (e.g. 2021). Five times the application rates (t/ha) in the project year for each country are considered as the total application rates of limestone/dolomite applied in the project scenario to ensure the conservativeness of the emission calculation and the consistency with the five-year baseline data.
Comments	See Section 3.6 Methodology Deviations.

Data / Parameter	EL_{wp}
Data unit	ktCO2e
Description	CO_2 emissions from liming in PAI *i* in year *t*.
Equations	Equation 9
Source of data	Box 1, option 4 in VM0042 v2.0 is used including regional average values for historic CO_2 emissions from liming. Regional data are derived from Tables 3.G-1 of the UNFCCC National Inventory Reports.
Description of measurement methods and procedures to be applied:	See source of data above.
Frequency of monitoring/recording	The data is recorded prior to each verification event.
QA/QC procedures to be applied	See source of data above.
Purpose of Data	Calculation of baseline and project emissions
Calculation method	The sum of the total emissions (kt CO2e) from liming activity from the five-year historic look-back period (2016 to 2020) for each country is considered as the total emissions (kt CO2e) from liming in the baseline.

	Five times the total emissions (kt CO2e) from liming activity in the project year (e.g. 2021) for each country are considered as the total emissions (kt CO2e) from liming activity in the project scenario to ensure the conservativeness of the emission calculation and the consistency with the five-year baseline data.
Comments	It was decided that a more transparent and fair approach to quantifying liming CO_2 emissions would be to utilise regional data rather than project activity data. This is mainly due to the fact that the farmers apply lime to soils in very irregular patterns and there are no sufficient levels of verification of farmer's data. Furthermore, the inclusion of equations for quantifying lime CO_2 emissions in VM0042 v 2.0 occurred after the farmers joined the AgreenaCarbon Project and thus they did not report this activity data. Application of the regional data to quantify emissions for a project activity is not directly consistent with recommendations provided in the VM0042 v 2.0 and a further explanation for the applied approach has been provided in Section 3.6 Methodology Deviations.

Data / Parameter	$EF_{limestone}$ *and* $EF_{dolomite}$
Data unit	t C/t (limestone or dolomite)
Description	Emission factor for the application of calcitic limestone and dolomite
Equations	Equation 10
Source of data	Section 11.3, Chapter 11, Volume 4 in the 2019 Refinement to the 2006 IPCC National Greenhouse Gas Inventories[292]
Description of measurement methods and procedures to be applied:	See source of data above.

[292] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf

Frequency of monitoring/recording	Checks for updated emission factors will be made prior to every verification period.
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	c
Data unit	Dimensionless
Description	Type of agricultural residue
Equations	Equation 15, Equation 33
Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	Baseline data are retrieved from the Baseline SoA. The annual type of agricultural residue is sourced through the regional default value as outline in Table 3.4
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information. This data is run through automated flagging systems in the project quality assurance and quality control procedures. Residue management is requested and confirmed through internal field inspections.
Purpose of Data	Calculation of baseline and project emissions

Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct"*

Data / Parameter	$FSN_{wp,i,t}$
Data unit	t N
Description	N inputs from N containing synthetic fertiliser applied for PAI i in year t in the project scenario
Equations	Equation 19 and 20
Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	The reported data is received through direct contact with the farmer by the project and uploaded to the platform. This is carried out each harvest year prior to each verification event as data is received.
Frequency of monitoring/recording	The data is monitored prior to every verification event.
QA/QC procedures to be applied	Outline of collection of data and QA/QC is in alignment with VM0042 v 2.0 and is presented in the Monitoring Plan. This data received from farmers will go through automated flagging systems based on different N demands of various crops in the project quality assurance and quality control procedures. If necessary, the data will be checked and confirmed by contacting farmers.
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct".*

Data / Parameter	OF_{wp}
Data unit	Dimensionless
Description	Type of organic N fertiliser
Equations	Equation 21
Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	The type of organic fertilisers is determined prior to each verification event. The reported data is received through direct contact with the farmer by the Project and uploaded to the platform.
Frequency of monitoring/recording	The annual data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information. This data received from farmers will go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the information will be checked and confirmed by contacting farmers.
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct"*

Data / Parameter	NC_{OF}
Data unit	t N/t fertiliser
Description	N content of organic fertiliser type *OF*

Equations	Equation 21
Source of data	Peer-reviewed published data (see list of references [293]).
Description of measurement methods and procedures to be applied:	Content of different organic fertilisers are from peer-reviewed published data.
Frequency of monitoring/recording	Prior to each verification period
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$M_{wp,OF,i,t}$

[293] Font-Palma, C. (2019). Methods for the treatment of cattle manure—a review. C, 5(2), 27.
Chambers, B. J., Lord, E. I., Nicholson, F. A., & Smith, K. A. (1999). Predicting nitrogen availability and losses following application of organic manures to arable land: MANNER. Soil use and management, 15(3), 137-143.
Cravotta, Charles. (1997). Use of Stable Isotopes of Carbon, Nitrogen, and Sulfur to Identify Sources of Nitrogen in Surface Waters in the Lower Susquehanna River Basin, Pennsylvania. US Geological Survey Water Supply Paper. 2497.
Nobile, C., Lebrun, M., Védère, C., Honvault, N., Aubertin, M. L., Faucon, M. P., ... & Houfertiliser022). Biochar and compost addition increases soil organic carbon content and substitutes P and K fertiliser in three French cropping systems. Agronomy for Sustainable Development, 42(6), 119.
Thongnan, R., Thongpan, H., Rakmak, N., & Siripatana, C. (2016). Modeling of anaerobic co-digestion of pig manure and domestic organic waste. Jurnal Teknologi, 78(5-6), 117-24.
Aboutayeb, R., Elgharous, M., Abail, Z., Faouzi, B., & Koulali, Y. (2014). Short term effects of chicken manure application on soil physicochemical properties cropped with silage maize. International Journal of Innovation and Applied Studies, 9(2), 662.
López-Cano, I., Roig, A., Cayuela, M. L., Alburquerque, J. A., & Sánchez-Monedero, M. A. (2016). Biochar improves N cycling during composting of olive mill wastes and sheep manure. Waste Management, 49, 553fertilisern, S., Stenberg, B., Nyberg, A., & Brohede, L. (2012). Potential methods for estimating nitrogen fertiliser value of organic residues. Soil Use and Management, 28(3), 283-291.
Fouda, Sara & Tucher, S. & Lichti, Fabian & Schmidhalter, Urs. (2013). Nitrogen availability of various biogas residues applied to ryegrass. Journal of Plant Nutrition and Soil Science. 176. 10.1002/jpln.201100233.

Data unit	t fertiliser
Description	Mass of N containing organic fertiliser applied in the project for PAI in year t
Equations	Equation 21
Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	Mass of N containing organic fertiliser is determined prior to each verification event. The reported data is received through direct contact with the farmer by the Project and uploaded to the platform.
Frequency of monitoring/recording	The annual data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information. This data will go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data will be checked and confirmed by contacting farmers.
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct"*

Data / Parameter	GWP_{N20}
Data unit	t CO_2e / t N_2O
Description	Global warming potential for N_2O
Equations	Equation 16, Equation 19, Equations 23 – 25, Equation 28, Equations 31-33

Source of data	IPCC Fifth Assessment Report (IPCC, 2013)
Description of measurement methods and procedures to be applied:	See source of data above. N_2O is converted using the 100-year global warming potential derived from the IPCC Fifth Assessment Report for GHG emission reductions occurring on or after 1 January 2021.
Frequency of monitoring/recording	Checks for updated values will be made prior to every verification period
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$EF_{Ndirect}$
Data unit	t N_2O-N/t N applied
Description	Emission factor for direct nitrous oxide emissions from N additions from synthetic fertilisers, organic amendments and crop residues
Equations	Equation 19 and Equation 25
Source of data	Tier 1 value from table Table 11.1, Chapter 11 volume 4 in IPCC (2019)
Description of measurement methods and procedures to be applied:	A value of 0.01 is applied as a conservative approach for estimating N_2O-N emissions from the addition from synthetic and organic fertilisers plus crop residue across multiple regions that is time-invariant.

Frequency of monitoring/recording	Checks for updated emission factors will be made prior to every verification period.
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	EF_{Nvolat}
Data unit	t N_2O-N / (t NH_3-N + NO_x-N volatilized)
Description	Emission factor for nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces
Equations	Equation 23
Source of data	Tier 1 value from Table 11.3, Chapter 11, Volume 4 in IPCC (2019)
Description of measurement methods and procedures to be applied:	A value of 0.01 is applied as a conservative approach for estimating N2O-N emissions from the atmospheric deposition of N on soils and water surfaces across multiple regions that is time-invariant.
Frequency of monitoring/recording	Checks for updated emission factors will be made prior to every verification period.
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions

Calculation method	Not applicable
Comments	None

Data / Parameter	EF_{NleaCh}
Data unit	t N_2O-N/t N leached and runoff
Description	Emission factor for nitrous oxide emissions from leaching and runoff
Equations	Equation 24 and 32
Source of data	Volume 4, Chapter 11, Table 11.3 (IPCC, 2019)
Description of measurement methods and procedures to be applied:	See source of data. A value of 0.011 is applied as a conservative approach for estimating N_2O-N emissions from leaching and runoff across multiple regions that is time-invariant.
Frequency of monitoring/recording	Checks for updated emission factors will be made prior to every verification period
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$Frac_{GASF,I,S}$
Data unit	Dimensionless

Description	Fraction of all synthetic N added to soils that volatilizes as NH_3 and NO_x for livestock type *l* and manure management system *S*
Equations	Equation 23
Source of data	Volume 4 Chapter 11, Table 11.3 (IPCC, 2019)
Description of measurement methods and procedures to be applied:	See source of data above. A value of 0.11 is applied as a conservative approach for estimating N_2O-N emissions from volatilisation of synthetic fertilisers across multiple regions that is time-invariant.
Frequency of monitoring/recording	Checks for updated values will be made prior to every verification period
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$Frac_{GASM,l,S}$
Data unit	Dimensionless
Description	Fraction of all organic N added to soils and N in manure and urine deposited on soils that volatilizes as NH3 and NOx
Equations	Equation 23, Equation 31
Source of data	Volume 4, Chapter 11, Table 11.3 (IPCC, 2019)

Description of measurement methods and procedures to be applied:	See source of data above.
Frequency of monitoring/recording	Checks for updated values will be made prior to every verification period.
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$Frac_{LEACH,l,S}$
Data unit	Dimensionless
Description	Fraction of N added (synthetic or organic) to soils and N in manure and urine deposited on soils that is lost through leaching and runoff in regions where leaching and runoff occurs
Equations	Equation 24, Equation 32
Source of data	Volume 4 Chapter 11 Table 11.3 (IPCC, 2019)
Description of measurement methods and procedures to be applied:	See source of data above.
Frequency of monitoring/recording	Checks for updated values will be made prior to every verification period.

QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	Wet climates occur in temperate and boreal zones where the ratio of annual precipitation: potential evapotranspiration > 1, and tropical zones where annual precipitation > 1000 mm. Dry climates occur in temperate and boreal zones where the ratio of annual precipitation: potential evapotranspiration < 1, and tropical zones where annual precipitation < 1000 mm.

Data / Parameter	$MB_{g,wp,i,t}$
Data unit	t dm
Description	Annual dry matter including aboveground and below ground of N-fixing species g returned to soils for PAI i in year t
Equations	Equation 26
Source of data	The annual dry matter of N-fixing species is determined using farmer-reported crop productivity data and the yield-to-residue equations based on Tables 11.1A and 11.2, Section 11.2.1.3, Chapter 11, Volume 4 in the IPCC 2019 Refinement guidelines.
Description of measurement methods and procedures to be applied:	The annual N-fixing species and their productivity data are received through direct contact with the farmer by the Project and uploaded to the platform. This is carried out each harvest year prior to each verification event.
Frequency of monitoring/recording	The data is monitored prior to each verification event.

QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information. The crop productivity data will go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data will be checked and confirmed by contacting farmers.
Purpose of Data	Calculation of project emissions
Calculation method	The crop yield-to-residue equations based on Tables 11.1A and 11.2, Section 11.2.1.3, Chapter 11, Volume 4 in the IPCC 2019 Refinement guidelines.
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct"*

Data / Parameter	$N_{content,g}$
Data unit	t N/t dm
Description	Fraction of N in dry matter for N-fixing species *g*
Equations	Equation 26
Source of data	Table 11.1A, Section 11.2.1.3, Chapter 11, Volume 4 in the IPCC 2019 Refinement guidelines.
Description of measurement methods and procedures to be applied:	The fraction of N in dry matter is determined based on the N-fixing species type.
Frequency of monitoring/recording	Checks for updated values will be made prior to every verification period
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of project emissions

Calculation method	Not applicable
Comments	None

Data / Parameter	g_{wp}
Data unit	Dimensionless
Description	Type of N-fixing species
Equations	Equation 26
Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	Type of N-fixing species is determined prior to each verification event. The reported data is received through direct contact with the farmer by the Project and uploaded to the platform. This is carried out each harvest year prior to each verification event.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years or prior to each verification event if less than five years.
QA/QC procedures to be applied	Type of N-fixing species is requested and confirmed through internal field inspections. If necessary, the information will be checked and confirmed by contacting farmers.
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct"*

Data / Parameter	p

Data unit	Categorical variable
Description	Crop product
Equations	Equation 35, Equation 36
Source of data	Farmer reported data from farm attestation
Description of measurement methods and procedures to be applied:	Not applicable
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information. Field data collection is conducted via internal field inspections and data is checked and described in the Agreena Adaptive Management Plan which contains all the steps of the QA/QC process and how risks are mitigated at each step of the data collection process.
Purpose of Data	Identification of crop product for project emissions and market leakage analysis
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct"*

Data / Parameter	$P_{wp,p}$
Data unit	t / ha
Description	Average productivity for product p during the project period
Equations	Equation 35, Equation 36

Source of data	Farmer reported data from farm attestation
Description of measurement methods and procedures to be applied:	Quantitative crop productivity data will be obtained from farmer reported data for every PAI in the project scenario over a ten-year period. The data will subsequently be used to calculate the change in productivity of crop product p and the productivity ratio per ha for each crop product p.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information. Field data collection is conducted via internal field inspections and data is checked and described in the Project Adaptive Management Plan which contains all the steps of the QA/QC process and how risks are mitigated at each step of the data collection process.
Purpose of Data	Calculation of project emissions and leakage
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct"*

Data / Parameter	$RP_{wp,p}$
Data unit	Output (e.g., kg)/ha
Description	Average regional productivity for product p during the same years as project period
Equations	Equation 36
Source of data	Regional productivity data from government (e.g., USDA Actual Production History data), industry, published, academic or international organization (e.g., FAO, Eurostat) sources.
Description of measurement methods	Not applicable

and procedures to be applied:	
Frequency of monitoring/recording	Every 10 years
QA/QC procedures to be applied	Not applicable
Purpose of Data	Determination productivity ratio for market leakage analysis
Calculation method	Not applicable
Comments	None

Data / Parameter	$SOC_{bsl,i,t}$,$SOC_{wp,i,t}$
Data unit	t C/ha
Description	The average soil organic carbon stocks for PAI i in year t under the baseline and Project scenarios
Equations	Equation 40 (VM0042 v2.0)
Source of data	For monitoring purposes SOC stocks will be monitored at PAI level. To increase the granularity of the analysis, values collected from SoilGrids at PAI level will be used as inputs for the calculations in the first time step ($SOC_{i,t-1}$). We assume the values obtained from soilgrids represent the equilibrium state of each PAI before the start of the project.
Description of measurement methods and procedures to be applied:	Soil organic carbon (SOC) stocks for the baseline (BLS) and project scenario (WP) are quantified using the following function. Per VM0042 v2.0 guidelines, the same model is utilized for projections in both the baseline and project scenarios. Consequently, for the sake of clarity and brevity, the indices representing the baseline and project scenarios are omitted, as they are the only parameters differing between the input datasets for both conditions.

$SOC_{i,t} = \int SOC_{i,t}(t, DPM_{i,t}, RPM_{i,t}, BIO_{i,t}, HUM_{i,t}, IOM_{i,t}, \text{Cover Crop adoption}_{i,t}, Ks_{i,t}, In_{i,t}, FYM_{i,t}, clay_{i,t}, Temp_{i,t}, Prec_{i,t}, Evap_{i,t}, TRM_{i,t})$

Where:

$SOC_{i,t}$: Modeled carbon dioxide emissions from soil organic carbon pool in the project scenario for PAI *i* at time *t* (tC /ha)

$\int SOC_{i,t}$: Functional representation of the RothC model for PAI *i* and time *t*.

$DPM_{i,t}$: Decomposable Plant Material for PAI i at time t.

$RPM_{i,t}$: Resistant Plant Material for PAI i at time t.

$BIO_{i,t}$: Microbial Biomass for PAI i at time t.

$HUM_{i,t}$: Humified Organic Matter for PAI i at time t.

$IOM_{i,t}$: Inert Organic Matter for PAI i at time t.

$\text{Cover Crop adoption}_{i,t}$: Adoption of cover crops for PAI i at time t.

$Ks_{i,t}$: Soil organic carbon decomposition rate for PAI i at time t.

$In_{i,t}$: Plant biomass carbon inputs for PAI i at time t.

$FYM_{i,t}$: Application of farmyard manure for PAI i at time t.

$clay_{i,t}$: Clay content in the soil for PAI i at time t.

$Temp_{i,t}$: Temperature for PAI i at time t.

$Prec_{i,t}$: Precipitation for PAI i at time t.

$Evap_{i,t}$: Evaporation for PAI i at time t.

$TRM_{i,t}$: Tillage rate modifier unit i at time t.

Soil organic carbon stocks will be determined from samples taken within the PAI. All aboveground litter and residue is removed from the intended sampling location. Soil cores are extracted to ≥30 cm depth. Where the soil profile is < 30 cm, soil

	cores will be extracted to the bedrock. Soil organic carbon concentration and bulk density are measured from the same cores to obtain the SOC stock. The rock fragment content of the soil sample is also recorded. Soil samples are to be kept cool (<4oC) andshipped to the laboratory for analysis within five days of sampling. The sampling locations are georeferenced and established prior to field visits. Re-sampling of the same PAIs will be carried out every five years. A stratified random sampling strategy will be utilised to quantify the SOC stocks for PAIs that are representative of each baseline scenario (see (Appendix 8 for further information).
Frequency of monitoring/recording	The Modeled SOC will be calculated on a yearly basis, while SOC measurements will be repeated at 5-year intervals.
QA/QC procedures to be applied	Field data collection is conducted via internal field inspections and data is checked and described in the Agreena Adaptive Management Plan which contains all the steps of the QA/QC process and how risks are mitigated at each step of the data collection process.
Purpose of Data	The data is intended for calculating project emissions and re-assessing initial SOC (Soil Organic Carbon) stocks. This reassessment allows for comparisons with predicted SOC changes and includes making any necessary adjustments (also known as “true-ups”) as outlined in Quantification Approach 1, Table 5 in VM0042 v2.0.
Calculation method	For the modeled SOC values see section “Description of measurement methods and procedures to be applied”
Comments	Soil organic carbon stocks at time t=0 can be either directly measured at t=0 or estimated retrospectively from data gathered within five years before or after t=0. These data points should be applied consistently in both the baseline and project scenarios for the entire duration of the project. For each PAI, the soil organic carbon stocks in the baseline scenario must be documented at intervals not exceeding five years.

Data / Parameter	$Green\ cover_{wp,\ i,t}$
Data unit	Number of green cover months / year

Description	This parameter represents the number of months an area is covered by green vegetation throughout the year.
Equations	Equation 6 (VM0042 v2.0)
Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	The RothC model takes as inputs the months in which there are green cover on the soil. In the context of agriculture, green cover refers to the duration periods when the soil is covered by either cash or cover crops. The application of cover crops is monitored throught the utilization of satellite images in our MRV process.
Frequency of monitoring/recording	Every year
QA/QC procedures to be applied	Field data collection is conducted via internal field inspections and data is checked and described in the Agreena Adaptive Management Plan which contains all the steps of the QA/QC process and how risks are mitigated at each step of the data collection process.
Purpose of Data	Calculation of project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	In_{bsl} / In_{wp}
Data unit	tC/ha
Description	The parameter 'In' represents the annual input of organic carbon to the soil. This includes carbon inputs from mulching plant residues.
Equations	Equation 6 (VM0042 v2.0)
Source of data	Farmer attestations

Description of measurement methods and procedures to be applied:	Project scenario and baseline plant carbon inputs (Inbsl, Inwp) are estimated at PAI level using the yield-to-residue equations based on Tables 11.1A and 11.2, Section 11.2.1.3, Chapter 11, Volume 4 of the IPCC 2019 Refinement guidelines.
Frequency of monitoring/recording	Every year
QA/QC procedures to be applied	Field data collection is conducted via internal field inspections and data is checked and described in the Agreena Adaptive Management Plan which contains all the steps of the QA/QC process and how risks are mitigated at each step of the data collection process.
Purpose of Data	*In* is a SOC model input representing the amount of carbon biomass added to the soil from plant material. As such, it is a driver of carbon accumulation in the soil represented in equation 6 (VM0042 v2.0)
Calculation method	*In* is calculate by applying the following equation from the IPCC 2019 Refinement guidelines: $In_{i,t} = P_{i,t} \times Slope_{crop\ type,} \times Intercept_{crop\ type} \times Dry\ Matter_{Crop\ type} \times$ Carbon Content. where: $P_{i,t,\ crop\ type}$ *: Crop productivity* $Slope_{crop\ type,}$ *: Slope parameter from the IPCC yield to residue equations* $Intercept_{crop\ type}$ *: Intercept parameter from the IPCC yield to residue equations* $Dry\ Matter_{Crop\ type}$: *Dry matter parameter from the IPCC yield to residue equations* *Carbon Content* : Carbon content of Plant residues
Comments	None

Data / Parameter	FYM_{bsl} / FYM_{wp}
Data unit	tC/ha
Description	The parameter 'FYM' represents the annual input of organic carbon specifically from farmyard manure.
Equations	Equation 6 (VM0042 v2.0)
Source of data	Farm attestations
Description of measurement methods and procedures to be applied:	Farmyard manure (FYM) is a crucial source of organic matter and nutrients for the soil. Project scenario and baseline FYM applications (FYM_{bsl}, FYM_{wp}) are estimated at the PAI level by collecting farm-reported data and calculating the carbon content of each application as detailed in the Calculation Method section.
Frequency of monitoring/recording	Yearly
QA/QC procedures to be applied	Field data collection is conducted via internal field inspections and data is checked and described in the Agreena Adaptive Management Plan which contains all the steps of the QA/QC process and how risks are mitigated at each step of the data collection process.
Purpose of Data	*FYM is a* SOC model input representing the amount of carbon biomass added to the soil from organic fertilisers. As such, it is a driver of carbon accumulation in the soil represented in equation 6 (VM0042 v2.0)
Calculation method	FYM is calculated by multiplying the amount of manure from different sources by their respective carbon contents. The amount of manure applied is collected through farm attestations. FYM is calculated as follows: $FYM = M_{OF,i,t} \times CC_{OF,I,t}$ The table below presents the logical evaluation of FYM inputs across various scenarios to exemplify how model inputs are derived from the data collected at the project area. Each row of the table specifies the prevailing practice from the baseline

period and contrasts it with the project scenario at the PAI level. The results from these comparisons serve as FYM inputs for calculating the project scenarios. For instance, the amount of organic fertiliser would be considered as FYM inputs in the PAIs that apply only synthetic fertiliser in the baseline but shift to only organic fertiliser in the project scenario. In contrast, PAIs that have consistently applied organic fertiliser would record no additional FYM inputs in the project scenario, as this practice does not increase the carbon added to the soil compared to previous activities.

Baseline	Project Scenario	Outcome at Project Scenario
Only Synthetic	Only Synthetic	No FYM inputs
Only Synthetic	Only Organic	FYM equals organic fertiliser
Only Synthetic	Mixed	FYM equals organic fertiliser in the mix
Only Organic	Only Synthetic	No FYM addition
Only Organic	Mixed	No FYM addition
Only Organic	Only Organic	No FYM addition
Mixed	Only Synthetic	No FYM addition
Mixed	Only Organic	No FYM addition
Mixed	Mixed	No FYM addition

Comments	None

Data / Parameter	•
Data unit	Dimensionless
Description	Gas or pool - This project uses quantification approach 1 for SOC only, thus this quantity exclusively refers to the SOC pool in this project.
Equations	Equation 51 – 54, Equation 65
Source of data	Not applicable
Description of measurement methods and procedures to be applied:	Not applicable
Frequency of monitoring/recording	Monitoring must be conducted at least every five years or prior to each verification event if less than five years.
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$\bar{\Delta}\bullet,t$ and $\bullet\bar{t}$
Data unit	t CO2e/unit area
Description	Average emission reductions from pool or source •, or stock of pool •, in year t. Note that this project uses quantification approach 1 for SOC stocks only, thus, as above, • will always refer to changes/stocks in SOC. Hence $\bar{\Delta}\bullet,t$ will be reported in subsequent verification

	reports as part of the calculation of the uncertainty deduction. As referenced in Section 8.6.1.1 of VM0042 v2.0,
Equations	Equation 53, Equation 54, Equation 65
Source of data	Calculated from modeled or calculated values in the project area
Description of measurement methods and procedures to be applied:	Not applicable
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of emission reductions
Calculation method	The average emission reductions from pool or source or stock of pool at time t are estimated using unbiased statistical approaches. These are outlined in the MVR VMD0053 v2.0.
Comments	None

Data / Parameter	$Buffer_{,t}$
Data unit	tCo2e
Description	Number of buffer credits to be contributed to the AFOLU pooled buffer account in year t
Equations	Equation 66
Source of data	The number of buffer credits to be contributed to the AFOLU pooled buffer account must be determined by applying the latest version of the VCS AFOLU Non-Permanence Risk Tool

Description of measurement methods and procedures to be applied:	Not applicable
Frequency of monitoring/recording	Prior to each verification event
QA/QC procedures to be applied	The number of buffer credits to be contributed to the AFOLU pooled buffer account must be determined by applying the latest version of the VCS AFOLU Non-Permanence Risk Tool
Purpose of Data	Calculation of project emissions and buffer credits
Calculation method	The number of buffer credits to be contributed to the AFOLU pooled buffer account must be determined by applying the latest version of the VCS AFOLU Non-Permanence Risk Tool
Comments	None

Data / Parameter	$M\_OA_{wp,l,t}$
Data unit	tonnes
Description	Mass of organic amendment applied as fertiliser on the project area in year t
Equations	Equation 34
Source of data	Mass of organic amendment applied as fertiliser is sourced from farmer-reported data.
Description of measurement methods and procedures to be applied:	Mass of organic amendment applied as fertiliser on the project area is determined prior to each verification event. The reported data is received through direct contact with the farmer by the Project and uploaded to the platform. This is carried out each harvest year prior to each verification event as data is received.
Frequency of monitoring/recording	The data is monitored prior to each verification event.

QA/QC procedures to be applied	See Monitoring Plan Section 5.3 for further information. This data will go through automated flagging systems in the project quality assurance and quality control procedures. Mass of organic amendment applied as fertiliser is requested and confirmed through internal field inspections.
Purpose of Data	Calculation of leakage from application of new organic amendments from outside of the project area
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct".*

Data / Parameter	$CC_{bsl,l,t}$ / $CC_{wp,l,t}$
Data unit	%
Description	Carbon content of organic amendment applied as fertiliser in the project area in year *t*
Equations	Equation 34
Source of data	Carbon content of manure is derived from peer-reviewed published data (see list of references [294]).

[294] Chambers, B. J., Smith, K. A., & Pain, B. F. (1999). Strategies to encourage better use of nitrogen in animal manures. Soil Use and Management, 15(S1), 190-194. doi:10.1111/j.1475-2743.1999.tb00094.x
Delin, S., Stenberg, M., Nyberg, A., & Brohede, L. (2012). Potential methods for estimating nitrogen fertiliser value of organic residues. Soil Use and Management, 28(3), 283-291. doi:10.1111/j.1475-2743.2012.00410.x
Fouda, S., et al. (2014). Evaluating the impact of manure management on soil carbon fluxes in agricultural lands. Journal of Environmental Quality, 43(5), 1617-1626. doi:10.2134/jeq2014.03.0112
Nobile, C., et al. (2022). Advances in sustainable agricultural practices for mitigating carbon emissions. Agriculture, 12(3), 149-164. doi:10.3390/agriculture12030149
Rachadaporn, C., et al. (2015). Assessing greenhouse gas emissions from rice paddies under different water management practices. Agricultural and Forest Meteorology, 213, 173-182. doi:10.1016/j.agrformet.2015.07.001
Aboutayeb, N., et al. (2014). The influence of organic amendments on soil carbon fluxes in Mediterranean agroecosystems. Soil Biology and Biochemistry, 68, 18-25. doi:10.1016/j.soilbio.2013.09.022
López-Cano, I., et al. (2016). Evaluating the carbon sequestration potential of cover crops in temperate climates. Geoderma, 271, 63-70. doi:10.1016/j.geoderma.2016.02.027
Delin, S., & Nyberg, A. (2013). Nitrogen efficiency in organic farming systems: A review. Agricultural Systems, 115, 63-72. doi:10.1016/j.agsy.2012.10.004

Description of measurement methods and procedures to be applied:	Carbon content of different organic fertilisers is from peer-reviewed published data.
Frequency of monitoring/recording	Prior to each verification period
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions and leakage from application of new organic amendments from outside of the project area
Calculation method	Not applicable
Comments	None

Data / Parameter	$EF_{CO2,LE}$
Data unit	t CO2 / GJ
Description	Emission factors of coal, oil and natural gas
Equations	Equation S1 (Derived from Equation 15 in CDM Methodological Tool: Project and leakage emissions from biomass v5.0) [295]
Source of data	Table 2.2, Chapter 2, Volume 2 in the 2006 IPCC) Guidelines for National Greenhouse Gas Inventories[296].

Palma, R. (2019). Organic farming practices for enhancing soil carbon sequestration. Environmental Science & Policy, 100, 67-73. doi:10.1016/j.envsci.2019.05.010
Cravotta, C. A., Trahan, M. K., & Pappas, E. A. (1997). Effects of agricultural practices on carbon fluxes and sequestration. Journal of Soil and Water Conservation, 52(2), 94-101. doi:10.2134/jswc1997.0520094

[295] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-16-v5.0.pdf

[296] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

	National energy statistics for each country were obtained from the International Energy Agency[297]
Description of measurement methods and procedures to be applied:	For coal, EF_{coal} = 0.0946 t CO2 / GJ; for oil, EF_{oil} = 0.0741 t CO2 / GJ
Frequency of monitoring/recording	Checks for updated emission factors will be made prior to every verification period.
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of leakage from diversion of biomass residues used for energy applications in the baseline scenario
Calculation method	Not applicable
Comments	None

Data / Parameter	$BR_{pj,n,y}$
Data unit	Tonnes on dry-basis
Description	Quantity of biomass residues of category n used in facilities which are located at the project site and included in the project boundary in year y
Equations	Equation S1 (Derived from Equation 15 in CDM Methodological Tool: Project and leakage emissions from biomass v5.0)[298].
Source of data	The quantity of biomass residues is determined using farmer-reported crop productivity data and the yield-to-residue equations based on Tables 11.1A and 11.2, Section 11.2.1.3, Chapter 11, Volume 4 in the IPCC 2019 Refinement guidelines.

[297] https://www.iea.org/countries
[298] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-16-v5.0.pdf

Description of measurement methods and procedures to be applied:	The crop productivity data is received through direct contact with the farmer by the Project and uploaded to the platform. This is carried out each harvest year prior to each verification event.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	The crop productivity data will go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data will be checked and confirmed by contacting farmers.
Purpose of Data	Calculation of leakage from diversion of biomass residues used for energy applications in the baseline scenario
Calculation method	The crop yield-to-residue equations based on Tables 11.1A and 11.2, Section 11.2.1.3, Chapter 11, Volume 4 in the IPCC 2019 Refinement guidelines.
Comments	Signed farmer attestation on the platform with the wording *"I declare that the information I have provided about my fields is true and correct".*

Data / Parameter	$NCV_{n,y}$
Data unit	GJ / tonne of dry matter
Description	Net calorific value of the biomass residues of category n in year y
Equations	Equation S1 (Derived from Equation 15 in CDM Methodological Tool: Project and leakage emissions from biomass v5.0)[299]
Source of data	Teagasc Agriculture and Food Development Authority [300]; Danish Energy Agency[301]

[299] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-16-v5.0.pdf
[300] https://www.teagasc.ie/media/website/publications/2010/868_StrawForEnergy-1.pdf
[301] https://ens.dk/sites/ens.dk/files/Statistik/metode_halm.pdf

Description of measurement methods and procedures to be applied:	See source of data above. The value 14.44 is applied.
Frequency of monitoring/recording	Checks for updated values will be made prior to every verification period.
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of leakage from diversion of biomass residues used for energy applications in the baseline scenario
Calculation method	Not applicable
Comments	None

Not Applicable Parameters

The following are parameters that are not applicable in the AgreenaCarbon Project in the initial verification period.

Table 5-2. Parameters not applicable in AgreenaCarbon project.

Parameter	Not Applicability Condition
$EF_{ent,l}$	These parameters are not applicable in the AgreenaCarbon Project as it does not incorporate livestock emissions or accept farmers that own livestock. Livestock farmers may be included in future iterations and verification periods.
$Pop_{wp,l-,i,P}$	
$Pop_{bsl,l-,i,P}$	
l, dimensionless	
P, unitless	
$AWMS_{l,i,t,P,S}$	
$EF_{CH4,md,l}$	
S	

$VS_{rate,l}$	
$W_{wp,l,i,t}$	
$W_{bsl,l,i,t}$	
$CC_{prj,i,t}$	
p	
$EF_{N2O,md,l,S}$	
Nex_l	
$MS_{bsl,l,i,t}$	
$N2O\_md_{bsl,i,t}$	
GWP_{CH4}	
CF_c	These parameters are not applicable in the AgreenaCarbon Project as the Project does not allow participants to conduct any burning of residues in entering the Project.
$EF_{c,CH4}$	
$MB_{wp,c,i,t}$	
$EF_{c,N2O}$	
$\Delta C_{SHRUB,bsl,i,t}$	Not applicable as these parameters are not included in the AgreenaCarbon Project and is not measured as the only eligible vegetation in the Project are arable fields. Woody biomass is not included in the baseline (see Section 4.1)
$\Delta C_{TREE,wp,i,t}$	
$\Delta C_{SHRUB,wp,i,t}$	
$f(N2O\_soilbsl,i,t)$	Not applicable as nitrogen fluxes are calculated using approach 3.
$f(CH_4soil_{bsl,l,t})$	Methane fluxes from soil methanogenesis are not included in the project boundary.
SF	These parameters are not applicable in the AgreenaCarbon Project as the nitrogen application rates of synthetic fertiliser (tN/ha) are directly collected from farmer or derived from the regional data. Therefore, Equation 20 in VM0042 V2.0 is not applicable in the AgreenaCarbon
NC_{SF}	
$M_{wp,SF,i,t}$	

$M_{bsl,SF,i,t}$	Project. Instead, the N amount of synthetic fertiliser applied to PAI i in year t in the baseline or project scenario (t N) ($FSN_{bsl,i,t}$ or $FSN_{wp,i,t}$) is calculated by multiplying the nitrogen application rates of synthetic fertiliser (tN/ha) by the area size of PAI.

5.3 Monitoring Plan

5.3.1 Overview of the Monitoring Plan

The data collection undergoes a QA/QC check through pattern analysis and remote sensing. The data and parameters that have been flagged as non-conforming will undergo a thorough communication process with the participant to understand where the flag is coming from and whether the project instance can remain in the Project. The details of the process and plan are described in the sections below.

The Monitoring Plan contains the procedures for collecting and reporting all data and parameters within the Project including the following information:

- Monitoring Tasks
- Monitoring Boundaries
- Parameters measured
- Data Collection
- Monitoring Frequency
- Baseline Control and Re-evaluation
- QA/QC Procedures
- Data Archiving
- Organizational Structure of the Monitoring Team
- Soil Sampling and Modeling Plan

5.3.1.1 Monitoring Tasks

Project participant data reporting occurs in a structured manner on the AgreenaCarbon platform.[302] This interface has several safeguards to assure data accuracy and completeness, including a two-step logic-based flagging process. This flagging process checks data entered by Project participants (i.e., farmers) using a combination of standard values and remote sensing analytics. The process is fully integrated into the platform; outlier values are flagged and checked

[302] A platform where the project participants can enter their historical data and field actuals and where the verifying data is also separately uploaded.

as depicted in figures 1 and 2. Project participant data reporting, and Quality Assurance (QA)/ Quality Control (QC) occurs in the following order:

1. Project participant subscribes to the AgreenaCarbon platform where they, provide information on the number, location and size of PAIs under their management. During the validation meeting with the Project proponent, a detailed description of soil characteristics and historical management practices are provided for each field.

2. Following the validation meeting and QA/QC review of the Project participant's data, the participant is briefed about the Project and its rules. The QA/QC review process assesses the practices performed on the farm during the last 5 years and ensures that an accurate baseline is established. Following QA/QC review, baseline establishment, and admission to the AgreenaCarbon Project, and implementation of Project activity, the Project participant enters their annual harvest data on the platform after the following harvest. This data undergoes QA/QC screening and is then utilized to calculate carbon sequestration and reductions on an annual basis as the harvest cycle progresses. The parameters monitored are fertiliser application, yield, tillage practice, residue management and catch/cover cropping practices.

3. Data are archived for retrospective assessments or auditing if required.

5.3.1.2 Monitoring Boundaries

The Project is organized and monitored by PAI. The boundaries of each field area associated with each PAI are determined by a remote sensing model based on pin locations provided by the Project participant. The Project sets accounting boundaries for carbon dioxide (CO_2) and nitrous oxide (N_2O) as described in Table 5-1.

Table 5-1. An outline of the monitoring of the Project boundaries

Greenhouse gas	Component	Activates
CO_2	Carbon stock changes	Tillage practices
		Res. mgmt. (storage)
		Cover Crops
		Org. input (storage)
N_2O	Residue emissions	Res. mgmt. (emissions)
N_2O	Soil emissions	fertiliser emissions
CO_2	Energy use	Soil management activity

5.3.1.3 Parameters Measured

The parameters subject to monitoring and QA/QC review are described in Section 5.1 and their quantification approach described in Table 5-2

Table 5-2. Parameters measured and their quantification approach within the project.

Parameter Measured	Parameter quantification approach
Baseline Fossil Fuel Type	Quantification Approach 3
Baseline Fossil Fuel Volume	Quantification Approach 3
Actual Fossil Fuel Type in a harvest year	Quantification Approach 3
Actual Fossil Fuel Volume in a harvest year	Quantification Approach 3
Baseline Synthetic fertiliser type	Quantification Approach 3
Baseline Synthetic fertiliser volume	Quantification Approach 3
Actual Synthetic fertiliser type in a harvest year	Quantification Approach 3
Actual Synthetic fertiliser volume in a harvest year	Quantification Approach 3
Baseline Organic fertiliser type	Quantification Approach 3
Baseline Organic fertiliser volume	Quantification Approach 3
Actual Organic fertiliser type in a harvest year	Quantification Approach 3
Actual Organic fertiliser volume in a harvest year	Quantification Approach 3
Baseline synthetic fertiliser N volume	Quantification Approach 3

Actual synthetic fertiliser N volume in a harvest year	Quantification Approach 3
Baseline organic fertiliser N volume	Quantification Approach 3
Actual organic fertiliser N volume in a harvest year	Quantification Approach 3
Baseline N-fixing type	Quantification Approach 3
Actual N-fixing type in a harvest year	Quantification Approach 3
Baseline residue management	Quantification Approach 1 (Measure & Model)
Actual residue management in a harvest year	Quantification Approach 1 (Measure & Model)
Baseline tillage practices	Quantification Approach 1 (Measure & Model)
Actual tillage practices in a harvest year	Quantification Approach 1 (Measure & Model)
Baseline crop types	Quantification Approach 1 (Measure & Model)
Actual crop types in a harvest year	Quantification Approach 1 (Measure & Model)
Baseline Cover /catch crops	Quantification Approach 1 (Measure & Model)
Baseline Cover/catch crops	Quantification Approach 1 (Measure & Model)

5.3.1.4 Data Collection

Project monitoring activities are aligned with European annual harvest cycles. Figure 5-1 depicts the periods when each monitoring activity occurs. Following validation meetings and signing of contracts, historical data[303] from the Project participants undergoes QA during Q3 and Q4. QA is only performed once, during the Project participant's first harvest year. After completion of QA, QC is carried out prior to each verification event, taking place during Q1 and Q2. QC is initiated when the Project participant has provided information on their PAI [304] to the AgreenaCarbon platform.

As Project participants follow the harvest year, the Project 'year' is defined as the year of harvest data being fully complete. For Eastern Europe, as harvest runs later into autumn and early spring, this does not strictly follow a calendar year process. Depending on geographical region the timing of QA and QC can therefore vary. The monitoring process however is continuous: it begins when a Project participant first provides location data for a new PAI, then through to QC on annual data for the key parameters monitored.

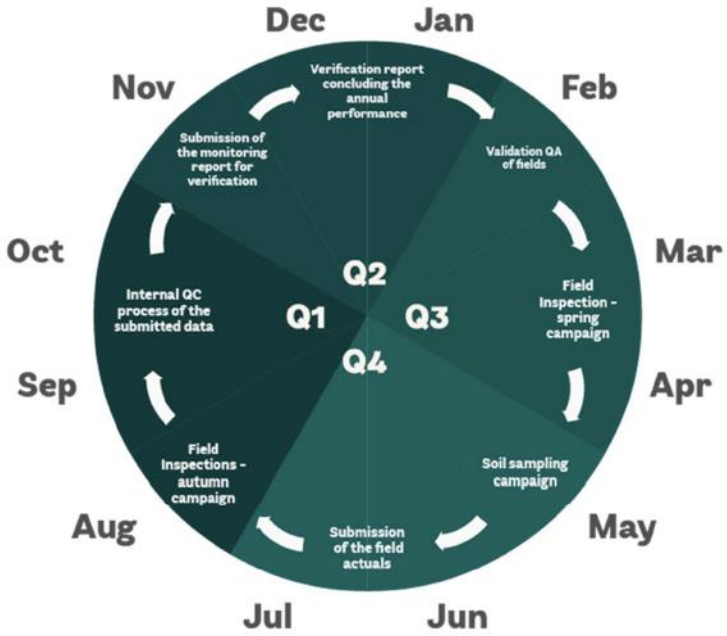


Figure 5-1. Annual cycle of monitoring plan overlaid with harvest year quarters. This adapts and changes depending on the country's harvest year.

The monitoring framework is designed for the Project and built upon in-house expertise and technologies. On top of the monitoring process and throughout the Project participants reported

[303] Data given for each PAI on a project proponents farm, covering the last 5 years. Field location, Soil characteristics and cultivation practices.

[304] Information on which Project Activities each PAI on a project participant's farm has been subjected to during the harvest year.

data, ground-truthing data and field inspections are used to supplement and provide accuracy to the models. An overview of these two processes is presented below.

Internal Inspections

Internal inspections are an on-the-ground monitoring approach for a subset of the Project, with the intention to supply validation data for the remote sensing model, drive improvements in the logic for data analytics, verify Project Activity, and strengthen relationships and integrity with the Project participants. The inspections are a bi-annual campaign encompassing an Autumn and Spring round performed by a third-party local agricultural expert or practitioner. The first campaign was carried out in the Autumn of 2021.

The first step in determining the PAI for inspection is to first determine the square root of the total portfolio of PAIs at the time of the inspection period.

$$\sqrt{\text{Total portfolio of PAIs}} = \text{Total no. PAIs to inspect}$$

Data from the inspections is used to complement the process of internal data validation and verification to improve the quality of data that is used for the final quantification of the GHG emissions reduction and removals (carbon sequestration). The outcomes of the inspection are recorded in the survey app "Fulcrum" and further applied to relevant data tools, depending on the collected data point. Following the comparison of inspection results with the reported data, individual farm inspection reports are created and provided to Project participants. These reports aim to serve as an additional resource for Project participants to understand their performance about how they report their data and highlight areas that would result in changes to their reported data.

Following the PAI calculations, the weighted average of each geography is applied to the number of PAIs to calculate the number of PAIs required to be inspected in each geography, with a threshold of above 10% to initiate inspections. PAIs are then selected at random for inspection. Where there are logistical constraints on the geographic spread of PAIs, some may be swapped to ensure visits are clustered into regions.

Data points collected during the inspections relate to soil texture, field location, field size, and soil moisture regime. These include tillage, residue management, cover cropping, fertilisation and pesticide applications. Additional data points collected include seeding and harvest dates for both cover crops and cash crops, types of cash crop (spring or winter), and additional machinery types. The customer satisfaction and project understanding questions related to their interaction with the platform, soil carbon knowledge and their understanding of the verification process.

The findings from the farm inspection are taken into account during the QC process whenever any mismatch of the data between the reported one with the ground truth data would be applied.

Ground-Truthing

The ground truth campaign aims to collect as much cash crop, cover crop and tillage data as possible throughout the season and across the Project regions to provide a dataset that is spatially stratified and representative of all PAIs and conditions in which the Project verifies agricultural practices.

In order to train remote sensing models to detect practice such as tillage and cover crops across a wide range of soil types, climates, and geographies a large robust training dataset is required. Primarily, this dataset is collected using roadside assessments by over 100 external contractors following a standardised data collection protocol. Over 250,000 field visits have been conducted across 18 European countries. Each data point consists of 2 roadside field photos as well as assessing the field on 20 agronomic factors including crop type, tillage intensity, and vegetation status. The contractors we use for this data collection are selected for their agricultural knowledge and are primarily agronomists, farmers, or hold positions in the wider agricultural industry and collect data for the AgreenaCarbon Project as part time work.

Ground truth collection frequency and Quality Control:

The ground truthing data collection quality control process ensures the quality and accuracy of the model training dataset as well as consistency between data collectors. This process is laid out in the quality control SOP and the framework implemented by the Project team and external contractors with agricultural expertise. Recruitment of collectors involves screening based on agricultural backgrounds and a thorough training process covering project fundamentals and software usage. Extensive feedback mechanisms assess and refine collectors' performance over time. Consistent quality assurance involves checking a subset of daily records, while a final check process involves outlier detection and data cleaning to ensure accuracy before the dataset is used for model training.

Ground truth data collection occurs on a continual basis across the Project area. The majority of data collection occurs in autumn and spring, when the relevant Project Activities (residue management, and cover/catch crops) can be identified. Once suitable quantities of data have been obtained per region, collection is scaled back to allow enough for ongoing model calibration/validation.

Ground truth data goes through a rigorous QA/QC process:

- Data collectors use an app that maintains consistency of values and labels.

- The app records GPS accuracy, and the collector manually sets the field location - the collector must be within 500 m of the field location they set.
- Data collectors are required to take photos of each field for QA and for our records.
- When data collectors first start with Agreena, the first day of data is fully checked; if there are issues, 100% of their data continues to be checked until data quality is confirmed and consistent.
- At least 10% of the entire project is manually checked on an ongoing basis, if there are issues they are red flagged and more checks are performed

5.3.1.5 Baseline Control and Re-evaluation Plan

The baseline is established based on the historic look-back period given during the validation meeting, as well as default regional values where required (see Table 3-4). To ensure the validity of this data, a QA process is implemented utilizing remotely sensed data, described in the QA/QC Procedures section. If inconsistencies between reported and measured data are identified during this process, a technical recalculation of the baseline may occur. The baseline is established for a period of 10 years. A second baseline will be established in 10 years in order to provide the required 20-year period. Each 10-year period will have a separate Project baseline. This is done in order to reflect the potential changes in the soil after 10 years of changing the ALM practices. The process of setting up a baseline for the first 10 years is described in chapter 3.4 of the PD. After the first 10-year period, the baseline will be updated. At this point, the Project will utilise the data collected over the previous ten years, data that has previously undergone QC, to establish an updated baseline. Because such data has already gone through the QC process described in this document and submitted as part of Project Monitoring, it will already meet all standards and requirements for data for this Project. The baseline will be reassessed according to VCS Standard v4.5 in Section 3.2.7 under ALM baseline reassessment. The baseline will be updated to reflect Project Activities using similar datasets to establish the baseline at validation. Historical management data will also be reassessed according to the Common Practice Test.

The baseline estimations are an automated process performed from data stored on the AgreenaCarbon platform. At the beginning of the last year (year 9) of the first crediting period the new baseline will be calculated according to the process described in the chapter 3.4 of PD. The draft of the baseline will be shared with each Project participant and the new baseline will be stated in the contract following approval.

5.3.1.6 Quality Assurance and Quality Control Procedures

To assure the validity of the data provided by the Project participants, a QA/QC process automatically flags data where a risk of overestimating GHG emissions is found, as shown Figure 5-2 and in greater detail in Appendix 5.

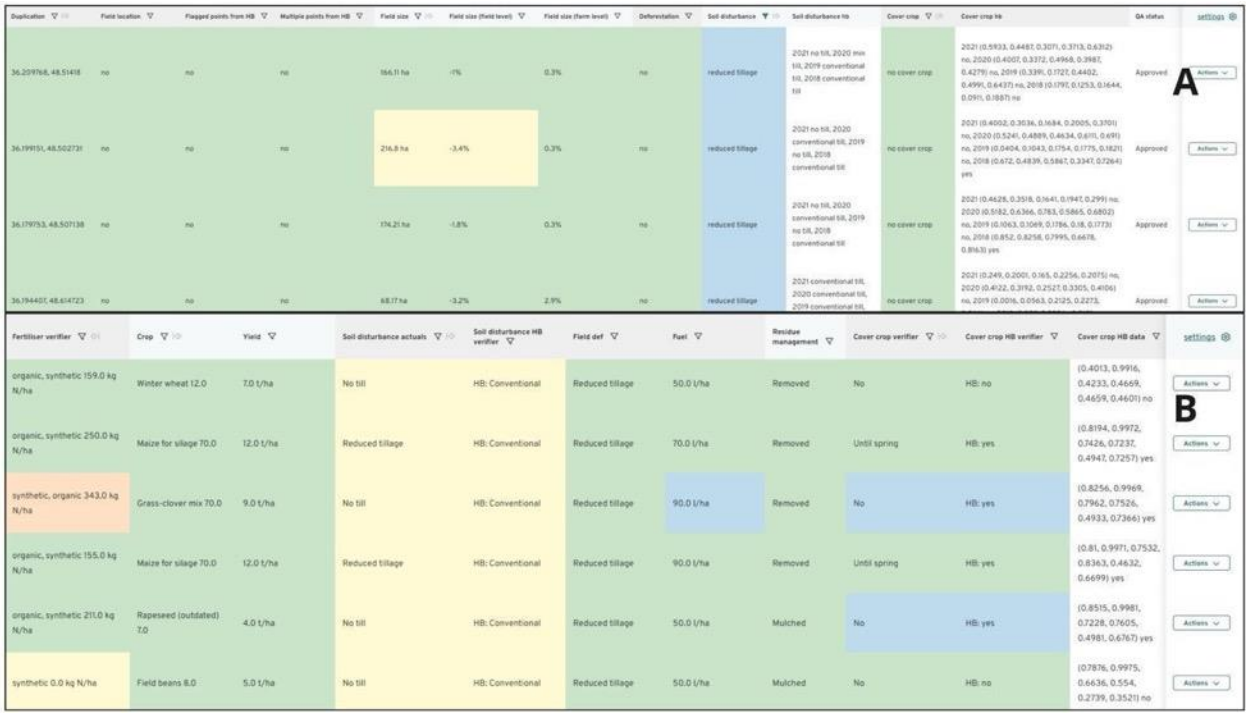


Figure 5-2. A visualization of (A) Quality Assurance (QA) and (B) Quality Control (QC) process of data within the Project platform. Each row represents one PAI/field managed within a farm. Columns are parameters monitored in the QA/QC process, as well as a record of any status change performed by monitoring analysts. A more detailed version can be found in Appendix 5 under Figure 1.1.

Data is organized within the QA/QC system with the flagging system shown in Figure 5-3.

Green flags are always approvable for both QA and QC. Blue flags are also approvable, except for field size written >100% in the QA section. Red, yellow, and orange flags always require a deeper analysis for both QA and QC. In the instance where further documentation is required from the Project participant, a Customer Success specialist contacts the participant to acquire the necessary documentation. For all parameters, a documentation request is always resulting in one of three outcomes; (1) Approval (2) Admin edit followed by an approval (3) PAI marked as "Non-compliance".

Flag color explanation

Data match	Project participant has entered data that may lead to an overestimation of GHG emissions
Project participant has entered data that may lead to an underestimation of GHG emissions	Clearing of natural ecosystems Burning crop residues
Extreme values entered by the project participant	

Figure 5-3. Explanation of flag system used during QA and QC process.

5.3.1.7 Quality Assurance (QA):

Remote sensing is the principal means of verifying field definitions used to set the baseline. Satellite data determines the following five parameters:

- PAI location
- Area associated with each PAI
- Clearing of natural ecosystems (and deforestation)
- Soil disturbance
- Cover cops

PAI location

This parameter verifies that the coordinates provided by the Project participant are correct. A PAI location may be flagged yellow in the QA/QC system, because: (1) the coordinates match with other PAIs; (2) coordinates are close to each other and lie on the same PAI; (3) the coordinates are close to each other but not on the same PAI. In the instance of a yellow flag, a monitoring analyst assesses the PAI in question. If the placement of the coordinates is deemed correct, the QA process will continue. If the locations are deemed incorrect, a Customer Success specialist will consult the Project participant. When the issue is resolved and a potential new location is provided, new remote sensing data is delivered by the remote sensing analyst, and QA continues on the rest of the parameters. In the instance where a Project participant has accidentally added two of the same PAIs, one of them is marked as non-compliant.

PAI size / farm size

After assuring that PAI coordinates are correct, field area associated with each PAI is evaluated. A PAI size can be flagged blue because: (1) PAI size is detected as being smaller than reported, in which case the field size is approved; (2) PAI size is detected as being larger than reported, and in this case Project participant is consulted. In the instance of a yellow flag, two things can happen. (1) If the farm size is blue or green and the boundary detection is deemed acceptable by the monitoring analyst, the PAI size is approved, and QA can continue. (2) If the farm size is yellow the process is equal to the one performed if a PAI is flagged blue >100% (Figure 5-3).

Clearing of native ecosystems (and deforestation)

Following approval of the location and field size, checks are performed to identify any clearing of natural ecosystems. The loss of forest canopy cover and of natural ecosystems are both checked over the course of 10 years. If more than 0.5 ha of contiguous forest canopy cover[305] has been lost from a PAI in the last 10 years then the field is flagged red. Additionally, if more than 5% of the PAI area has been created from the loss of native ecosystems (including natural vegetation and wetland habitats, but excluding forest) in the last 10 years, then the field is flagged red. A proportional threshold of 5% is used for non-forested native ecosystems because there is likely to be some noise and uncertainty around PAI boundaries, caused by a mixture of features such as hedgerows, adjacent natural habitats and unmanaged vegetation. A red flag always leads to a consultation with the project participant.

Checks for deforestation, native ecosystem and wetland clearing are performed using datasets produced by the Global Land Analysis and Discovery (GLAD) laboratory[306], which are derived from Landsat data. The GLAD datasets include annual tree deforestation (vegetation greater than 5 metres in height) and 5-yearly land cover change, which includes cropland and native ecosystem categories for short vegetation and wetlands. Each PAI boundary is assessed against these two datasets to ensure that PAIs were not created by the clearing of forests, native ecosystems or wetlands during the last 10 years.

Soil disturbance

Soil disturbance is sorted into three categories (1) Conventional tillage (2) Reduced tillage (3) No-tillage. In the case of a yellow flag the Project participant is consulted (see Appendix 8 for complete description of the model development for tillage detection and the application of the model for monitoring and verification).

Cover crops

[305] The definition of a forest in the FAO's Global Forest Resources Assessment 2020, specifies land spanning more than 0.5 ha with trees higher than 5 metres. https://openknowledge.fao.org/server/api/core/bitstreams/531a9e1b-596d-4b07-b9fd-3103fb4d0e72/content

[306] Potapov, Peter, et al. "The global 2000-2020 land cover and land use change dataset derived from the Landsat archive: first results." Frontiers in Remote Sensing 3 (2022): 856903. https://doi.org/10.3389/frsen.2022.856903

The cover crop parameter is sorted into four categories: (1) no cover crops; (2) catch crops; (3) cover crops up until winter; and (4) cover crops up until spring. The remote sensing-based cover crop detection model uses a time-series of all bands available from the Sentinel-1 (radar) and Sentinel-2 (optical) satellite constellations, plus a number of vegetation indices, to determine whether a cover/catch crop is present or not to determine whether a cover/catch crop is present or not. If the parameter is flagged yellow, the monitoring analyst performs additional checks beyond the cover crop detection model output. For this, they assess monthly NDVI values. If deemed acceptable the parameter is approvable. If there's discrepancy between the NDVI and the reported data, the Project participant is consulted. Additional information about the differentiation between NDVI results is in the description below. When all parameters are approvable the PAI undergoes a status change to "approved". The PAIs will undergo QA one time during the first harvest year during which the Project participant enlisted their farm.

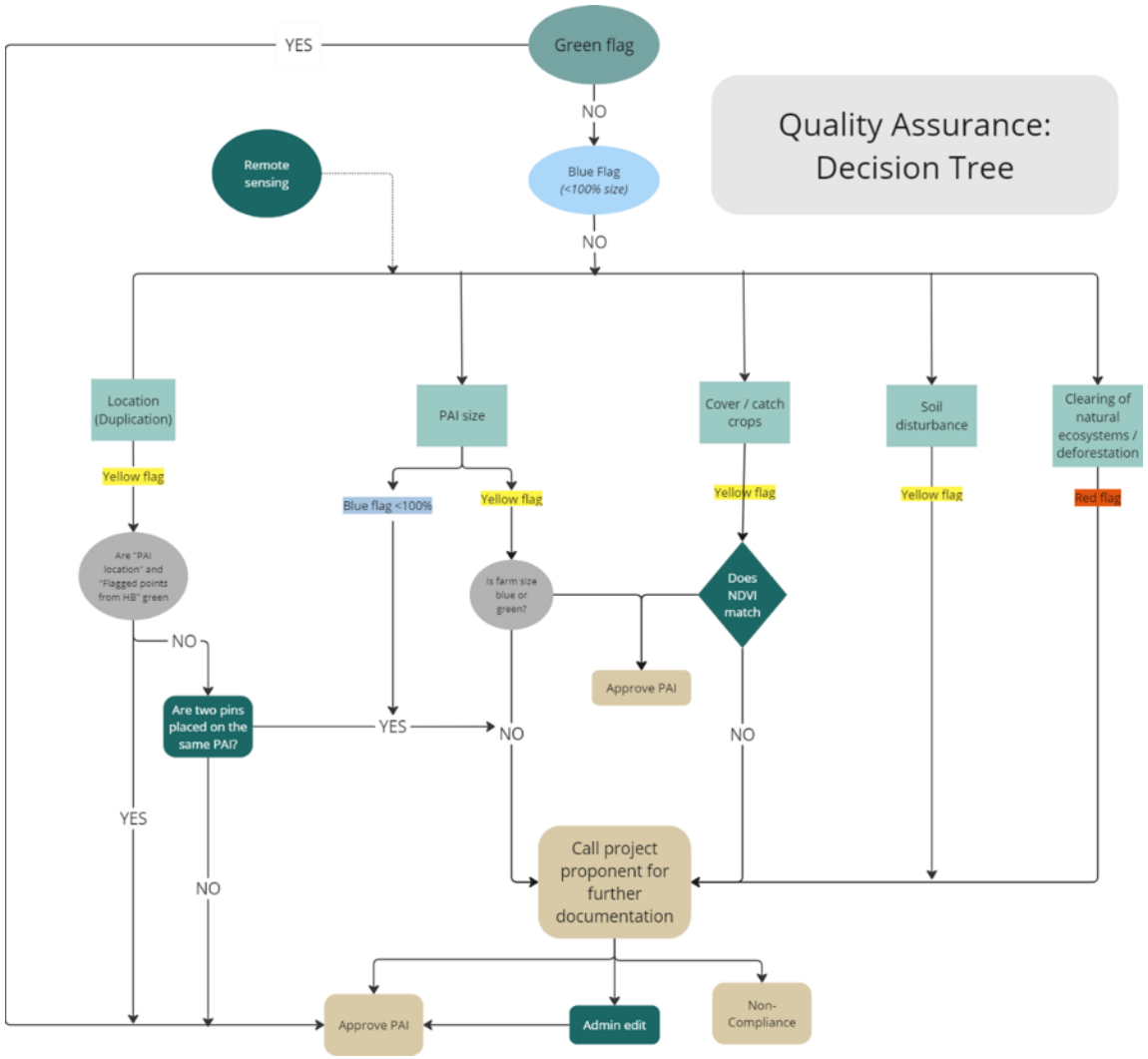


Figure 5-4. Overview of the Project's quality assurance (QA) process and how decisions are made. The following five parameters are assessed: location (duplication), PAI size (farm size), soil disturbance, clearing of natural ecosystems, and cover crops. Dotted lines represent the data source for the verification method feeding into the five parameters. The verifier triggers a certain flag depending on whether it deviates from the reported historical practices (Figure 5-3). All flags will either result in a PAI approval, admin edit followed by approval, or a status change to non – compliance.

5.3.1.8 Quality Control (QC):

After the PAIs have been QA approved, PAIs undergo QC. This process verifies the following parameters:

- Fertiliser
- Crop type/yield
- Soil disturbance
- Residue management
- Cover/catch crops

These parameters are, unlike QA, not dependent on each other for accuracy. A Customer Success specialist can therefore address several issues simultaneously with a Project participant.

Fertiliser

Ranges in reported fertiliser application rates give a green, yellow or orange flag. A yellow flag results in an assessment carried out by the monitoring analyst. Two things can happen: (1) if no/ or a low amount of fertiliser is applied but it is a nitrogen fixing crop type, then the parameter is deemed approvable; or (2) further documentation is needed, and a Customer Success specialist is enlisted to contact the Project participant. An orange flag occurs in the instance where the Project participant has applied >250 Kg. N/Ha. In this case, further documentation is necessary.

The documentation associated with fertiliser is a key component of the QC process. For each crop a minimum and maximum bar of expected use of nitrogen is assumed, according to standard values of crop specific optimal available nitrogen. During QC (monitoring of the Project activities), the Project participant will be asked to present a fertiliser management plan if there is a flag - i.e., a discrepancy between Project participant reported and the average range for that given fertiliser. The documentation that is asked for is often not available, in which case the real value is confirmed over the phone or email to cross-check this. All this information is stored in the Hubspot Communication site, used for all Project participant communication. When a fertiliser management plan is available, it is stored on the AgreenaCarbon internal Google Drive. When it is not, the phone call is taken and the Project participants reported input is verified. This monitoring process allows for the verification of the Project participant reported input and when additional documentation is available and presented, it is stored.

Yield

Reported yields are likewise compared to standard values and result in a green, yellow, or orange flag. A yellow flag can result in two actions: (1) if the crop is a perennial, a higher yield is accepted, and the parameter is approvable; (2) a Customer Success specialist is enlisted to acquire further documentation from the Project participant.

Soil disturbance

The soil disturbance parameter is verified by remote sensing and fuel use ranges (Table 5-2). Fuel usage is normally used as the final verifier. Green, blue, yellow, or orange flags can occur, resulting in one of the following outcomes.

(1) If both the remote sensing and fuel usage verifier result in a green or blue flag, the parameter is approvable. (2) If remote sensing flags yellow, but the fuel usage flags green or blue, the parameter is approvable. (3) If the remote sensing flags green or blue but the fuel usage flags orange further documentation is required (4) If the remote sensing verifier flags yellow and the fuel usage orange, the necessary documentation is likewise required. (5) If the remote sensing verifier flags yellow, and the field definition is conventional tillage while the field actuals are no tillage, then the Project participant is contacted by a Customer Success specialist regardless of the flag on fuel usage (see Appendix 5).

Residue management

Monitoring of residue undergoes QC in a variety of ways. This parameter, related to the mulching or removal of residues, can result in three flags: green, yellow and red. If the residue management does not match with the crop type the PAI is admin edited and deemed approvable afterwards. Yellow flags come to be if (1) residues are reported mulched in a perennial crop field, as mulched perennial crops often prevent good regrowth, or (2) a Project participant report no-tillage and a winter crop with mulching of previous crop, as residues mulched can result in fungi or diseases spreading to the next crop. If the parameter is flagged red the PAI is directly marked as in “Non-compliance”.

As with other monitoring procedures, flags that result from the checking of residue management will result in the Project participant consultation which will further be recorded and stored in the Hubspot Communications site.

Liming

The Project has brought forward a methodology deviation (see Section 3.6) which further explains the monitoring of the liming parameter, as it is a key practice within the VM0042 v2.0 methodology.

In the absence of Project participant reported data, the Project activity emissions were quantified based on the regional data provided by countries based on the National Inventory Reports submitted to the United Nations Convention on Climate Change (UNFCCC). The UNFCCC requires that all countries submit their GHG emission inventories in a common reporting format framework utilising the most up-to-date methodologies from the IPCC National Inventory Guidelines and

Good Practice Guidelines.[307] The standardisation of reporting amongst different nations ensures greater compatibility of emissions and transparency on calculation estimates.

With the National Inventory Reports both the quantity of lime used for agricultural purposes and the actual agricultural land area under agriculture are validated. Additionally, this approach for determining the baseline scenario avoids gaps in the data and includes all emissions associated with the activity. This method for calculating an activity's emission is therefore more robust and accurate, in comparison to an alternative method of estimating lime CO_2 emissions under hypothetical scenarios. The principles of conservativeness and accuracy are applied to ensure no overestimation of GHG emission reductions and removals. The data provided from the relevant sources are monitored and will be checked from updated version prior to every verification.

Cover/Catch crops

The cover/catch crop parameter is verified by remote sensing and reported values. Three flags can occur: green, blue and yellow. If the parameter is flagged yellow the monitoring analyst checks the NDVI values returned by the verifier and also that the crop type matches the cover crop practice. This results in one of these 5 outcomes, (1) The NDVI and crop type values match the field actuals. The parameter is approvable. (2) The crop type matches the PAI, but the NDVI does not. An admin edit is performed followed by an approval of the parameter. (3) The NDVI match but the crop type does not match with reported cover crop practice. The crop can only be sown during either winter or spring. An admin edit is performed followed by an approval of the parameter (4) The NDVI match, but the crop type does not match with reported cover crop practice. The crop can both be sewn during winter or spring. Here, further documentation is requested. (5) A catch crop has been reported, and further documentation is likewise required.

Differentiating Cover/Catch crop detection and NDVI

The cover/catch crop detection model uses a time-series of all bands available from Sentinel-1 and Sentinel-2, and a range of vegetation indices - NDVI alone is not used to distinguish between cover crops, cash crops and other vegetation. The output of the model is a binary classification of whether or not a cover/catch crop was present in a given PAI in a given season. The model is trained using ground truth data on cover crop fields, with negative cases including bare fields, fields with winter cash crops, and fields with other vegetation. This means the model accurately distinguishes between cover crops and non-cover crops (cash crops and other vegetation).

NDVI is used as an additional check by a monitoring analyst when there are disagreements between project participant reported data and cover/catch crop model outputs. In those cases,

[307] Lokupitiya, E., & Paustian, K. (2006). Agricultural soil greenhouse gas emissions: a review of national inventory methods. *Journal of Environmental Quality*, *35*(4), 1413-1427.

monthly NDVI values help determine a timeline of vegetation cover, for example indicating if vegetation was present up until winter or up until spring.

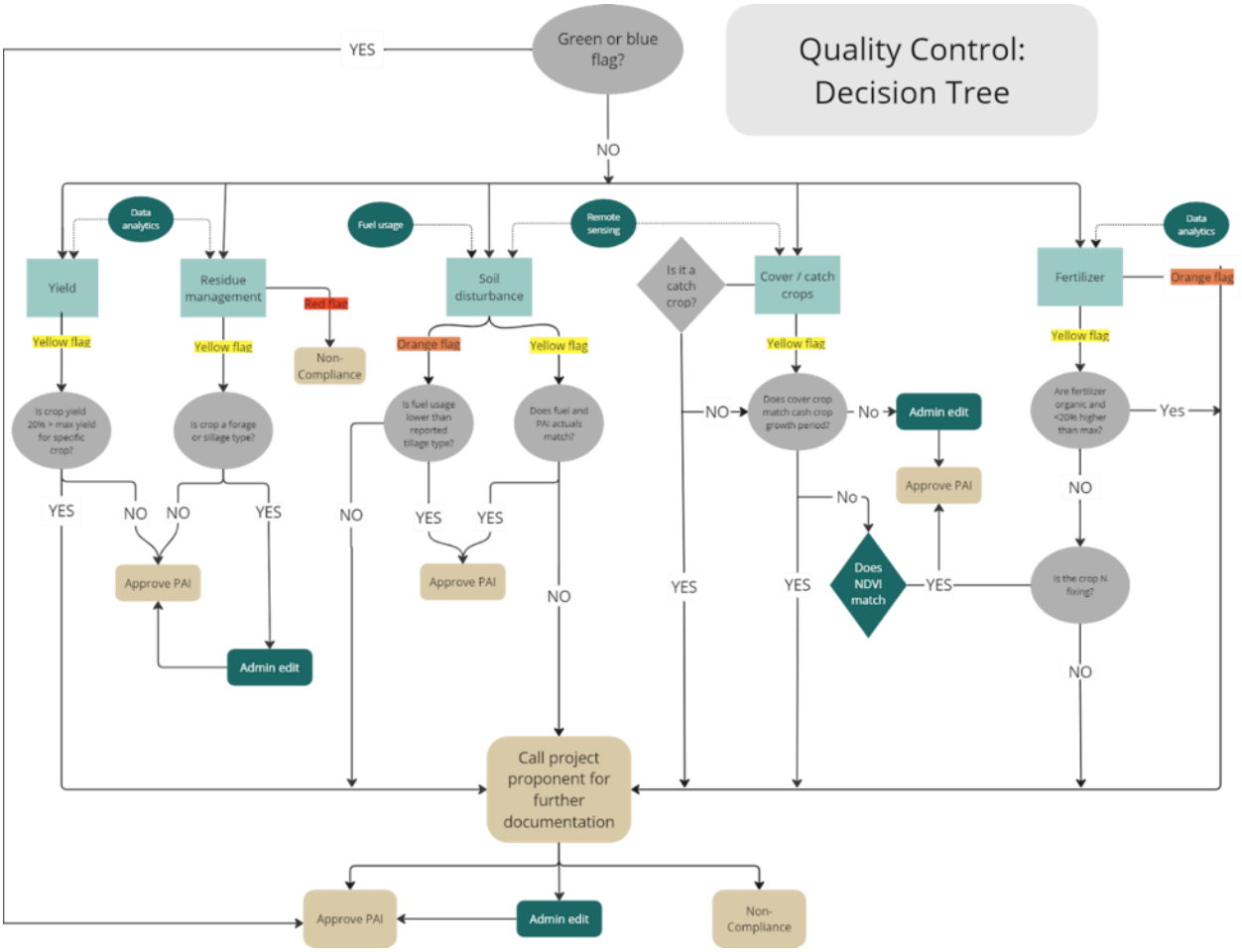


Figure 5-5: Overview of the Project Quality control (QC) process and how decisions are made, with the following five parameters being assessed; yield, residue management, soil disturbance, cover/catch crops, and fertiliser. Dotted lines represent the data sources for the verification method feeding into the five parameters. Each verifier triggers a certain flag depending on whether it deviates from set standards (Figure 5-3). All flags either result in a PAI approval, admin edit or non–compliance action. Green and blue flags are always approved while yellow or orange flagged PAIs might need further clarification and documentation prior to a status change. In this situation Project participants are consulted.

5.3.1.9 Leakage

As presented in Section 4.3 of the methodology, leakage must be taken into account in the calculations and Project activities. For this matter, both leakage from organic amendments as well as yield information is gathered on a yearly basis in order to capture potential leakage that could result from Project implementation.

Every year, as part of the capturing of information from Project participants regarding their Project activities and inputting this into the AgreenaCarbon platform, any Project participants that input organic amendments in their Project Activity but not in their baseline are identified and their inputs from organic amendments are further examined. Equation 34 is then applied in case leakage occurrences could be identified. For each PAI included for the leakage analysis, the leakage C02e is calculated, then the effect is summed for all of the PAIs to estimate the leakage effect of the entire portfolio. In the ERR spreadsheet, in the sheet labelled "input" the PAIs which are initially included for the analysis can be seen.

According to VM0042 v2.0, it is also necessary to capture the productivity related to leakage every ten years and as such the following procedure will be completed under monitoring procedures:

Step 1: Using yield data will use Equation 35 to calculate the average with-Project productivity of each product to average pre-Project productivity of the same crop product. If it has been found that productivity has improved stayed constant or declined by less than 5% no further action is needed. If there is a reduction greater than 5% than Step 2 must be completed.

Step 2: Determine whether it is a short-term change in productivity repeat Step 1 calculation excluding data input from the first three years of project implementation. If the decline is still greater than 5% then Step 3 must be taken.

Step 3: Determine whether the result of a loss in yield is due to a combination of factors such as different practice changes, crop type, soil type, or climatic zone. If it is found that a combination of factors then the combination of factors must be removed for future iterations of that Project instance.

5.3.1.10 Non - compliance

PAIs not adhering to the Projects set standards, are marked as non-compliance. This encompasses the following instances:

- Duplicated PAIs / wrongly added PAIs
- PAIs where a clearance of natural ecosystems has happened in the last 10 years
- PAIs where practices not included in the project methodology is performed
- PAIs where crop residue has been burned

A PAI marked as non-compliance will not generate certificates.

5.3.1.11 Data management safeguards

The Project has designed and implemented a system to automatically gather and display data processed in each of the carbon quantifications to minimise the potential for errors. Amazon Web Services (AWS) stores copies of all Project data that pertains to monitoring reports. Project participant input data is collected and processed on the AgreenaCarbon platform together with the quantification engine; they are amassed in a database that allows for automatized daily updated data and the creation of data insights and customized dashboards. This dataflow minimizes human error at the reporting stage compared to manually extracting data from the Platform into Excel/Word or other tools for reporting purposes.

5.3.1.12 Data Archiving

To ensure that the Project maintains a reliable record of all data, all data is rigorously backed up. This process ensures that the Project has access to the same code and data at any given time, even years down the line. The whole archive process is triggered by sending the monitoring report to the Auditor body. The backup process involves several steps namely:

1. The IT department downloads a copy of the database, ensuring that the Project has a complete record of the data that was used.
2. The IT department downloads the code from Github, ensuring that the Project has access to the exact version of the code that was used to generate the results. A backup of the database is also performed every day, ensuring multiple backups are available in case any data is lost or corrupted.
3. Once both the code and data are retrieved, they are moved to an archiving system designed to preserve data long term. This includes services such as AWS S3 Glacier or Google Drive, which are specifically designed to store large amounts of data for extended periods.

By following this rigorous backup process, the Project can ensure that a complete record of the same data and code can be accessed at any given time. This not only ensures that results can be reproduced in the future, but it also provides a valuable record of the work performed which can be used for future reference or analysis.

Archiving of remote sensing data

In the process of data archiving, the Project also archives satellite imagery along with the attached data. In the case of remote sensing imagery, two primary sources are commonly utilized, namely Sentinel 1 and Sentinel 2.

Sentinel 2 imagery, originating from a public source, is already processed and readily available. As a result, the data is not stored separately. Instead, it is requested on an "as-needed basis" and stored by the supplier, the European Space Agency (ESA), which manages the storage and retrieval of imagery.

The Sentinel 1 data requires processing once it is downloaded. This processed data is then stored and referenced indefinitely. The processing steps involve converting the raw radar data into usable imagery, which involves calibration, geo-referencing, and other necessary adjustments. Once the data is processed, it is stored in designated storage buckets with redundancy protection measures in place. This ensures that accidental deletions or potential data loss due to system breaches can be mitigated, and all data can be recovered in such situations.

Overall, the storage and archiving of satellite imagery and associated data, involves secure storage methods, redundancy protection, backup systems, and comprehensive metadata management. These measures ensure the preservation and accessibility of valuable remote sensing data, enabling ongoing analysis and research in various domains. All systems are maintained and managed by the data science unit. The process of archiving is supervised by the remote-sensing data manager.

5.3.1.13 Organizational structure of the Monitoring Team

The Monitoring team consists of a team of data analysts, remote sensing analysts, customer support specialists and developers. A wide range of competencies are involved in the monitoring process which is outlined in the Table 5-8 below.

Table 5-3. Overview of the Monitoring Team

Team Role	Skills Required	Responsibilities
Head of Program	Project Management	• Oversee Project timeline • Ensure adherence to processes for monitoring • Provide resources and development for skills required in the monitoring process • Mitigate risks and discrepancies

Data Monitoring Analysts	- QGIS - Excel - Agricultural expertise - Data Analytics - Quicksight	● Process data required for Project monitoring ● Oversee flagging system for data ● Identify risks to data quality and address ● Approve compliant information ● Forward questions and flagged data for confirmation to the Customer Success team
Remote Sensing specialists	- Data Science - Machine learning - Remote sensing model capabilities	● Assess field boundaries, and management practices from received field location data ● Train and model remote sensing tools to provide accurate reading of fields
Customer Relations/Success managers	- Customer relations - Excel - Quicksight - Agricultural expertise	● Onboard new fields into the project with adequate data from the farmer ● Follow up on data that is not confirmed with the farmer (project participant) ● Manage farmer data inputs, additions and annual data

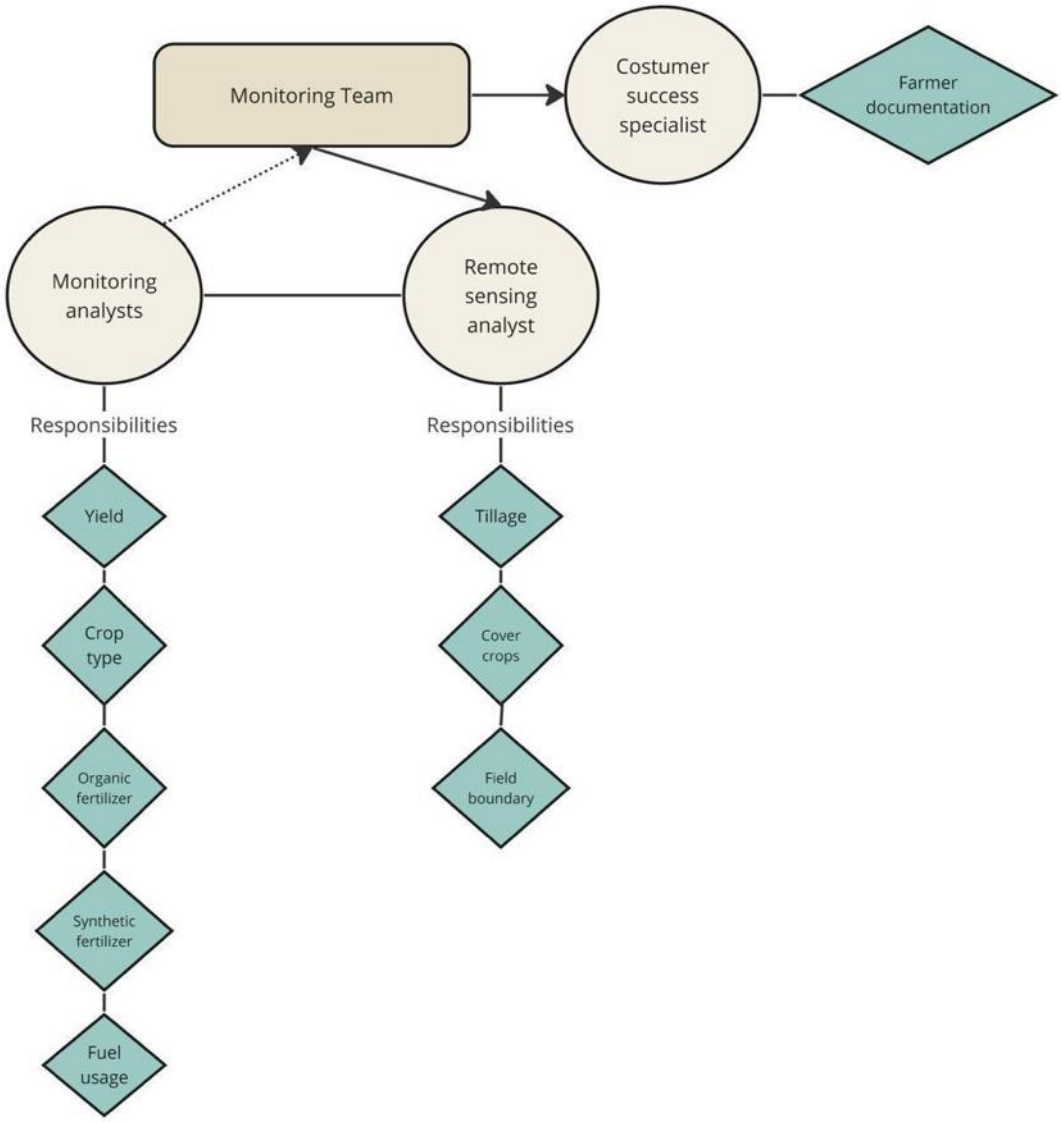


Figure 5-6. A structural overview of the monitoring team.

5.3.2 Soil Sampling Plan

The VM0042 v2.0 guidelines require the AgreenaCarbon Project to sample soil from PAIs within the Project area. Soil organic carbon (SOC) stocks display high variability at multiple spatial scales and are subsequently characterised by large uncertainties. This uncertainty stems from the innate properties of soil at the local scale (e.g., SOC concentration, bulk density, soil depth), and variation in environmental processes and human influences on SOC storage at larger scales. Additionally, the temporal variability in SOC stocks is modulated by the interaction of these factors

i.e., soil physicochemical properties, climate and land management. Within the Project, PAIs are located across the European continent, across regions with varying and diverse climate, geology, and topography profiles. The soil sampling plan has been designed and developed for measuring PAI-level SOC stocks and the calculated uncertainty, accounting for the heterogeneous landscape of Europe.

The Project will estimate changes in SOC stocks resulting from improved ALM practices by running the aforementioned soil carbon model for the PAIs within Project area. To comply with VM0042 v2.0, these PAI-level model runs are initialised with direct soil carbon measurements derived from soil samples. Measurements from the selected soil sampling locations, not precluding an expanded set including the initial sampling locations, will be retaken after 5 years and used for model true up. This section details the stratified sampling approach the Project will take to soil sample collection and monitoring.

The aim of the Projects soil sampling plan is to apportion (i.e., stratify) PAIs into suitably homogeneous strata, such that PAIs within a given strata would be appropriately represented by the within-strata subset of PAIs selected for soil sampling. This controls Project costs, ensuring that the Project is economically viable and minimising risks to permanence, whilst facilitating the initialisation of the soil carbon model using direct soil carbon measurements. Stratification occurs at two levels: a Project-wide level, where PAIs are grouped together based on geographic, biophysical and land management factors; and at a PAI level, where relevant short-scale properties, for example field topography, are used to locate specific sampling/coring points within the field area associated with a PAI.

5.3.2.1 Project level stratification

PAIs are apportioned into suitably homogeneous strata using a clustering method that takes, as input, a combination of management, soil, climate, and geopolitical data. Specifically, the clustering process ingests at a minimum, for each PAI:

- The 5-year baseline historical schedules of activities for each PAI, including primary production crops grouped by crop functional group (CFG), tillage, cover crop, residue, and qualitative fertiliser management data;
- Silt, sand, and clay percentages retrieved from a global gridded soil database (SoilGrids);
- IPCC climate zone;
- Country

These inputs align with those used in in the MVR (CZ/CFG/PC) to align with VMD0053 v2.0, as well as a subset of the factors listed in Table 7, Section 8.2 of VM0042 v 2.0, that are known to influence soil carbon dynamics (soil texture - derived from silt, sand, and clay percentages), and

geopolitical boundaries that might further drive differences in management practices (country). Additional covariates may be used to further stratify the PAIs should they be insufficiently stratified using only the above.

The apportionment of PAIs to strata then proceeds via a hybrid hierarchical, k-means clustering algorithm,[308] where a hierarchical clustering is split into k clusters to initialise a standard k-means clustering.[309] The number of strata (clusters) is selected via cross-validation and gap statistical[310] analysis to maximise the number of strata, in line with the recommendation from Section 8.2.1.2 of VM0042 v2.0. Future PAIs joining the Project are then assigned to existing strata by locating the closest cluster centre and assigning the new PAIs to the corresponding strata. Reassessment of stratification and re-clustering will occur at project re-baselining (i.e. after 10 years). This clustering process may result in strata that span multiple Geographic Areas, even though Country is an explicit covariate int the development of project strata.

PAIs are randomly selected within each strata for soil sampling. All strata will have the minimum required 3-5 PAIs selected for soil sampling or will have all PAIs sampled where strata contain fewer than the minimum required. After all strata have had the minimum number of samples drawn, a minimum detectable difference (MDD) analysis becomes possible, and will be performed to guide subsequent sampling efforts where prudent. The MDD analysis will use the initial soil sampling results to estimate a range of plausible SOC change rates for MDD (as a sensitivity analysis), and the formula provided in Equation (3) of Section 8.2.1.3 of VM0042 v2.0 to estimate within strata SOC stock variation. Strata are project-specific and at this Project-wide level; strata area and soil sampling points within those strata will be reported at verification to comply with Section 8.2.1.2. of VM0042 v2.0.

5.3.2.2 PAI level sub-stratification

Selected PAIs are further sub-stratified to randomly allocate specific sample/core locations within homogeneous zones within the field areas associated with each PAI. PAI-level sub-stratification assists in quantifying within PAI variation in a manner suitable for calculating the "sampling uncertainty" component of the uncertainty deduction, described in Section 8.6.1.1.3 of VM0042 v2.0. As inputs, PAI-level sub-level stratification uses a mixture of remotely sensed inputs, specifically field topography (slope class or equivalent direct measurement), and Sentinel-2 derived NDVI and field brightness for pixels within the field area associated with the PAI. Given such within PAI sub-strata, an appropriate number of cores per PAI are randomly allocated. As a

[308] Hastie, T., Tibshirani, R., & Friedman, J. H. (2009). *The elements of statistical learning: Data mining, inference, and prediction* (2nd ed.). Springer. https://doi.org/10.1007/b94608
[309] Kassambara, A., & Mundt, F. (2020). *factoextra: Extract and visualize the results of multivariate data analyses* [Manual]. https://CRAN.R-project.org/package=factoextra
[310] Tibshirani, R., Walther, G., & Hastie, T. (2001). Estimating the number of clusters in a data set via the gap statistic. *Journal of the Royal Statistical Society. Series B, Statistical Methodology*, *63*(2), 411–423. https://doi.org/10.1111/1467-9868.00293

default, there are 9 coring locations per PAI, apportioned amongst the within PAI sub-strata. However, after initial sampling results are obtained, this value may be revised to better reflect within PAI variation.

5.3.2.3 Data collection techniques

Soil cores are to be taken to a fixed depth of 60 cm. Each soil core will be segmented into three depth increments of 0-15, 15-30 and 30-60 cm. In shallower soils (< 30 or <60 cm), samples will be taken down to the bedrock layer. Bulk density will be determined via the core method (ISO 11272:2017) for each depth increment. The fine bulk density (FBD; g/cm3) can be subsequently determined by removing the coarse fragments to obtain the dry fine earth fraction (<2 mm).

Soil organic carbon (SOC) concentration will be determined using two analytical methods. Dumas dry combustion analysis using an elemental analyser (ISO 10694:1995) will be used to measure the total C content of a sample and the total OC concentration can be determined after correcting for the inorganic carbon (IC) present in carbonates. Where dry combustion analysis is not available, the Walkley-Black (wet oxidation) method will be used to determine the OC concentration of a sample. A comparison of OC concentration values between the Walkley-Black and the dry combustion method will also be assessed where possible.

5.3.2.4 Collected samples

The sampling campaigns are estimated to be completed within 60 days within the same season. Any PAI receiving organic amendments close to the scheduled sampling campaigns will be avoided. All samples will be time stamped and georeferenced for the purpose of resampling in the same season and same locations. The dried soil samples are to be archived in a dark, cool and dry room for potential future use and verification. All soil sampling's results and calculated deviations are to be documented at verification.

5.3.3 Modelling Plan

The modelling plan aims to ensure the accuracy and reliability of the model outputs by following a structured approach. As the Project participants follow the harvest year, the Project 'year' is defined as the year of harvest data being fully complete. For further details see Figure 5-1. The plan consists of several steps designed to validate inputs, estimate emissions, account for model uncertainty, check for outliers, and continuously evaluate and improve the model. For a complete description of the modelling plan including parameters, descriptions, and validation of the model, please refer to the VMD0053 MVR Report provided as required under the VCS Standard v4.5 and VM0042 v2.0. The monitoring plan contain five basic elements:

Frequency of Monitoring

The anticipated frequency of monitoring will be on a yearly basis such that the verification period will be one year running from September post-harvest to September to capture a full harvest cycle. The QC process of new PAIs begins in September as outlined in Figure 5-1. As each verification period is one year, the checking of the PAIs should be happening on a continual basis and the new PAIs will be fed into the validated and calibrated model according to VMD0053. The baseline emissions will be estimated using the baseline schedule of activities for the PAI. Historical management data will also be reassessed according to the Common Practice Test as laid out in Section 3.5.3. All data fed into the model will be updated in order to reflect the most up to date climate, soil, and practice data across project area.

Use of Approved Model Version

The Project utilizes the approved version of the model according to the guidelines set forth by VMD0053 and stored in the Agreena GitHub repository. To make precise predictions about changes in SOC resulting from the implementation of regenerative agricultural practices, VM0042 v2.0 guidelines require using a process-based model (Page 18, Table 5. "Summary of Allowable Quantification Approaches"). This model must be properly calibrated and validated for the Project boundaries in accordance with the guidelines outlined in VMD0053 methodology, which provides guidance on calibrating and validating models for improved agricultural land management. The report has been validated and calibrated by an IME as per VMD0053 v2.0 guidelines. The parameters can be found in the MVR report submitted as part of the validation process.

Quality Assurance/Quality Control (QA/QC) of Inputs Set up

In order to guarantee accurate data input to the model it is set up to run only with the data that passes the QA and QC procedures described in the sections above. The model is also fed with additional data that, among others, characterize the weather conditions, climate zones and soil characteristics collected from public sources. The sources are annually reviewed to ensure the gathering of the most updated data. The full description of the sources and types of data is provided in the MVR.

Calculation Pipeline

Once the necessary data is gathered, it is fed into a calculation pipeline designed to estimate emissions and emission reductions for both the baseline and project scenario runs. This pipeline follows a standardized methodology, ensuring consistency and reliability in the calculation process. Importantly, the pipeline takes the model uncertainty into account and deducts any associated uncertainties from the changes in carbon emissions.

Outlier Detection

After the final output is generated, it undergoes a thorough outlier detection process. Any outliers identified are individually investigated to understand their causes. This step helps identify any anomalies or errors that may have occurred during QA/QC or the modelling process. It ensures the integrity of the results. The outlier detection is conducted by Independent Modelling Experts.

APPENDICES

Appendices have been redacted from the Public Version of this document as per VCS definitions (v4.5) of *sensitive information.*