



Verified Carbon Standard

AGREENACARBON MONITORING REPORT: 1ST VERIFICATION PERIOD

Agreena

Project title	AgreenaCarbon Project
Project ID	4022
Monitoring period	15-September-2021 to 31-December 2023
Original date of issue	12-February-2025 is the date the monitoring report was completed following the completion of the audit.
Most recent date of issue	12-September-2025 is the date on which the document was most recently submitted
Version	4.4
VCS Standard Version	4.7
Prepared by	Agreena ApS

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The AgreeaCarbon Project (hereafter also referred to as the “Project”) reduces agricultural greenhouse gas (GHG) emissions by promoting the implementation of farming practices based on the central principles of regenerative agriculture. The Project intends to help farmers (i.e., Project participants) transition to regenerative agriculture by applying sustainable management practices to maintain yields while ensuring the long-term viability of their farms and land. Regenerative agriculture describes holistic farming practices that improve soil fertility, enhance the storage of soil organic carbon (SOC) and focus ‘on the regeneration of living soil, improved micro hydrology, and conserving biodiversity at all trophic levels while enhancing inputs, use-efficiency and ecosystem services.’ The Project activities performed during this monitoring period were as follows:

1. Tillage Reduction
2. Residue retention (Leaving crop residues on the fields)
3. Planting cover crops
4. Planting catch crops
5. Reduction in synthetic fertilisers

The technologies and activities that have been implemented during the Project’s first verification period are outlined in the table below along with their respective weight (Table 1-1). This is further supplemented by the internal Tillage Manual distributed to Project participants to provide technical input. The percentage of Project participants who have taken up specific Project activities is shared in Table 3-1. Project activities were implemented at different times during the harvest cycle (see Table 1-1) of the year 2022 and 2023 across a total of 1,652,643.85 hectares of European cropland. Their contribution to SOC buildup were aggregated to calculate the total GHG Emission Reductions and Removals (ERRs) achieved in this verification period – i.e., September 15, 2021, to December 31, 2023. The net GHG emission reductions and removals (as defined in equation 39 of VM0042 V2.0) achieved amounted to 2,679,896.74 tCO₂e out of which 355,183.10tCO₂e is allocated to the buffer pool. Detailed information on a per-Project Activity Instance (PAI) basis is provided in the attached ERR sheet for this verification cycle and is further detailed in Chapter 5 “Quantification of GHG Emission Reductions and Removals”.

Table 1-1. Technologies used and activities employed during Project implementation. ¹

¹ These values are derived from the transition data provided in the attached Emission Reduction and Removal spreadsheet, complemented by the schedule of activity of Project Activity Instances. The Implementation Status reported here is a comparison to pre-existing values. The Project activities themselves are summarised in Chapter 3, Implementation Status in Table 3-1.

Project Activities	Technologies	Transition Status	Date of Implementation
Reducing tillage to lower soil disturbance and increase residue retention and carbon inputs.	Tine Drill, Disc Drill, Harrow, Cultivator Drill, Strip Till Seeder, Low Disturbance Subsoiler	Vintages 2021, 2022 and 2023 implemented reduced soil disturbance ² across 0.00%, 89.89% and 72.32% of hectares respectively.	Tillage is done year-round and throughout the growing season.
Leaving crop residues on top of the soil to improve nutrient cycling and soil quality.	Straw Harrow	Vintages 2021, 2022 and 2023 implemented incorporation of residues into the soil across 98.92%, 54.66% and 35.83% of hectares respectively.	Crop residues are left after harvest, typically in July and August, depending on the crop and crop type.
Planting a cover crop through the winter or all the way through to the next cash crop seeding to increase organic matter carbon inputs.	Seeding: Tine Drill, Disc Drill Termination: Crimper/Topper	Vintages 2021, 2022 and 2023 implemented spring or winter cover crops across 3.60%, 3.61% and 2.50% of hectares respectively.	Cover crops are planted in winter after harvest to ensure soil is not kept bare.
Planting catch crops in between spring and winter crops.	Seeding: Tine Drill, Disc Drill Termination: Crimper/Topper	Vintages 2021, 2022 and 2023 implemented a catch crop across 2.32%, 0.87% and 0.58% of hectares respectively.	Catch crops are grown between the spring and winter crops.
Reducing the rate of nitrogen fertiliser applied	Disc Incorporations	Vintages 2021, 2022, 2023 implemented only organic fertilisers	Fertiliser is used during the growing season, either

²This value represents that percentage of aggregated hectares of PAIs that transitioned from conventional to reduced tillage or no-till, or reduced tillage to no-till. Reduction of tillage is an eligibility criteria for the AgreeaCarbon Project.

and switching from synthetic fertilisers to organic fertiliser (manure).	(Harrow and Tine)	across 0.00%, 3.86% and 5.22% of hectares respectively. When synthetic fertilisers remained, vintages 2021, 2022 and 2023 implemented a reduction ³ in application rates across 93.94%, 87.33% and 90.26% of hectares respectively.	throughout the traditional growing season or on cover and catch crops.
Applying nitrification inhibitors to limit nitrification within the soil.	Incorporated into existing technological requirements	N/A	Throughout the growing season.

1.2 Audit History

This Monitoring Report represents the AgreeenaCarbon Project first verification period, running from 15 September 2021 (i.e., Project start date) to 31 December 2023. The verification period covered in this Monitoring Report includes both Harvest Year (HY) 2022 and HY 2023. Thus, it includes data that has been collected and checked through QA/QC mechanisms for HYs 2022 and 2023. The following terms provide a full understanding of the Project vintage years and monitoring cycle and are in accordance with the VCS Program Definitions (v4.5) documents:

- 1) **Monitoring cycle** – Refers to the annual cycle for completing data collection from a given HY. It covers both the baseline data and actuals data collection process as well as the QA/QC procedures to verify such data - outlined in Section 4.3 Monitoring Plan. It follows the same cycle as a harvest year (see below).
- 2) **Harvest Year (HY)** – Refers to the annual cycle starting in mid-September to the following September and covers Project practices implementation, starting with cover crop adoption and ending after harvest.
- 3) **Verification period** – The period specified in a Monitoring Report during which the GHG ERRs were generated and verified by a validation/verification body (see VCS Program

³In accordance with VM00042 v2.1, in order to qualify as “reduced”, a PAI has implemented a quantitative adjustment in synthetic fertiliser application rate that exceeds 5% of the pre-existing value.

Definitions v4.5). This may also be referred to as “monitoring period” throughout the present report. Each verification period may cover more than one HY as long as the HY in question underwent the monitoring cycle.

- 4) **Vintage year** – Refers to the year in which corresponding ERRs are generated. One verification period can have multiple vintages from different vintage years, but a vintage year cannot span across multiple years, e.g. Vintage 2021 covers ERRs generated between 15 September 2021 and 31 December 2021.

Audit type	Period	Program	Validation/verification body name	Number of years
Validation	20 January 2023 – 16 January 2025	Verified Carbon Standard	Earthood Services Limited	1 year
Verification	3 March 2024 – 25 February 2025	Verified Carbon Standard	Earthood Services Limited	1 year
Total	2 years	VCS	Earthood Services Limited	2 years

1.3 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 category⁴	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 nitrous oxide (N₂O) emissions and/or reducing methane (CH₄) emissions.

⁴ See Appendix 1 of the VCS Standard v4.7

Project activity type	The Project is a large project (greater than 300,000 tonnes of CO₂e per year reduced or removed) and a grouped project with multiple project activity instances (PAIs) across the pan-European geography. The project activity builds upon the VCS methodology VM0042 Methodology for improved agricultural land management, Version 2.0 (30 May 2023).
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1.4 Project Proponent

Organization name	Agreena ApS
Contact person	Karolina Kenney
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1.5 Other Entities Involved in the Project

There are no entities besides the project proponent and its subcontractors.

1.6 Project Start Date

Project start date	15 September 2021
Justification	According to VCS Standard (v4.7, section 3.8) the start date corresponds to “the date on which activities that lead to the generation of reductions or removals are implemented”. Project participants were onboarded and signed their participation contracts as early as July 2021. Looking at the harvest cycle, the first of the Project-supported activities that early participants could have adopted on their PAIs is cover cropping. Reason being, the seeding for cover crops occurs right after cash crops harvest, which is usually in late summer or early autumn for European countries. AgreenaCarbon conducted a NDVI assessment on a sample of early participants, comparing vegetation cover (i.e., the hallmark of a growing crop) between autumn 2020 and autumn 2021. The NDVI assessment yielded a range of mean monthly values where a noticeable difference was detected, of which September 15th 2021 was the earliest. The accuracy and conservativeness of this start date

is further substantiated by the following consideration: for a vegetation cover change to be detectable in September, the seeding had to happen earlier, possibly in August. For more information on this topic, please consult section 1.8 of the PD.

1.7 Project Crediting Period

Crediting period	☐ Seven years, twice renewable ☐ Ten years, fixed ☒ Other (20 Years Crediting period as per VCS Standard 4.7 Section 3.9.3 for AFOLU projects)
Start and end date of first or fixed crediting period	15 September 2021 – 14 September 2041

1.8 Project Location

The Project is based in temperate climates across the European continent and located across ten countries. Namely: Denmark, United Kingdom, Ukraine, Romania, Moldova, Spain, Lithuania, Estonia, Latvia, and Bulgaria. Figure 1-1 below shows the PAIs locations, which constitute the Project area: additional PAIs will be onboarded in future verification periods. As per VCS requirements, a KML file is attached to this Monitoring Report to allow access to geodetic coordinates for each PAI.

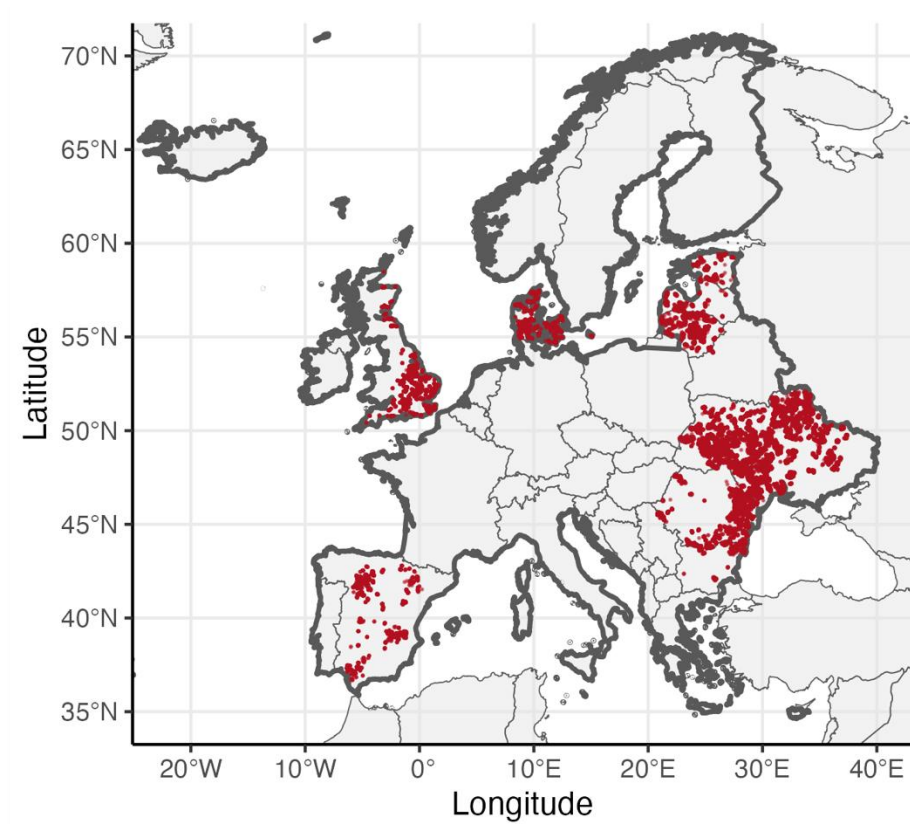


Figure 1-1 Geographical presence of AgreeenaCarbon Project for vintages 2021, 2022 and 2023 (the verification period spanned by this report). The individual Project Area Instances (PAIs) are depicted with red (•) symbols.

The term PAI refers to a demarcated field area defined by the Project participants who wishes to enrol it in the Project. This field area may or may not have different crops, practices, or size than other field areas demarcated as other PAIs on the same farm. Instead, the input data from individual PAIs are used to calculate carbon potentials and for monitoring throughout the Project. Thus, PAIs constitute the Project's sample unit, and are aggregated to calculate farm-level carbon sequestration achievements. The number of PAIs per vintage year are listed in the table below.

Table 1-3A. Total number of PAIs per vintage year for this verification period.⁵

Vintage	PAIs	Hectares
2021	421	18,854.16
2022	12,198	471,872.02
2023	40,571	1,652,643.85

⁵ The PAIs are reflected in full in the attached KML file with all PAI boundaries.

Table 1-3B. Breakdown of PAIs and hectares per country for vintage 2023.⁶

Country	PAIs	Hectares
Bulgaria	488	11192
Denmark	2238	33925
Estonia	839	13214
Latvia	712	16525
Lithuania	3447	68857
Moldova	3594	178236
Romania	4357	141798
Spain	2071	28084
Ukraine	18851	1106636
United Kingdom	3974	54178
Total	40571	1652645

1.9 Title and Reference of Methodology

The Project was designed and developed with full implementation of the VM0042: Methodology for Improved Agricultural Land Management, Version 2.0, 30 May 2023, Sectoral Scope 14. Additional documents used for report development are detailed below.

Table 1-2: Standards, Methodologies, Tools and Modules applied to the Project

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version
Methodology	VM0042	Methodology for Improved Agricultural Land Management, Sectoral Scope 14	2.0

⁶ Per country information for vintage 2021 and 2022 available in registered PD, Table 1-2

Module	VMD0053	Model Calibration, Validation, and Uncertainty Guidance for the Methodology for Improved Agricultural Land Management	2.0
Requirement		VCS Standard	4.7
Requirement		VCS Program Definitions	4.5
Requirement		VCS Program Guide	4.4
Requirement, procedural		Registration and Issuance Process	4.5
Requirement, procedural		AFOLU Non-Permanence Risk Tool	4.2

1.10 Double Counting and Participation under Other GHG Programs

1.10.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

☐ Yes ☒ No

1.10.2 Registration in Other GHG Programs

Is the project registered or seeking registration under any other GHG programs?

☒ Yes ☐ No

The Project is also certified under ISO 14064-2: 2019 Greenhouse gases standard. The Agreea ISO project has been validated and verified by Den Norske Veritas (DNV) in 2021, 2022, and 2023. The Project works to 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 receive VCUs from other Programs. The following steps have been followed for this process:

1. A subset of Agreea 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.

2. These fields are marked as ISO fields and removed through the fallow classification from the list of PAIs entering the upcoming VCS verification period. This ensures that these fields are still accounted for and reported but earn zero VCUs.
3. 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.
4. In case there are fields that are demarcated as ISO fields, 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.

To ensure that there is no double counting, the Project has defined and allocated the PAIs that are ISO-eligible only and the resulting certificates are reserved for only ISO as well. The Project makes a clear distinction between PAIs as they enter the respective GHG programme. The PAIs submitted as part of this verification are strictly Verra PAIs and no fields from the ISO programme are included in the Verra project.

This is managed in an internal inventory management system. All field certificates, PAIs and other information is held in one place with a mapping to the resulting VCUs. The inventory system ensures 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.

1.11 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.11.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐ Yes

☒ No

1.11.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐ Yes

☒ No

1.11.3 Supply Chain (Scope 3) Emissions

Do the project activities affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☒ Yes

☐ No

Is the project proponent(s) or authorized representative a buyer or seller of the product(s) (goods or services) that are part of a supply chain?

☒ Yes

☐ No

Has the project proponent(s) or authorized representative posted a public statement on their website saying, "Carbon credits may be issued through the Verified Carbon Standard project [project ID] for the greenhouse gas emission reductions or removals associated with [project proponent or authorized representative organization name(s)] [name of product(s) whose emissions footprint is changed by the project activities]."

☒ Yes

☐ No


Figure 1-2. Demonstration of statement present on Agreena's webpage.⁷

1.12 Sustainable Development Contributions

With reference to the 2030 Agenda for Sustainable Development (SD) and the UN SDGs^{8,9,10}, Project activities (i.e., reduced tillage; cover and catch crops; sustainable management of crop residue and fertilizers) result in SD contributions when implemented. By improving water cycling and quality, crop resilience, and soil health while reducing GHGs emissions, Project activities contribute to SDG 2 (Zero hunger), SDG 13 (Climate Action), and SDG 15 (Life on land).¹¹ The latter two are national priorities in Spain, Latvia, Estonia, Lithuania, Bulgaria, and Denmark; the former SDG only in Bulgaria and Denmark.¹²

The following table describes and quantifies how the regenerative agricultural practices adopted by Project participants furthered these UN SDGs objectives during the present monitoring period, with additional evidence available in Appendix 5.

⁷ <https://agreena.com/agreena-business-solutions/>; <https://agreena.com/about/>

⁸ <https://knowsdgs.jrc.ec.europa.eu/policies-sdgs>

⁹ <https://www.unglobalcompact.org.uk/halfway-to-2030-how-is-the-uk-performing-on-the-sustainable-development-goals/>

¹⁰ <https://ukraine.un.org/en/sdgs> <https://moldova.un.org/en/sdgs>

¹¹ SDG 15 (Life on Land): Biodiversity is not monitored in the Project, but the land area that is degraded will decrease as a result of the Project. This can be tracked via the number of hectares in this verification periods and will increase throughout subsequent verifications.

¹² EEA Report no.21/2020 "Sustainable Development Goals and the environment in Europe: a cross-country analysis and 39 country profiles. doi: 10.2800/044724

Table 1-4: Sustainable Development Contributions

Row	SDG target	SDG indicator	Net impact on SDG indicator	Current project contributions	Contributions over project lifetime
1)	2.4	2.4.1 Proportion of agricultural area under productive and sustainable agriculture	Implemented activities to increase	In the first verification period, 1,652,643.85 hectares were monitored and verified have participated in regenerative agricultural practices (i.e., Project activities).	As this is the first Monitoring Report developed for the Project, its cumulative contributions to SDG 2 equate to what reported under previous column: 1,652,643.85 hectares of land under regenerative agriculture management.
2)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to decrease	In the first verification period the net GHG emission reductions and removals (ERRs) (as defined in equation 39 of VM0042 V2.0) were equal to 2,679,896.74 mtCO ₂ eq by integrating regenerative agricultural practices aimed at improving SOC stocks and decreasing the GHGs fluxes associated with conventional farming.	As this is the first Monitoring Report developed for the Project, its cumulative contributions to SDG 13 equate to what reported under previous column: 2,679,896.74 mtCO ₂ eq of total ERRs achieved.

3)	15.3	15.3.1 Proportion of land that is degraded over time	Implemented activities to decrease	In the first verification period, 1,652,643.85 hectares were monitored and verified to be managed with regenerative agricultural practices.	As this is the first Monitoring Report developed for the Project, its cumulative contributions to SDG 15 equate to what reported under previous column: 1,652,643.85 hectares of land under regenerative agriculture management. .
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1.13 Commercially Sensitive Information

Commercially sensitive information, program sensitive information, and sensitive information (as defined in the VCS Program Definitions v4.2, 21 December 2022) has been excluded from the public version of the PD. All commercially sensitive information is captured in Appendix 1 of this report.

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

Stakeholder Identification	The stakeholder groups the Project engages with have not changed during this monitoring period: farmers – and more specifically Project participants - remain the main stakeholder of interest for the development and execution of the Project. The description of the stakeholder mapping process and salient stakeholder groups' identity in section 2.2 “Local Stakeholder Consultation” of the PD is still applicable for this verification period.
Legal or customary tenure/access rights	The Project takes place exclusively on historical European farmland that is privately owned or leased by Project participants. Thus, Project participants have legal tenure/access and operational rights over the land they wish to enrol in the Project. If a prospective participant is leasing their fields they must demonstrate willingness to renew the lease. All property-related and ownership rights are clearly established during the onboarding phase, and further specified in the Benefits Contract that all participants must sign before officially joining the Project.

	No indigenous people (IPs), local communities (LCs),¹³ or other customary rights holders to Project-affected land and resources have been identified during this monitoring period. Also considering the inherent nature of land rights in pan-European countries, no conflict related to property, tenure/access or operational rights is expected to arise during the Project lifetime. QA/QC procedures and local market partners verify whether Project participants might be unlawfully encroaching on land and resources they do not have the legal/customary rights to. Such instances would be promptly addressed and can result in expulsion and even legal action.
Stakeholder diversity and changes over time	Since the stakeholder makeup did not change from Validation, the description of stakeholders socioeconomic and cultural diversity in section 2.2.2 of the PD is applicable and relevant to this Verification period. Please refer to this section for further information on the topic.
Expected changes in well-being	Transitioning to Project-supported regenerative agriculture practices can place an initial economic toll on participants, who might need to invest in new implements and observe a short-term decline in crop yields. The latter is caused by the local soil structure and microbiota needing to adapt to the new, less invasive farming practices. However, such changes are not only mitigated (see section 2.2 of this document) but are also expected to be offset over time, leading to overall economic benefits to Project participants. The environmental co-benefits generated by Project activities can also improve participants and their surrounding communities' overall well-being. The most immediate and direct economic benefit resulting from Project participation is the additional revenue stream from VCUs sale. Plus, Project participants can come to enjoy greater field profitability and financial independence over time, also because regenerative farming fosters crops resilience to environmental risks (e.g., droughts, wildfires) - see section 2.4 "Ecosystem Health" of this

¹³ Here intended as those whose livelihood might hinge on the resources affected by Project (i.e., arable fields across Europe),

document. By offsetting harvest losses and reducing recovery costs, Project participation can directly benefit participants' finances. A recent study demonstrated that a regenerative agriculture farm can be around 78% more profitable than conventional one.¹⁴ Indeed, by reducing reliance on costly external inputs (e.g., synthetic fertilizers, fuel for machinery), regenerative farmers can reduce operational costs by up to $\geq 30\%$. By focusing on profit per hectare instead of yield per hectare, regenerative farmers become less vulnerable to changes in input/output market prices, fluctuations in crops yield due to exogenous shocks, and benefit from greater profit margins and earnings. All in all, Project participation fosters participants' financial resilience and independence.

On top financial benefits, Project activities ought to contribute to participants' well-being through the fostering of environmental co-benefits, such as:

- Improve water quality because of reduced synthetic fertilizer use and agricultural run-offs to local water catchment.
- Mitigate droughts and floods thanks to better soil water holding and water infiltration capacity, stemming mainly from reduced soil disturbances and improved soil health and root systems. This also reduces the stress on local water tables levels from agricultural production.
- Preserve agricultural soil by avoiding tillage and using catch/cover crops, which shield from wind and rain erosion while boosting soil health.
- Promote biodiversity in farmland and surrounding ecosystems. Pollinator insects, birds, and soil microbiota (e.g., bacteria, fungi, nematodes) benefit the most from the resources provided by cover/catch crops, reduced soil disturbances, and less intensive farming practices. In turn, thriving native fauna can hamper local outbreaks of agricultural pests and pathogens.

These environmental benefits may spill over outside the Project's PAIs. For example, reduced agricultural run-offs can improve the

¹⁴ LaCanne & Lundgren (2018), Regenerative agriculture: merging farming and natural resource conservation profitably, NCBI

		quality of other habitats and communities served by the same water catchment. More broadly, these environmental benefits may play a crucial role in ensuring Project participants' adaptive capacity and resilience to future climate change impacts. See Section "Ecosystem Health" of this Chapter for more information.
Location of stakeholders	of	The KML file uploaded with this document contains the precise location of all Project participants across Bulgaria, Romania, Ukraine, Moldova, Spain, Estonia, Latvia, Lithuania, Denmark, and the UK. In this monitoring period, no IPs or LCs were present within Project area boundaries. Project impacts are predicted to be mainly localised to enrolled PAIs. The only Project-driven changes that may affect stakeholders other than Project participants are of positive nature; as discussed in the previous row, regenerative farming can drive environmental benefits at broader geographical scales.
Location of resources		The location of the resources available to Project participants (i.e., arable fields) is synonymous with their own location, provided in the KML file.

2.1.2 Stakeholder Consultation and Ongoing Communication

The Project relies on a variety of mechanisms to ensure continuous and transparent communication with Project participants, farmers and business partners. While each mechanism absolves a different function (e.g., feedback collection vs education), all communication efforts are developed and lead with consideration of market-specific customs, social norms, and languages.

Ongoing consultation	The monitoring cycle (see section 4.3) includes gathering participants' self-reported and agricultural data, estimating PAI-specific Project activities implementation and the resulting ERRs at a farm- and Project-level. Only after this information undergoes QA/QC, Agreena personnel would relay to each participant the estimated ERRs they may have generated during a Harvest Year (HY). All communication occurs in a culturally sensitive manner. Project participants are invited to express any doubt, concern or question they might have regarding any aspect of the
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	Project or the monitored results – e.g., the ERRs generated and Project activities implementation.
Date(s) of stakeholder consultation	HY 2022 and 2023 are included in this Monitoring Report. Given the considerable number of Project participants, communication of monitored results occurred continuously over certain time windows. For HY 2022, Project participants received information about their yearly performance and estimation of resulting ERRs between May and July 2023. For HY 2023, the Project developed and issued Credit Reports (see next row in this table) between September and October 2024.
Communication of monitored results	In the User's homepage and profile of the AgreeenaCarbon Platform (where users also input field data for baseline and project activity), Project participants can access country-specific educational material on the potential impacts of Project participation, Project-relevant workers' rights laws and regulations (including ratified ILO conventions), and a summary of the VCS validation/verification and VCUs issuance process. For the HY 2022, Agreeena communicated the monitored results to each Project participants through e-mail and oral communication. For HY 2023, personalised Farm Credit Reports were developed and forwarded via e-mail to each participant. These e-mails also contained a presentation with educational material to remind participants of key topics: what the Project activities consists of; overview of Monitoring, Reporting, Verification (MRV) processes and mechanisms; baseline setting and ERRs quantification; VCUs sale process and revenue sharing options. After the conclusion of the Verification process and VCUs issuance, Agreeena will confirm to Project participants the final number of VCUs they are eligible for under VCS. Thanks to these measures, Project participants could review their annual performance, be refreshed on key topics, and express any doubt, concern or questions in a timely manner – well before the Validation and first Verification event.
Consultation records	E-mail communication and outcomes of oral communication are recorded and archived in HubSpot with internal access.
Stakeholder input	While this specific form of communication is rather monodirectional, Project participants can always reach out to dedicated contact points (e.g., CS personnel) for any doubt, question or concern regarding their

	Credit Reports, monitored results, ERRs or VCUs generation, sale processes, or any other aspect of the Project.
Ongoing consultation	The Monitoring Plan (see section 4.3) includes in-person field inspections during the spring and autumn of each HY. A secondary goal of these farm visits is to collect qualitative feedback from Project participants to evaluate, address, and if needed act upon.
Date(s) of stakeholder consultation	The autumn and spring field visits included in this Monitoring Report cover HYs 2022 and 2023 and took place during these time windows. HY 2022 Autumn visits: between 11/09/2021 and 12/11/2021 Spring visits: between 13/14/2022 and 29/05/2022 HY 2023 Autumn visits: between 07/10/2022 and 20/12/2022, though there were late visits in January, February, and March 2023 Spring visits: between 18/04/2023 and 11/06/2023 (not including the late autumn visits mentioned above).
Communication of monitored results	After comparing participants' self-reported data with field visits' results, individual Farm Visit Reports are created and made available to participants. These Reports summarise: the role of site visits for MRV procedures; details of the PAIs visited; type of the machinery used by participants; soil conditions and characteristics; and Project activities implementation status. Any Project or operational update resulting from stakeholders' feedback would be communicated with a case-by-case approach.
Consultation records	In HY22, field inspectors recorded their observations in spreadsheets, archived and placed onto AgreeenaCarbon's Cloud Drive. As of HY23, field inspectors record their observations and the feedback provided by participants in the survey app "Fulcrum", and via notetaking.

	Documentation and feedback are placed onto the internal Cloud Drive and intranet with employee-access.
Stakeholder input	A section of the survey that participants are asked to complete during field visits includes questions that directly and explicitly promote stakeholder inputs. For example, if they have any ideas for improving the program, their personal understanding of soil carbon storage and Project's QA/QC processes, and their overall experience with the Project. Dedicated personnel would then assess each piece of feedback to individuate areas for improvement, macro-themes, and resolve comments that do not require further action. The Program team reviews annual reports of the feedback so collected. The feedback so collected resulted in the following updates: • Upon demand for more tech-friendly approaches, AgreeenaCarbon introduced (a) platform usability processes and (b) personal interviews, an additional in-person feedback collection channel with a focus on understanding common traits and challenges faced by Project participants. • Upon demand for additional information, AgreeenaCarbon implemented (a) "user profiles/personas", archetypical and theoretical avatars depicting Project participants' goals, backgrounds, and specific skills, and (b) case studies.
Ongoing consultation	A variety of two-way communication channels enable year-round collection of salient stakeholders' inputs and the sharing of key Project updates. These channels include call centre, chat support ("Intercom"), enquiry emails, webinars, educational tours and farms visits, social media, and contact points with dedicated personnel. All communication is led in a language participants are fluent / native in.

Date(s) of stakeholder consultation	Channels are open year-round, hence were constantly active throughout this verification period.
Communication of monitored results	Feedback is resolved on an individual basis, and outcomes of feedback analysis are mostly also communicated on a case-by-case basis.
Consultation records	Feedback received through the call centre, Intercom, and email is recorded and dealt with by Customer Success personnel through HubSpot. All other feedback is recorded via notetaking and placed onto internal Cloud Drive and the intranet.
Stakeholder input	All the comments, concerns, questions, and input received through ongoing communication channels are individually recorded, reviewed, and assessed. Dedicated personnel analyse each piece of feedback to individuate areas of improvement, mega trends, and resolve feedback that does not warrant further action. When necessary, stakeholders' input is escalated through AgreeenaCarbon's internal structure and potentially integrated into Project design and implementation. During this verification period, Project enhancements based on the feedback received through year-round communication have included: • Creation of a FAQs section in the AgreeenaCarbon platform • New forms for special requests and changes • Development of a pilot-app for tracking the progress of Project participants and enable an additional avenue of communication • Additional crop types being vetted and then added into the eligible crop list for Project participants.

2.1.3 Free, Prior, and Informed Consent

Consent	Insofar no land use, property rights, territory access or related conflicts arose - nor are they expected to occur because no IPs, LCs or other customary rights holders have been identified in the areas in-/directly
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impacted by Project implementation.

The Project takes place exclusively in historically farmed cropland that is lawfully owned or leased by Project participants. During the onboarding process, prospective participants must provide a statement confirming that they own and/or have operational rights over the fields they wish to enrol in the Project, plus specify their fields exact size and location. QA/QC mechanisms (e.g., remote sensing) allow AgreeenaCarbon analysts to ascertain the exact boundaries and location of each PAI, so that any discrepancy with what stated by the participants would be promptly discovered and addressed. Non-compliances and breaches would be addressed following AgreeenaCarbon's conflict resolution policy, which prioritises conflict de-escalation, peaceful resolution, and respect of local legislation and sociocultural context.

The onboarding process ensures that farmers' participation occurs exclusively with their explicit consent and only after achieving a clear understanding of what Project participation entails. At the end of the onboarding process, farmers can review and eventually accept the Terms & Conditions (TCs) and Benefit Contract (BC), and so officially become Project participants.

The main team involved in the onboarding process is Customer Success (CS), who may be flanked by an external partner - providing country-specific linguistic and cultural knowledge - and/or either or both a Key Account Manager (KAM) and Onboarding Specialist (OS) personnel,

Regardless of the exact teams involved, the onboarding process follows these sequential steps. First, a potential participant is vetted to verify their interest and eligibility in the Project. Then, prospective participants would be invited to an Onboarding Meeting where their historic baseline data and crop rotation is established. Afterwards, farmers join a Validation Meeting led by CS – and if necessary, an external partner. All meetings are held in a language that the farmer is fluent in and a culturally appropriate manner. Prospective participants are encouraged to ask any questions they might have and are provided with points of contact for follow-up questions. In the Validation Meeting, prospective participants are equipped with a more detailed agronomic and

	operational understanding of the Project. The following topics are covered: • Purpose of the Project, and a clarification that participants can withdraw their participation at any time. • What the Project activities consist of, likely impacts, and a clarification that Project participants can implement them at their own pace. AgreeenaCarbon personnel are ready to answer the questions farmers might have. • What would farmers have to do if they chose to join the Project, including an overview of parameters monitored, data collection and QA/QC processes. • The benefit sharing process, carbon credit generation and ownership. • The personnel who would follow farmers throughout their Project participation, and the key points of contact to rely on. The provisions of the T&Cs and BC further ensure that farmers consent to participate in the Project knowingly, being aware of their responsibilities, rights and obligations. Given that the regenerative ALM practices prescribed by the Project are self-enacted by participants on their farms, Project activities cannot occur without the prior knowledge and consent of Project participants.
Outcome of FPIC	As explained in the previous row, the Project reaches a transparent agreement with its participants on an individual basis. The onboarding process is rooted in education and two-way communication. If at the end of onboarding a farmer chooses to join the Project, they would have to review, accept and sign the T&Cs and BC. Along with the regular Project participants communication channels, this process ensures that the farmers deciding to join the Project do so knowingly, willingly, and before any change to their fields management may happen. To reiterate, Project activities must be self-enacted by participants on the cropland they own and/or have operational rights over, hence cannot be implemented without their prior knowledge and consent. In this verification period, no land encroachment, non-consensual relocation of people, or forced economic displacement of local communities occurred because of Project implementation. Existing

monitoring mechanisms ensure that any such event would be promptly flagged and dealt with.

2.1.4 Grievance Redress Procedure

AgreenaCarbon aims to ensure that any concern, complaint, or grievance related to the Project is acknowledged and dealt with in a timely and effective manner. Ensuring stakeholders and Project participants satisfaction is key to its long-term and successful execution.

During this verification period, no grievances were raised through either the Grievance & Complaints channel or the Whistleblowing Hotline. These two channels are easily, readily and freely available to external (e.g., Project participants) and internal (e.g., employees) stakeholders respectively. Project participants can also choose to raise their concerns to the different dedicated support teams and through the various communication channels at their disposal.

Participants and other external stakeholders can file at no cost, at any time, and in any language a complaint or grievance through a dedicated email address (grievance@agreena.com) available on the company website. AgreenaCarbon would then send a receipt of acknowledgement within 10 working days and start addressing the complaint as soon as possible. Translational services are offered when necessary. As for employees, the Whistleblower Hotline is readily and easily accessible on the internal intranet to report any issues, concerns and grievances. It is monitored by an external legal partner to ensure complete neutrality, who did not report any issue being raised insofar.

The guiding principles of the Grievance & Complaint Resolution Policy are conflict de-escalation, promotion of accountability, targeted case-by-case resolution, open and continuous communication, maintenance of an unbiased and neutral stance, fair and transparent dispute resolution aligned with applicable inter-/national legislation. For more information on this topic, please refer to section 2.2.6 of the PD.

Grievances received	Resolution and outcome
N/A	N/A

2.1.5 Public Comments

The comments Project participants might have had during monitoring are collected via year-round communication channels and the field inspections for MRV purposes. Public comments received as part of pipeline listing have been addressed as part of Validation and are summarized below.

One additional public comment was received during this monitoring period, outside of the pipeline listing period. The actions taken to address it are also presented in the table below.

Summary of comments received	Actions taken
Pipeline Listing Comment 1 The first comment contained seven (7) paragraphs of concerns. Each was addressed individually during the validation process with the VVB.	It is important to note that several of the concerns presented by the commenter pertained VM0042 methodology itself, not AgreeenaCarbon's Project Description. Those were not responded to given that the Project Proponent does not have control over the revision process of methodologies under Verra.
Pipeline Listing Comment 2 The second comment was anonymous.	Could not be verified, therefore no action was taken.
Monitoring Period Comment The comment was from an anonymous source containing a general overview of the VCM and concerns related to land used for forestry projects versus agriculture.	Due to the fact that the public comment cannot be validated as it is from an anonymous source, the details within cannot be verified. Nevertheless, there are several important points that are brought forward that AgreeenaCarbon has responded to. The overview is presented in the Verification Report.

2.2 Risks to Stakeholders and the Environment

2.2.1 Management Experience

AgreeenaCarbon is the sole entity involved in Project design and implementation. The internal management team presents the necessary expertise and relevant experience to be able to properly engage with salient stakeholders, ensure Project implementation proceeds as intended, and work towards Project permanence in the face of external, internal, natural, and climate change-driven risks. This is exemplified by the following extract from the Non-Permanence Risk Report (NPRR), produced alongside this Monitoring Report.

Experts with Project Management Experience		
Name and Surname	Role	Profile

Roberta McDonald	Head of Carbon Programme	Roberta leads the AgreeenaCarbon team of scientists, technical experts and data operatives to measure, guide and report on-farm sustainable practices. Roberta holds a PhD and has completed further studies in behaviour management. She has had well over 10 years of Project Management and project development experience. change amongst farmers, animal science and project
Valentine Ganseman	Head of Customer Success	Valentine is a result-driven leader with 8+ years of professional experience. Valentine has a background in building professional commercial teams in start-ups and scale-ups, helps them track performance, set up customer service processes, generate leads, nurture sales deals, and create success for customers. In Agreeena Valentine is responsible for building and maintaining the relationship with project farmers. She is leading the 30+ people team of customer success specialists working across the whole Agreeena portfolio. Her main focus is on both direct B2B sales with large farms and agro-holdings and customer success.
Marcelo Galdos	Innovation Lead	As Program Innovation Lead at Agreeena, Mr. Galdos applies expertise in sustainable agricultural systems and almost 30 years of experience in soil health, climate-smart agriculture, and net-zero strategies to develop and evaluate innovative solutions for enhancing soil carbon sequestration and reducing greenhouse gas emissions from agricultural systems. He has significant experience in both leading and contributing to multiple interdisciplinary projects involving soil carbon dynamics, crop/soil modelling, life cycle assessment, and carbon foot-printing.

Experts with AFOLU-Specific Experience

Petros Georgiadis	Lead Soil Scientist	Experienced environmental and land use specialist focused on natural resource management. Petros holds PhD in land use management and soil sciences and also has 10+ years of professional experience in project management and in agriculture and forest research. Petros is responsible for keeping the carbon quantification process and linking it with the requirements for data collection and processing them. Petros has experience with formulating methodologies and scientific concepts with practical solutions. Petros is responsible for the proper maintenance and regular validation and calibration carbon model.
Tomasz Kowalczewski	Carbon Accounting Expert	Tomasz has a track record of 14+ years of experience related to Climate Change, EU Agricultural including being Team Leader and Senior expert in the field of Climate Change UNFCCC AFOLU expert. Working in the Carbon team in Agreeena and responsible for proper implementation of

		the Sustainable agriculture methodologies and applying the GHG Accounting rules and principles. Involved in the establishment of the program and metrology development and verification procedures. Working on positioning the program on the voluntary carbon market and ensuring that the program is in line with certificated and globally recognized standards for carbon projects and programmes.
Karolina Kenney	AgreenaCarbon Program Specialist	Karolina has had several years of project management in consulting as well as at Agreena. She has worked on nature-based solutions and AFOLU for the past 5 years specifically with DG AGRI and DG CLIMA on projects related to LULUCF and the carbon market. At Agreena, she works on integrating the teams in order to combine and track the data integration process. She is also in charge of making sure the Project is aligned with the latest version of the VCS methodologies.
Macdara O'Neill	AgreenaCarbon Soil Scientist	Macdara is one of the lead scientists at Agreena with experience in land use and soil science. He has a PhD in biology and environmental science from the University of Dublin and worked as a researcher for nearly 10 years in the areas of agricultural GHG emissions, soil science and carbon sequestration. He also has a focus on different land management practices and their impact on GHG emissions in the soil. At Agreena he supports the science team and develops the soil sampling protocols.
Marta Suber	Monitoring, Reporting and Verification Specialist	Marta Suber is an expert in Agriculture, Forestry, and Other Land Use (AFOLU) greenhouse gas (GHG) accounting with a focus on Measurement, Reporting, and Verification (MRV) systems. Marta has extensive expertise in developing carbon accounting frameworks, integrating data collection processes with international standards, and ensuring the accuracy and compliance of emissions quantification. At Agreena, she is responsible for streamlining the carbon quantification process, aligning it with policy and certification requirements, and supporting its practical implementation for farmers. With a strong background in Latin America, Marta bridges technical methodologies and policy frameworks to ensure actionable climate solutions. She also brings years of experience in aligning AFOLU activities with Nationally Determined Contributions (NDCs) and driving the adoption of sustainable land-use practices.

2.2.2 Risk assessment

	Risk identified	Mitigation or preventative measure taken
Natural and human-induced risks to stakeholders' wellbeing	No risk identified	Project implementation is not expected to promote natural and/or human-induced threats to the wellbeing of any salient stakeholder group, such as Project participants, neighbouring farmers, or external business partners. The Project solely consists of supporting pan-European farmers in transitioning from conventional agriculture to regenerative, agroecological farming by adopting key ALM practices. It does not affect the natural or human-driven stressors that might be affecting Project participants and/or any other stakeholder group impacted by Project implementation.
Risks to stakeholder participation	Initial financial toll Via: A. Short-term yield decrease B. Cost of uptake (new machinery, equipment, seeds, other implements) Once tillage is reduced or eliminated altogether, the biophysical properties of soil must be rebuilt by soil microbiota. However, this	In this monitoring period, the main avenue through which AgreeenaCarbon mitigated against this financial risk was an initial pre-payment of estimated ERRs, generated as market estimates. Project participants would be compensated with the output and depending on the future sale of credit certificates in the market, they would be compensated further. Project participants can also rely on year-round communication channels with dedicated personnel to express their concerns and receive support.

	process is not immediate, and a reduction in crop yield might occur. Along with the fact that new farming implements might have to be purchased to start adopting Project-supported ALM practices, this might expose Project participants to an initial financial risk.	
Risks to Stakeholder Participation	Negative peer judgment and social isolation. Project participants might experience a lack of support or negative criticisms from neighbouring farmers, who might perceive any effort to change conventional, historical farming as a disruption of status quo and traditions.	AgreenaCarbon mitigates this social risk by enabling capacity building, undertaking stakeholder engagement events at the market level, and providing Project participants with year-round contact points. For example, webinars and Agreena-led events can allow Project participants to connect with each other and feel part of a supportive network. The use of social media channels, regular posting of updates on topics of interest, can also foster a sense of belonging, especially for participants who live in remote areas.
Working conditions	Project participants might subject the agricultural workers operating in their PAIs to unsafe, unfair, and unjust working conditions.	The ten pan-European countries in which the Project operates have recognised and adopted international conventions, including ILO conventions, determining safe, fair, and just working conditions for all commercial, industrial sectors and demographics. Each country also presents a suite of national laws, regulations, and policies that defend workers' rights and define minimum acceptable working conditions. The Terms & Conditions (TCs) and Benefit Contract (BC) farmers must

		sign before joining the program specify that Project participants must comply with all applicable laws to Project implementation, which therefore includes regulations on safe, fair and just working conditions for farmers and agricultural workers. Project participants are reminded of the most relevant national laws regulating workers' rights as part of ongoing communication efforts. Additionally, Agreeena's Supplier Code of Conduct¹⁵, which all stakeholders are expected to follow, fully supports international guidelines on working conditions, including the UN Guiding Principles on Business and Human Rights and the International Labour Organisations' Declaration on the Fundamental Principles and Rights at Work. Thanks to QA/QC procedures and the available Grievance & Complaints plus Whistleblower channels, AgreeenaCarbon can effectively detect any breach Project participants or other stakeholders might commit. Non-compliance can result in legal action and expulsion from the Project, thus preventing risks of unlawful, unsafe, unfair, and unjust working conditions being perpetrated by stakeholders associated with Project design, implementation, and AgreeenaCarbon's internal operations.
Safety of women and girls	Project participants may operate in such a way that the safety of women and	The ten pan-European countries in which the Project operates have recognised and adopted international conventions to safeguard the rights, well-being and safety of

¹⁵ https://agreeena.com/wp-content/uploads/2023/05/Agreeena_Supplier_Code_of_Conduct.pdf

	girls working in their farms is jeopardised.	women and girls. Each country also presents a suite of national laws, regulations, and policies addressing these issues. The T&Cs and BC farmers must sign before joining the Project specify that all participants must comply with all relevant laws to Project implementation, which would therefore include regulations promoting the safety of women and girls, as such demographic is an integral part of all local communities. As part of ongoing communication efforts, Project participants are provided with material on the key workers' rights regulations within their jurisdiction; among these regulations generally figure legislation that aim at safeguarding the safety, equality and rights of women in the workplace. Additionally, the internal Supplier Code of Conduct,¹⁶ which every stakeholder is expected to uphold, fully supports international guidelines such as the UN Guiding Principles on Business and Human Rights and the International Labour Organisations' Declaration on the Fundamental Principles and Rights at Work. The QA/QC procedures. and the available Grievance & Complaints plus Whistleblower channels, allow AgreeenaCarbon to detect breach Project participants or other stakeholders might commit. Non-compliances can result in legal action and expulsion from the Project, thus mitigating against risks to the safety and rights of women and girls.
Safety of minority and marginalized	Project participants might operate in such a way that	The pan-European countries in which the Project operates have recognised and

¹⁶ https://agreeena.com/wp-content/uploads/2023/05/Agreeena_Supplier_Code_of_Conduct.pdf

groups, including children	the safety of minority and marginalised groups, including children, is jeopardised; for example, by encroaching on territories outside of their PAIs or forcing children into agricultural labour.	adopted international conventions to safeguard the rights, well-being and safety of minority and marginalised groups, including children. Each of the ten countries included in the Project area also have a suite of national laws, regulations and policies on such topics. The T&Cs and BC specify that all participants must comply with applicable laws – thus including regulations against child labor, discriminatory behaviours in the workplace, and threats to the safety of minorities and marginalised groups. As part of ongoing communication efforts, Project participants are provided with material on the key workers’ rights legislation in their nation, which include regulations to safeguard minorities, children, and marginalised group in the workplace, The internal Supplier Code of Conduct,¹⁷ which all stakeholders are expected to follow, fully supports international guidelines on working conditions, including the UN Guiding Principles on Business and Human Rights and the International Labour Organisations’ Declaration on the Fundamental Principles and Rights at Work. Thanks to QA/QC procedures, and the available Grievance & Complaints and Whistleblower channels, AgreeenaCarbon can detect any breaches Project participants, or any other stakeholders, might commit. Non-compliance can result in legal action and expulsion from the Project, overall mitigating risks to the safety and rights of minorities, marginalised groups, or children.
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¹⁷ https://agreeena.com/wp-content/uploads/2023/05/Agreeena_Supplier_Code_of_Conduct.pdf

Pollutants (air, noise, discharges to water, generation of waste, release of hazardous materials, and chemical pesticides and fertilizers)	Agrochemicals discharges to water, leading to watershed eutrophication and soil pollution. Given the agricultural nature of the Project, it is inevitable that pesticides and fertilizers will be used in varying quantities by Project participants as they implement Project activities.	The level of risk posed to the environment by the agricultural runoffs associated with Project activities is no greater – if not lower – than the pollutants risk associated with conventional, business-as-usual agriculture. Firstly, reducing synthetic fertiliser and switching to organic amendments is among the Project-supported farming practices. Secondly, Project activities are known to promote soil health, soil fertility, and farmland ecosystems’ biodiversity. In order to identify the impacts of project activities, these practices have been assessed and conclude that over time, improved soil fertility might reduce the need for external, synthetic fertilizers, while enhanced local farmland biodiversity has been shown to help with controlling the spread of agricultural pests, pathogens and weeds.^{18 19 20} As such, over time the agrochemicals pollutants risk associated with Project implementation might be even lower than business-as-usual scenario (i.e., the continuation of conventional, high inputs intensity agriculture). In order to mitigate any negative impacts of these practices Project participants are contractually expected to respect all inter-/national laws that may apply to Project implementation. EU Member States follow the
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¹⁸ Michels (2022). Regenerative Agriculture Effects on Invertebrate and Bird Communities, and Insect-provided Ecosystem Services.

¹⁹ <https://link.springer.com/article/10.1007/s10311-008-0147-0>

²⁰ ayaraman et al., (2021). Disease-suppressive soils – beyond food production: a critical review. *Journal of Soil Science and Plant Nutrition*. <https://doi.org/10.1007/s42729-021-00451-x>

precautionary principle and an environmental-oriented approach in regulating agrochemicals use. Alignment with the EU regulatory framework is the norm for Moldova and Ukraine, which are on a path towards EU membership. MRV mechanisms continuously monitor Project participants' farming operations, including type and quantity of fertilizer applied. Breaches and non-compliances would be quickly detected and addressed. By doing so, AgreenaCarbon mitigates against this risk. Relevant market and location-specific legislations include:

Ukraine: Order No. 55 of the Ministry of Health validating Hygienic standards and regulations for the safe use of pesticides and agrochemicals.²¹

Moldova: Order No. 160 of the Ministry of Agriculture, Regional Development and Environment validating the Code of Good Agricultural Practices for the protection of waters against nitrate pollution from agricultural sources.²² Government Decree No. HG1045/2005 validating the Regulations on import, storage, marketing and use of phytosanitary products and fertilizers.²³

UK: Control of Substances Hazardous to Health (COSHH) Regulation, 2002. Nitrate Pollution Prevention (Amendment) Regulations 2016 (S.I. No. 1190 of 2016).²⁴

²¹ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC214021>

²² <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC224722>

²³ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC223062>

²⁴ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC163358>

		EU Directives on the safe use and management of hazardous agricultural substances, that all Member States must adapt into national law: Sustainable Use of Pesticides Directive (2009/128/EC); Plant Protection Products Regulation (2009/1107/EC); Industrial Emissions Directive (2010/75/EU); REACH Regulation (2006/1907/EC); Nitrates Directive (91/676/EEC). In addition, the practices are monitored over time through farmer engagement and data collection of practice implementation, remote-sensing monitoring over time as well as a selection of internal visits carried out as outlined in the Monitoring Chapter 4.
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2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

Risk Identified		Mitigation or preventative measure(s) taken
Discrimination	AgreenaCarbon personnel may engage in discriminatory behaviours towards either internal or external stakeholders.	In this verification period no incident related to discrimination incident was reported. There are channels in place for external (Grievance & Complaints procedure) and internal (Whistleblower hotline) stakeholders to report any such incidents. QA/QC mechanisms (e.g., the interviews held as part of in-person field visits) help detect whether AgreenaCarbon personnel may have subjected Project participants to discriminatory behaviour or any other behaviour against the Code of Conduct. As noted in section 2.2.2, the internal Code of Conduct is based on the UN Guiding Principles on Business and Human Rights and the International Labour

		Organisation's Declaration on Fundamental Principles and Rights at Work. All AgreeenaCarbon personnel is encouraged to review the Code of Conduct and Culture Playbook, the latter emphasising AgreeenaCarbon efforts to create a safe and welcoming workplace environment for everyone. Thus, AgreeenaCarbon clearly condemns discriminatory behaviours, would quickly address any such instance, and works to mitigate this risk.
Sexual Harassment	AgreeenaCarbon personnel may sexually harass either internal or external stakeholders	In this verification period no incident related to sexual harassment was reported. There are channels in place for external (Grievance & Complaints procedure) and internal (Whistleblower hotline) stakeholders to report any such incidents. Monitoring steps help detect whether AgreeenaCarbon personnel may have sexually harassed Project participants or subjected them to any other behaviour going against the Code of Conduct. As noted in section 2.2.2, the internal Code of Conduct is based on the UN Guiding Principles on Business and Human Rights and the International Labour Organisation's Declaration on Fundamental Principles and Rights at Work. All AgreeenaCarbon personnel is encouraged to review the internal Code of Conduct and Culture Playbook, the latter emphasising Agreeena's willingness to create a safe, respectful work environment based on transparent communication. Thus, AgreeenaCarbon clearly condemns sexual harassment, would quickly address any such instance, and works to mitigate against this risk.

Gender and equity in labor and work	AgreenaCarbon personnel may treat internal and external stakeholders in a biased or unequitable manner according to their gender and/or gender expression.	No incident related to gender inequity in labour and at work was reported through the readily available channels for external (Grievance & Complaints Procedure) and internal (Whistleblower Hotline) stakeholders. QA/QC mechanisms help ensure that no such incidents would occur undetected. Breaches to inter-/national legislations safeguarding gender equity in the workplace, to which all Project participants and other stakeholders are required to abide by, or the Code of Conduct would be promptly addressed. As noted above, the latter document is based on the UN Guiding Principles on Business and Human Rights and the International Labour Organisation's Declaration on Fundamental Principles and Rights at Work. All AgreenaCarbon personnel are encouraged to review the internal Code of Conduct and Culture Playbook emphasising Agreena's willingness to create a safe, respectful work environment for everyone based on transparent communication. Non-compliance would be addressed on a case-by-case approach.
Forced labor	Project participants may be forcing agricultural workers operating on their PAIs to provide their labour.	No incident related to forced labour was reported during this verification period through the dedicated channels (Grievance & Complaints, Whistleblower hotline), nor any unlawful or criminal practices and breach to the internal Code of Conduct was flagged by active QA/QC mechanisms. Breaches of inter-/national laws against forced labour, to which all Project participants must abide by per contract, can lead to participants expulsion from the Project and legal action. As part of ongoing communication, AgreenaCarbon provides Project participants with material detailing key workers' rights legislations

		in their nation. Altogether, these measures help prevent instances of forced labour from occurring in association with the Project.
Child labor	Children may be forced to work on the PAIs included in the Project area by Project participants.	No incident related to child labour was reported during this verification period through the dedicated channels (Grievance & Complaints, Whistleblower hotline), nor any unlawful or criminal practices and breach to the internal Code of Conduct was flagged by active QA/QC mechanisms. Breaches of inter-/national laws against child labour, to which all Project participants must abide by per contract, can lead to participants expulsion from the Project and legal action. As part of ongoing communication, AgreeenaCarbon provides Project participants with material detailing key workers' rights legislations in their nation, which include regulations against child labor. Altogether these measures help prevent instances of child labor from occurring in association with the Project.
Human trafficking	No risk identified	On account of the local-scale and agronomic nature of the Project, no avenue through which its implementation may foment human trafficking has been identified; thus, this risk category does not apply.

2.3.2 Human Rights

Risk identified	Mitigation or preventative measure(s) taken
No risk identified	There are no Indigenous People (IPs), Local Communities (LCs) ²⁵ , or other customary rights holders to the land and resources affected by the Project within its geographical boundaries.

²⁵ Intended as communities whose livelihood is directly dependent on the resources located within the Project area and/or affected by Project activities

The respect of internationally recognized human rights is a guiding principle for the development and implementation of the AgreeenaCarbon Project. As previously stated, the internal Code of Conduct, which employees, business partners, and Project participants alike are expected to follow, fully supports the UN Guiding Principles on Business and Human Rights as well as the International Labour Organisation's Declaration on Fundamental Principles and Rights at Work. Moreover, Project participants are required to abide by all inter-/national laws applicable to Project implementation, thus including provisions to safeguard human rights, workers' rights and safety. Non-compliances are monitored by diverse whistleblowing and QA/QC mechanisms, promptly addressed, and can result in expulsion and legal action.

2.3.3 Indigenous Peoples and Cultural Heritage

Risk identified	Mitigation or preventative measure(s) taken
No risk identified	There are no IPs, LCs, or other customary right holders to the areas and natural resources affected by the Project within its geographical boundaries. Considering that the Project solely aims at helping pan-European farmers transition from high-intensity industrial farming systems towards regenerative ones, and in so doing generate ERRs, its implementation does not impact the cultural heritage of Project participants nor of their surrounding communities. To make sure cultural differences are respected and properly addressed, all communication material is tailored to the language, social norms and customs of each of the ten countries included in the Project area. Such measures ensure that the cultural heritage of all Project participants and other stakeholders is respected and not infringed upon by AgreeenaCarbon's activities.

2.3.4 Property Rights

Risk identified	Mitigation or preventative measure(s) taken
No risk identified	There are no IPs, LCs, or other customary right holders with property/access rights over the farmland areas enrolled in the Project besides the Project participants themselves. Ownership, operational, tenure and access rights are established during the onboarding and validation phases, ensuring that each participant has full legal control as well as operational rights over the land they wish to enrol in the Project. Lease agreements cannot be short-term, and participants must show their intention to renew it. Therefore, the Project does not in any way impact the property rights of any of the stakeholders involved in or affected by Project implementation, nor it is expected to do so. MRV mechanisms would detect any infringement to property rights, and Project participant can contact dedicated personnel (e.g., CS) or rely on the Grievance & Complaints channel to report any such issues.

2.3.5 Benefit Sharing

This section will be left blank per VCS Monitoring Report Template instructions, where it is stated that the table below is to be filled “*where the project impacts property rights as described in Section 2.3.4 above*”. However, that is not the case for the present Project.

Summary of the benefit sharing plan	N/A
Benefit sharing during the monitoring period	N/A

2.4 Ecosystem Health

The Project operates under a No-Net Harm scenario (see section 2.1 of the PD), whereby no negative environmental impacts are expected to stem as a direct or indirect consequence of Project implementation. On the contrary, Project-supported farming practices are expected to (a) pose less of a risk to local ecosystems compared to conventional, business-as-usual agricultural practices, and (b) generate a suite of environmental co-benefits. Among others: improved water quality, biodiversity support, drought and flood mitigation, and soil preservation. These benefits would be primarily localised to PAIs and surrounding habitats but might have far-reaching positive effects in some instances. For example, reduced agricultural runoffs from decreased synthetic fertilisers inputs can benefit all ecosystems served by a given watershed.

Risk identified		Mitigation or preventative measure(s) taken during the monitoring period
Impacts on biodiversity and ecosystems	No risk identified.	The Project poses no threat to pan-European ecosystems and biodiversity. On the contrary, its implementation (i.e., the adoption of key regenerative agriculture practices) is expected to protect local wildlife, promote biotic communities’ well-being, and better support the delivery of farmland ecosystems goods & services compared to the business-as-usual scenario. Farms under regenerative management regimes have been reported to support diversity and

		abundance of pollinating insects and bird species better than conventionally managed farms,^{26 27} and enhance biodiversity at all trophic levels.²⁸ The IPCC Fifth Assessment Report (WGII AR5)²⁹ identifies low-tillage cultivation as a win-win-win strategy that contributes to both climate change mitigation and adaptation while also promoting faunal & floral species abundance and diversity. Overall, adoption of Project-supported regenerative ALM practices (i.e., low/no-tillage; cover and catch crops; crop residue mulching; reducing synthetic fertilisers in favour of organic amendments) should mitigate and help counter the negative trends in biodiversity and ecosystem quality observed throughout Europe.³⁰ Cover and catch crops provide additional over-winter habitat and forage resources for a host of faunal
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²⁶ Michels (2022), Regenerative Agriculture Effects on Invertebrate and Bird Communities And Insect-Provided Ecosystem Services, South Dakota State University

²⁷ Fenster, T. L. D., Oikawa, P. Y., & Lundgren, J. G. (2021). Regenerative Almond Production Systems Improve Soil Health, Biodiversity, and Profit. *Frontiers in Sustainable Food Systems*, 5, 256. <https://doi.org/10.3389/fsufs.2021.664359>

²⁸ EASAC policy report 44 (2022). Regenerative Agriculture in Europe: a critical analysis of contributions to European Union Farm to Fork and Biodiversity strategies. Available

https://easac.eu/fileadmin/PDF_s/reports_statements/Regenerative_Agriculture/EASAC_RegAgri_Web_290422.pdf

²⁹ Kovats, R.S., R. Valentini, L.M. Bouwer, E. Georgopoulou, D. Jacob, E. Martin, M. Rounsevell, and J.-F. Soussana, 2014: Europe. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1267-1326

³⁰ EASAC policy report 44 (2022). Regenerative Agriculture in Europe: a critical analysis of contributions to European Union Farm to Fork and Biodiversity strategies. Available

https://easac.eu/fileadmin/PDF_s/reports_statements/Regenerative_Agriculture/EASAC_RegAgri_Web_290422.pdf

		species,^{31 32 33} including taxa occupying the habitats surrounding farmland. The prolonged presence of living roots, along with reduced tillage, promotes the diversity and abundance of all trophic levels: from invertebrates³⁴ to birds³⁵ and, most directly, soil microbiota. Arbuscular mycorrhizal fungi (AMF) networks especially benefit from the adoption of Project practices.³⁶ Importantly, AMF networks abundance and richness have been linked to improved plant growth, nutrient cycling, disease and drought resistance.^{37 38} Plus, Project adoption promotes reduced reliance on synthetic fertiliser input, known to harm farmland birds and pollinator insects^{39 40} and cause watersheds eutrophication.⁴¹
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³¹ Michels (2022), Regenerative Agriculture Effects on Invertebrate and Bird Communities And Insect-Provided Ecosystem Services, South Dakota State University

³² Carrié, R., Ekroos, J., & Smith, H. G. (2018). Organic farming supports spatiotemporal stability in species richness of bumblebees and butterflies. *Biological Conservation*, 227, 48–55. <https://doi.org/10.1016/j.biocon.2018.08.022>

³³ Bryan, C. J., Sipes, S. D., Arduser, M., Kassim, L., Gibson, D. J., Scott, D. A., & Gage, K. L. (2021). Efficacy of Cover Crops for Pollinator Habitat Provision and Weed Suppression. *Environmental Entomology*, 50(1), 208–221. <https://doi.org/10.1093/ee/nvaa159>

³⁴ Ullman et al., (2016). Impact of tillage on the crop pollinating, ground-nesting bee, *Peponapis pruinosa* in California. *Agriculture, Ecosystems & Environment*, 232, 240–246. <https://doi.org/10.1016/j.agee.2016.08.002>

³⁵ VanBeek, et al., (2014). Does no-till soybean farming provide any benefits for birds? *Agriculture, Ecosystems & Environment*, 185, 59– 64. <https://doi.org/10.1016/j.agee.2013.12.007>

³⁶ Bowles et al., (2016). Ecological intensification and arbuscular mycorrhizas: a meta-analysis of tillage and cover crop effects.

³⁷ Bowles et al., (2016). Ecological intensification and arbuscular mycorrhizas: a meta-analysis of tillage and cover crop effects. *Journal of Applied Ecology*. doi: 10.1111/1365-2664.12815

³⁸ Brussaard, L. (1998). Soil fauna, guilds, functional groups and ecosystem processes. *Applied Soil Ecology*, 9(1), 123–135. [https://doi.org/10.1016/S0929-1393\(98\)00066-3](https://doi.org/10.1016/S0929-1393(98)00066-3)

³⁹ Michels (2022), Regenerative Agriculture Effects on Invertebrate and Bird Communities And Insect-Provided Ecosystem Services, South Dakota State University

⁴⁰ Ceulemans, T., Hulsmans, E., Vanden Ende, W., & Honnay, O. (2017). Nutrient enrichment is associated with altered nectar and pollen chemical composition in *Succisa pratensis* Moench and increased larval mortality of its pollinator *Bombus terrestris* L. *PLOS ONE*, 12(4), e0175160. <https://doi.org/10.1371/journal.pone.0175160>

⁴¹ Kovats, R.S., R. Valentini, L.M. Bouwer, E. Georgopoulou, D. Jacob, E. Martin, M. Rounsevell, and J.-F. Soussana, 2014: Europe. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S.

		Given that agriculture is responsible for as much as 50% of watercourses pollution, large-scale adoption of regenerative agriculture practices can drive improvements of water quality at larger geographical scales. Simply, the less polluted a watershed, the better for all biotic communities it serves. Moreover, as Project implementation improves local biodiversity, it can help reduce the likelihood and severity of invasive pest and pathogens outbreaks. In the literature, thriving native communities are believed to act as biological control agents against the spread of non-native, potentially harmful invasive species through predation, resource competition and other antagonistic ecological dynamics.^{42 43 44} All in all, the regenerative farming practices supported by the Project are expected to not only be less impacting on biodiversity and ecosystems than conventional, business-as-usual farming, but also promote the richness, diversity and abundance of European wildlife, and in so doing safeguard the health and quality of local ecosystems.
Soil degradation and soil erosion	No risk identified	A third circa of the global agricultural soils are acutely degraded, with an estimated 75 to 100 billion tons of topsoil being lost to erosion and degradation annually. Tillage and exposure of bare soils to the elements are significant underlying drivers,⁴⁵ meaning that conventional farming directly contributes to global soil

MacCracken, P.R. Mastrandrea, and L.L.White (eds.)). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1267-1326

⁴² Michels (2022). Regenerative Agriculture Effects on Invertebrate and Bird Communities, and Insect-provided Ecosystem Services.

⁴³ <https://link.springer.com/article/10.1007/s10311-008-0147-0>

⁴⁴ Jayaraman et al., (2021). Disease-suppressive soils – beyond food production: a critical review. *Journal of Soil Science and Plant Nutrition*. <https://doi.org/10.1007/s42729-021-00451-x>

⁴⁵ Rust & Williams, How Tillage Affects Soil Erosion & Runoff, USDA

		degradation and erosion trends. Therefore, regenerative agriculture practices targeting soil health, such as the ones supported by the Project, directly tackle and ameliorate the risk of such downwards trends. When implemented, Project activities (most notably use of cover & catch crops and lower tillage disturbances) can significantly reduce soil run-offs and soil vulnerability to wind and rain erosion^{46 47} while increasing soil organic matter content. The latter is directly correlated with soil health, meaning that Project implementation can help preserve and restore agricultural soils against continued degradation - a fundamental resource to ensure long-term global food security in the face of climate change. ^{48 49}
Water consumption and stress	No risk identified	The Project-promoted ALM practices can not only mitigate drought and flood risk but also decrease participants' water dependency and consumption. Even though agricultural activities necessarily entail water consumption (e.g., for irrigation purposes), the water footprint of Project participants is expected to

⁴⁶ Madarász et al. (2021), Long-term effects of conservation tillage on soil erosion in Central Europe, Soil & Tillage Research

⁴⁷ Soane, B.D., B.C. Ball, J. Arvidsson, G. Basch, F. Moreno, and J. Roger-Estrade, 2012: No-till in northern, western and south-western Europe: a review of problems and opportunities for crop production and the environment. Soil and Tillage Research, 118, 66-87.

⁴⁸ Kovats, R.S., R. Valentini, L.M. Bouwer, E. Georgopoulou, D. Jacob, E. Martin, M. Rounsevell, and J.-F. Soussana, 2014: Europe. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1267-1326

⁴⁹ IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., doi: 10.59327/IPCC/AR6-9789291691647.

		be lower than conventional farmers. Compared to a business-as-usual scenario, Project implementation poses the same if not less of a risk to water consumption and stress in Europe. Reducing tillage and the living roots network of catch and cover crops, also thanks to their beneficial effect on organic matter build-up, equip local soils with both higher water infiltration and holding capacity. In turn, this mitigates the severity and likelihood of droughts and floods respectively.⁵⁰ A silt loam soil with 4% organic matter holds more than twice as much water as one with 1% organic matter,⁵¹ and more generally, soil organic matter can hold up to 20 times its weight in water.⁵² This also means that the crops cultivated on such soils (that is to say, Project participants' crops) can come to require less irrigation compared to conventionally farmed crops. Thus, Project implementation can equip participants' farms with increased resilience to floods, droughts, extreme weather conditions, and precipitation-driven soil erosion. Importantly, such stressors are expected to become more frequent with climate change.
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⁵⁰ Antolini et al. (2019), Flood Risk Reduction from Agricultural Best Management Practices, JAWRA

⁵¹ Hudson (1994), Soil organic matter and available water capacity, Journal of Soil and Water Conservation

⁵² Post, J., T. Conratt, F. Suckow, V. Krysanova, F. Wechsung, and F.F. Hattermann, 2008: Integrated assessment of cropland soil carbon sensitivity to recent and future climate in the Elbe River basin. Hydrological Sciences Journal, 53(5), 1043-1058.

2.4.1 Rare, Threatened, and Endangered species

Species or habitat	Project activities are expected to have an overall positive environmental impact on European ecosystems. Benefits include improved soil health, better nutrient cycling, water quality and availability, and thriving soil microbiota. These benefits might ripple to the ecosystems adjacent to the PAIs. For example, cover and catch crops provide additional shelter and forage resources for a host of faunal species, including bird species from pristine habitats neighbouring Project areas. Also considering that the Project takes place exclusively in historical farmland (i.e., European cropland for the past 10 years or more, see section 2.4.3), and that all participants are contractually obliged to respect all legislation applicable to Project implementation (including biodiversity protection regulations), no adverse effect to any rare, threatened or endangered species and/or habitats is expected to happen as a result of Project activities. Breaches and non-compliances are monitored and promptly addressed and can result in a farmer expulsion from the Project. To reiterate, the Project is introduced on already intensively managed croplands. Compared to conventional farming practices, Project activities exert less stress on local ecosystems. Therefore, the Project provides no additional stress to adjacent habitats or wildlife compared to a business-as-usual. Moreover, Project participants are contractually expected to respect inter-/national legislation and regulations applicable to Project implementation, including biodiversity policies. Habitats and species in EU countries (Denmark, Lithuania, Estonia, Latvia, Spain, Romania, and Bulgaria) are protected from the impacts of agriculture by each country's execution of the EU-level Habitat Directive⁵³, Birds Directive⁵⁴, Sustainable Use of Pesticides Directive⁵⁵, and Nitrate Directive.⁵⁶ Habitats and wildlife in non-EU countries (United
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⁵³ Council Directive 92/43/EEC

⁵⁴ Directive 2009/147/EC

⁵⁵ Directive 2009/128/EC

⁵⁶ Directive 91/676/EEC

	Kingdom, Ukraine, and Moldova) are protected by a range of specific national laws and regulations. In the UK, the Conservation of Habitats and Species Regulations (2017)⁵⁷ implements the EU Habitats and Birds Directives, safeguarding natural habitats and species through the establishment of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). Additionally, the Wildlife and Countryside Act 1981⁵⁸ provides comprehensive protection for wild birds, animals, and plants, and facilitates the designation of Sites of Special Scientific Interest (SSSIs). In Ukraine, Law No. 3055-III of 2002 on Red Book, lists and protects endangered species, while other laws, such as The Law of Ukraine on Flora⁵⁹, delineates protections of listed endangered species in accordance with international law. Moldova has a similar structure to Ukraine, with Law on the Red Book of the Republic of Moldova (Law No. 325-XVI of 15 December 2005) which is a national registry of all endangered and protected species. Laws in Moldova, such as the Animal Kingdom Law (No.439-XIII of April 27, 1995), the Vegetal Kingdom Law (No. 239 – XVI of November 8th, 2007), and the Wildlife Law (No.439), all have provisions for protection of listed species.
Areas needed for habitat connectivity	As explained in the previous row, Project implementation is not expected to have an adverse environmental effect on the areas surrounding the PAIs – on the contrary, it is expected to be less impacting than the business-as-usual scenario, where Project participants would have continued practicing conventional agriculture. MRV mechanisms, most notably satellite imagery and remote sensing, allow AgreeaCarbon to verify that (a) the size of a given PAI remains stable throughout the crediting period, and (b) that any new additions or expansions would be the result of lawful processes, not land encroachment and/or conversion of surrounding pristine areas that may be needed for habitat connectivity.

⁵⁷ <https://www.legislation.gov.uk/uksi/2017/1012/contents>

⁵⁸ <https://www.legislation.gov.uk/ukpga/1981/69>

⁵⁹ <https://faolex.fao.org/docs/pdf/ukr45800E.pdf>

Risks Identified		Mitigation or preventive measure(s) taken
Habitats for rare, threatened, and endangered species	No risk identified	Please refer to the previous table, where it is explained that the Project has not and cannot foreseeably negatively impact habitats for rare, threatened and endangered species
Areas for habitat connectivity	No risk identified	Please refer to the previous table, where it is explained how Project implementation has not and cannot foreseeably negatively impact natural areas necessary for habitat connectivity.

2.4.2 Introduction of species

Species introduced	Classification	Justification for use	Adverse effects and mitigation
N/A	N/A	N/A	N/A

The Project does not involve the planting of novel non-native species into the Project area. The crops eligible for participation are those historically reported in European farmland, those most commonly used for agricultural purposes across pan-European regions.⁶⁰ A complete list of the crop types admitted for use by Project participants has been provided in the Model Validation Report of the Project.⁶¹ The areas in which GHG certificates are generated grow annual row crops that are native or have been proven to be adapted to the agro-ecological zone. Many of these crops have been grown and cultivated in Europe since the prehistoric age, and that is the case for the 10 countries included in this Monitoring Report.⁶² Crop types are also thoroughly assessed, with only certain combinations of crop type, agroecological zone, and cultivation technique being accepted in the Project. For example, certain activities cannot be implemented simultaneously, i.e. cover crops and residue mulching. Crop type lists are curated by AgreeenaCarbon agronomists, and each new crop type is vetted before being added.

⁶⁰ FAOSTAT (2023): Production. Crops and livestock products. <https://www.fao.org/faostat/en/#data/QCL>

⁶¹ Agreeena (2023): Calibration and Validation Report. v 4.0. Appendix 6.1, Table 6.1. Issued 14/08/2023

⁶² Valamoti, S. M., Marinova, E., Heiss, A. G., Hristova, I., Petridou, C., Popova, T., ... & Ruseva, T. K. (2019). Prehistoric cereal foods of southeastern Europe: an archaeobotanical exploration. *Journal of Archaeological Science*, 104, 97-113.

That being said, many of the agricultural crops commonly used in the pan-European regions are technically non-native to the area.⁶³ However, none of the crop species eligible for Project participation are listed in the Invasive Alien Species Regulation (No 1143/2014) of the EU,⁶⁴ which governs the introduction of invasive species.⁶⁵ The law is aimed at preventing and managing the spread of non-native species that may harm ecosystems. It creates an EU-wide list of invasive species, restricts their import and movement, and requires countries to monitor, quickly eradicate new threats, and manage existing ones. Member States also develop national action plans and can make their own lists of harmful species specific to their regions. The UK and Moldova, although not a part of the EU, aligns itself to the EU Invasive Species Regulation to ensure effective management, prevention and mitigation. Ukraine manages invasive species through national legislation and international agreements that aim to protect local ecosystems from non-native threats.

By contract, all farmers that decide to join the Project must respect and abide by all applicable laws and regulations, which would therefore include measures to properly manage existing invasive agricultural species and avoid the introduction of novel alien species. Regulatory compliance helps prevent threats to native habitats and biotic communities stemming from Project implementation. Breaches and non-compliances are monitored, promptly addressed, and can result in a farmer expulsion from the Project. Find below more details on the existing agricultural invasive species present across the Project area, plus EU- and country-specific policies to effectively manage them.

Existing invasive species	Mitigation measures to prevent spread or continued existence of invasive species
PAIs are distributed across the UK, Moldova, Ukraine and seven EU Member States: Denmark, Bulgaria, Romania, Spain, Latvia, Lithuania and Estonia. The invasive alien species (IAS) present in EU countries are listed in	In the scientific literature, thriving native biodiversity is often indicated as a “natural control agent” against the spread of invasive alien species (IAS) thanks to the establishment of multiple antagonistic ecological interactions (e.g., predation, resource competition)

⁶³ Naithani S. (2021): The origin of crop plants. in: History and science of cultivated plants. Oregon State University. ISBN: 978-1-955101-08-0. <https://open.oregonstate.education/cultivatedplants/>

⁶⁴ Commission Implementing Regulation (EU) 2022/1203 of 12 July 2022 amending Implementing Regulation (EU) 2016/1141 to update the list of invasive alien species of Union concern. http://data.europa.eu/eli/reg_impl/2022/1203/oj

⁶⁵ Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. <http://data.europa.eu/eli/reg/2014/1143/oj>

the Union List⁶⁶, annex to the Alien Species Regulation.⁶⁷ The Union List was updated through the Commission Implementing Regulation (EU) 2017/1263⁶⁸ and Commission Implementing Regulation (EU) 2019/1262.⁶⁹ The Union List contains all the known IAS of concern at the EU level, developed also with IUCN support.⁷⁰ Often, member states create their own national lists of species considered locally invasive, including taxa that can be spread through the agricultural industry. Creating national lists of IAS of concern is undertaken by the non-EU countries included in the Project

between native and non-native taxa.^{97 98 99} By enhancing native biodiversity and farmland habitat quality¹⁰⁰, the regenerative farming practices supported by the Project can indirectly mitigate against the spread of alien species when compared to conventional, business-as-usual farming practices. This is particularly relevant considering that agricultural pests & pathogens in European landscapes are also non-native to the area, and can locally establish as IAS.

Regulatory compliance is the most direct way for the Project to mitigate the risks alien species can pose to native ecosystems and biodiversity. All ten countries in the Project area adopt inter-/national policies and laws to effectively manage and monitor the spread of IAS. By contractual duty, all Project participants must abide by all laws applicable to Project implementation, which would include farming-related requirements to effectively tackle invasive species. Examples of key national legislations on

⁶⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02016R1141-20220802&from=EN>

⁶⁷ Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. <http://data.europa.eu/eli/reg/2014/1143/oj>

⁶⁸ <https://eur-lex.europa.eu/legal-content/en/TXT/HTML/?uri=CELEX:32017R1263&from=LV>

⁶⁹ <https://eur-lex.europa.eu/legal-content/en/TXT/HTML/?uri=CELEX:32019R1262&from=LV>

⁷⁰ <https://iucn.org/our-work/topic/invasive-alien-species/invasive-alien-species-additional-external-resources> contains further list of IAS of EU concern

⁹⁷ <https://pmc.ncbi.nlm.nih.gov/articles/PMC8150874/#sec3-insects-12-00440>

⁹⁸ Michels (2022). Regenerative Agriculture Effects on Invertebrate and Bird Communities, and Insect-provided Ecosystem Services.

⁹⁹ <https://link.springer.com/article/10.1007/s10311-008-0147-0>

¹⁰⁰ Kovats, R.S., R. Valentini, L.M. Bouwer, E. Georgopoulou, D. Jacob, E. Martin, M. Rounsevell, and J.-F. Soussana, 2014: Europe. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1267-1326.

area as well. The Invasive Species Specialist Group (ISSG) regularly updates the Global Register of Introduced and Invasive Species (GRIIS), which presents validated and verified national checklists of IAS at the country and territory levels.^{71 72}

For lists of IAS at country level, please consult the related Supplementary Information document, which goes over several IAS databases including: Denmark^{73 74}; Bulgaria^{75 76 77};

or related to IAS management, monitoring, and preventative measures against agro-pests & pathogens spread are listed below.

Ukraine

- Law No. 1264-XII on environmental protection.¹⁰¹ Sets the framework for preventing and controlling invasive species
- Law No. 3348-XII on plant quarantine¹⁰²
- Order No. 731 of the Ministry of Agrarian Policy and Food¹⁰³

⁷¹ <https://www.gbif.org/publisher/cdef28b1-db4e-4c58-aa71-3c5238c2d0b5>

⁷² <https://www.nature.com/articles/sdata2017202>

⁷³ <https://www.gbif.org/dataset/ad5cba8c-45fb-428c-aafa-7ff013d0fdaf>

⁷⁴ <https://www.retsinformation.dk/eli/lta/2018/1285/#B4>

⁷⁵ https://invasiveplants.eu/wp-content/uploads/2019/04/national_legislation_IASBG.pdf

⁷⁶

https://www.researchgate.net/publication/312631601_Alien_species_in_Bulgaria_Policy_projects_research_and_awareness_raising_In_Rat_M_T_Trichkova_R_Scalera_R_Tomov_A_Uludag_Eds_First_ESENIAS_Report_State_of_the_Art_of_Invasive_Alien_Species_in_South-Ea

⁷⁷ <https://www.gbif.org/dataset/d015d9e7-9eed-47c6-a0cd-62c627ad1e8b>

¹⁰¹ <https://faolex.fao.org/docs/pdf/ukr45101.pdf>

¹⁰² <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC038316>

¹⁰³ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC170179>

Romania^{78 79 80}; Spain^{81 82 83}; Latvia^{84 85 86}; Lithuania^{87 88}; Estonia^{89 90 91}; UK^{92 93}; Moldova^{94 95}; Ukraine.⁹⁶ .

- Order No. 107 of the Ministry of Ecology and Natural Resources.¹⁰⁴
- Ukraine's Biodiversity Conservation Program involves plans for monitoring, early eradication of new threats, and management of established IAS.

Moldova

⁷⁸ <https://bdj.pensoft.net/article/119539/>

⁷⁹ <https://www.gbif.org/dataset/9f51fefe-3943-4d39-8939-dfe3d95db1f0>

⁸⁰ Universitatea din Bucuresti, Ministerul Mediului, Apelor si Padurilor (2023). Managementul adecvat al speciilor invazive din România, în conformitate cu Regulamentul UE 1143/2014 referitor la prevenirea și gestionarea introducerii și răspândirii speciilor alogene invazive. <https://invazive.ccmesi.ro/>.

⁸¹ <https://www.gbif.org/dataset/c7873d63-4c63-419f-8d84-a7a6cb29c5e8>

⁸² "Catálogo Español de Especies Exóticas Invasoras" can be accessed through <https://www.miteco.gob.es/es/biodiversidad/temas/conservacion-de-especies/especies-exoticas-invasoras/ce-eei-catalogo.html>

⁸³ <https://www.boe.es/eli/es/rd/2019/03/29/216/con>

⁸⁴ <https://www.gbif.org/dataset/c7056977-c11e-45d7-a348-11ff192a3cae>

⁸⁵ Can be accessed through <https://www.vaad.gov.lv/en/list-species>

⁸⁶ <https://gd.eppo.int/reporting/article-7634>

⁸⁷ <https://www.gbif.org/dataset/ced4b662-2201-4c55-b31b-fc5643a9a72f>

⁸⁸ Recent and thorough list available in the paper:

https://www.researchgate.net/publication/373603395_Invazines_ir_svetimzemes_rusys_Lietuvoje_-_Invasive_and_Alien_Species_in_Lithuania

⁸⁹ <https://cloud.gbif.org/griis/resource?r=griis-estonia>

⁹⁰ <https://www.riigiteataja.ee/akt/12828512>

⁹¹ <https://keskkonnaamet.ee/en/banned-alien-species-permits#plants> and more general information available at <https://keskkonnaamet.ee/en/wildlife-nature-protection/alien-species>

⁹² embedded in <https://www.gov.uk/guidance/invasive-non-native-alien-animal-species-rules-in-england-and-wales#non-native>

⁹³ included in <https://www.legislation.gov.uk/uksi/2019/527/contents>

⁹⁴ <https://www.gbif.org/dataset/1aac3463-39ee-4a81-81f0-0a5718b218f3>

⁹⁵ section 25 of <https://faolex.fao.org/docs/pdf/mol163161.pdf>

⁹⁶ <https://www.gbif.org/dataset/d006d8bb-cf1e-46ff-a054-c6768e23d86d/project>

¹⁰⁴ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC171940>

	• Government Decision No. HG624/2023 validating the National Climate Change Adaptation Program until 2030¹⁰⁵ • Law No. 228 On plant protection and phytosanitary quarantine¹⁰⁶ • Government Decree No. 558 On urgent measures in the phytosanitary area to prevent import and spreading of certain organisms that are harmful to plants and plants products¹⁰⁷ • Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and the Action Plan¹⁰⁸ • Regulation No. 14 of the Ministry of Ecology and Natural Resources validating the procedure for the issuance of permits for import and export of wild flora and wild fauna species.¹⁰⁹ UK • The invasive Alien Species (Enforcing and Permitting) Order 2019 No. 527¹¹⁰ • The Animal Health, Invasive Alien Species, Plant Breeders' Rights and Seeds (Amendment etc.) (EU Exit) Regulations 2019 No. 1220¹¹¹ • The Animal Health, Alien Species in Aquaculture and Invasive Non-native Species (Amendment) (EU Exit) Regulations 2019 No. 813¹¹²
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¹⁰⁵ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC224167>

¹⁰⁶ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC179371>

¹⁰⁷ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC178680>

¹⁰⁸ <https://faolex.fao.org/docs/pdf/mol163161.pdf>

¹⁰⁹ <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC092647>

¹¹⁰ <https://www.legislation.gov.uk/uksi/2019/527/contents>

¹¹¹ <https://www.legislation.gov.uk/uksi/2019/1220/contents>

¹¹² <https://www.legislation.gov.uk/uksi/2019/813/contents>

- The Animals, Aquatic Animal Health, Invasive Alien Species, Plant Propagating Material and Seeds (Amendment) (EU Exit) Regulations 2020 No. 1388¹¹³

EU countries implement the Invasive Alien Species Regulation (1143/2014)¹¹⁴, along with national legislation.

Denmark: BEK n3 1285 (12/11/2018) “Bekendtgørelse om forebyggelse og håndtering af introduktion og spredning af invasive ikkehjemmehørende arter på EU-listen og om en national liste med handelsforbud m.v. over for invasive arter”¹¹⁵

Bulgaria: НАЦИОНАЛНО ЗАКОНОДАТЕЛСТВО ЗА ИНВАЗИВНИТЕ ЧУЖДИ ВИДОВЕ (ИЧВ) във връзка с прилагането на Регламент (ЕС) № 1143/2014 относно предотвратяването и управлението на въвеждането и разпространението на инвазивни чужди видове¹¹⁶. For an overview, see Trichkova (et al.)¹¹⁷

Romania: Managementul adecvat al speciilor invazive din România, în conformitate cu Regulamentul UE 1143/2014 referitor la prevenirea și gestionarea introducerii și răspândirii speciilor alogene invazive. More information on ¹¹⁸

¹¹³ <https://www.legislation.gov.uk/ukxi/2020/1388/contents/made>

¹¹⁴ <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1483614313362&uri=CELEX:32014R1143>

¹¹⁵ <https://www.retsinformation.dk/eli/Ita/2018/1285/#B4>

¹¹⁶ https://invasiveplants.eu/wp-content/uploads/2019/04/national_legislation_IASBG.pdf

¹¹⁷

https://www.researchgate.net/publication/312631601_Alien_species_in_Bulgaria_Policy_projects_research_and_awareness_raising_In_Rat_M_T_Trachkova_R_Scalera_R_Tomov_A_Uludag_Eds_First_ESENIAS_Report_State_of_the_Art_of_Invasive_Alien_Species_in_South-Ea

¹¹⁸ <https://invazive.ccmesi.ro/>.

	Spain: Ley 42/2007¹¹⁹, Real Decreto 630/2013¹²⁰, Ley 7/2018¹²¹, Real Decrto 216/2019¹²² Latvia: Noteikumi nr. 467 - Invazīvo augu sugu izplatības ierobežošanas noteikumi¹²³; MK Noteikumi nr. 468 - Invazīvo augu sugu saraksts¹²⁴ Lithuania: Law on the Protected fauna, flora and fungi species and communities (No. VIII-499, 1997)¹²⁵ ; Order on the Approval of the Action Plan on the Conservation of Landscape and Biological Diversity for 2015-2022.¹²⁶ Estonia: Looduskaitseadus¹²⁷, and ad hoc management plans developed by the Estonian Environmental Board, for example against Himalayan balsam.¹²⁸
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Risks identified		Mitigation or preventative measure(s) taken
Invasive species	Invasive species of agricultural pests and pathogens may have an outbreak, disrupting crop production and Project activities implementation.	A significant percentage of pan-European agricultural pests are not native to the continent. ¹²⁹ The Project mitigates the occurrence of invasive pest and disease agents outbreaks, either from new or existing invasive alien species (IAS), directly through participants' regulatory compliance and indirectly by better supporting local and native biodiversity compared to business-as-usual,

¹¹⁹ <https://www.boe.es/eli/es/l/2007/12/13/42/con>

¹²⁰ <https://www.boe.es/eli/es/rd/2013/08/02/630/con>

¹²¹ <https://www.boe.es/eli/es/l/2018/07/20/7>

¹²² <https://www.boe.es/eli/es/rd/2019/03/29/216/con>

¹²³ <https://www.vvc.gov.lv/en/laws-and-regulations-republic-latvia-english/cab-reg-no-467-restricting-spread-invasive-plant-species>

¹²⁴ <https://www.vvc.gov.lv/en/laws-and-regulations-republic-latvia-english/cab-reg-no-468-list-invasive-plant-species>

¹²⁵ <https://e-seimas.lrs.lt/portal/legalActPrint/lt?jfwid=i3h7wep49&documentId=TAIS.111980&category=TAD>

¹²⁶ <https://www.cbd.int/doc/world/lt/lt-nbsap-v2-en.pdf>

¹²⁷ <https://www.riigiteataja.ee/akt/114112018008>

¹²⁸ <https://keskkonnaamet.ee/en/himalayan-balsam#state-controlled-era>

¹²⁹ Ward, N.L., and Masters, G.J., (2007). Linking climate change and species invasion: An illustration using insect herbivores.

		conventional farming practices. The basic tenets of ecology state that the more biodiverse an ecosystem, the harder it is (a) for extant IAS to expand its realised niche and (b) for new IASs to establish and spread within the ecosystem. The main underlying mechanisms are the antagonistic ecological dynamics (e.g., resource competition, parasitism, predation) that would be established with the thriving and abundant native species populations. The "natural enemies" of IAS can act as a biological control agents against pests and pathogens.¹³⁰ At the same time, crop diversification (e.g., from cover cropping) has been shown to reduce plant disease transmission.¹³¹ Please refer to the Non-Permanence Risk Report (NPRR) for a more complete discussion of how all Project activities not only better support existing biological communities but also are less impacting to biodiversity than conventional agricultural practices. All countries included in the Project area present regulations and policies to manage and prevent the spread of IAS across farmland systems. By contract, all Project participants are expected to abide by Project-applicable legislations, which would therefore include such IAS-related measures. The Plant Health Law (Regulation 2016/2031)¹³² sets out EU-level protective measures (e.g., plant quarantine) against agro-pests and pathogens outbreaks across Member States. The EU Invasive Alien Species Regulation (No 1143/2014)¹³³
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¹³⁰ Michels (2022). Regenerative Agriculture Effects on Invertebrate and Bird Communities, and Insect-provided Ecosystem Services

<https://link.springer.com/article/10.1007/s10311-008-0147-0>

¹³¹ <https://academic.oup.com/bioscience/article/61/3/183/238071>

<https://www.nature.com/articles/nature09575>

Devot, A., Royer, L., Arvis B., Deryng, D., Caron Giauffret, E., Giraud, L., Ayrat, V., and Rouillard, J. 2023, Research for AGRI Committee – The impact of extreme climate events on agriculture production in the EU, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels

¹³² <https://eur-lex.europa.eu/eli/reg/2016/2031/oj>

¹³³ Commission Implementing Regulation (EU) 2022/1203 of 12 July 2022 amending Implementing Regulation (EU) 2016/1141 to update the list of invasive alien species of Union concern. http://data.europa.eu/eli/reg_impl/2022/1203/oj

		governs management efforts to prevent the spread of harmful non-native taxa, creates a list of invasive species, and requires member states to monitor and eradicate new threats while managing existing ones. This regulation, to which both Moldova and the UK are aligned, intrinsically provides preventative measures against pest outbreaks. Ukraine has developed its own yet similar mechanisms for IAS control. ¹³⁴ Plus, all ten countries included in this Monitoring Period collaborate in the European and Mediterranean Plant Protection Organisation (EPPO). The EPPO is a central communication database with records of pests absent or present only in some of the EPPO countries, as well as an 'Alert List' to provide early warning systems. ¹³⁵ To conclude, there are policies and instruments setting out early detection, prevention and monitoring measures - such as phytosanitary inspections at European borders ¹³⁶ - that are enacted at a national level by the ten countries within the Project area to manage the risks of agricultural pests and disease outbreak.
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2.4.3 Ecosystem conversion

Risk Identified		Mitigation or preventative measure(s) taken
Ecosystem conversion	Project participation may encourage ecosystem clearing and conversion to arable land.	The Project area comprises only historical farmland: arable fields that have been such for the past 10 years or more across European landscapes. This is an eligibility criterion all prospective participants must meet. In other words, no PAI has been recently (i.e., in the 10 years prior to Project start date) cleared of native ecosystems. Ensuring that the Project does not foment the destruction of pristine habitats is an important aspect of monitoring efforts. At Validation, prospective participants need to provide a statement substantiating that the

¹³⁴ <https://faolex.fao.org/docs/pdf/ukr45101.pdf>

¹³⁵ [EPPO activities on plant quarantine](#)

¹³⁶ [Gaps in Border Controls Are Related to Quarantine Alien Insect Invasions in Europe | PLOS ONE](#)

		fields they wish to enrol are not located in an area that has been cleared from native habitats in the previous 10 years. As part of QA/QC process, AgreeenaCarbon checks participants' declarations against regional data and with remote sensing. Following approval of the location and field size, further checks are regularly performed per Monitoring Plan (section 4.3). The loss of forest canopy cover and of other natural ecosystems are checked over the course of the previous 10 years. If more than 0.5 ha of contiguous forest canopy cover¹³⁷ has been lost from a field in the last 10 years, then the field is flagged red. If more than 5% of the field area has been created from the loss of non-forest native ecosystems in the last 10 years, then the field is also flagged red. A proportional threshold of 5% is used for non-forested native ecosystems to account for likely noise and uncertainty around field boundaries. The latter can be 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 and native ecosystem clearing are performed using datasets produced by the Global Land Analysis and Discovery (GLAD) laboratory,¹³⁸ which are in turn derived from Landsat data. The GLAD datasets include annual tree deforestation (vegetation greater than 5 meters in height) and 5-yearly land cover change, which includes cropland and native ecosystem categories. Each PAI boundary is assessed against these two datasets to ensure that fields were not created by the clearing of forests or native ecosystems during
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¹³⁷ 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 meters.

<https://openknowledge.fao.org/server/api/core/bitstreams/531a9e1b-596d-4b07-b9fd3103fb4d0e72/content>

¹³⁸ 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 10 years prior to their enrolment in the AgreeenaCarbon Project.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The Project focuses on reducing agricultural GHG emissions through the implementation of defined cropland management practices that increase agricultural soils' carbon sequestration potential. As outlined in Section 1.1 of this document, Table 1-1, Project activities include:

Project Activities
Reducing tillage to lower soil disturbance and increase residue retention and carbon inputs
Leaving crop residues on top of the soil to improve nutrient cycling and soil quality
Planting a cover crop through the winter or all the way through to the next cash crop seeding to increase organic matter carbon inputs
Planting catch crops in between spring and winter crops
Reducing the rate of synthetic nitrogen fertiliser applied and switching to organic fertiliser (manure)

The Project reduces agricultural GHG emissions and increases removals through the implementation of the activities described above, which are rooted in the central principles of regenerative agriculture. The Project intends to help Project participants transition away from conventional, intensive agriculture and adopt said sustainable farming practices, which can maintain yields while ensuring long-term viability of their farms and land resources – most notably, agricultural soils. Regenerative agriculture describes holistic farming practices that improve soil fertility and enhance storage of soil organic carbon (SOC) while generating a suite of environmental

and ecological co-benefits.¹³⁹ Depending on country-level additionality, practices can be implemented individually or as a combined suite of activities.

In this verification period, comprising the monitoring cycles of HY 2022 and 2023 as well as the vintage years 2021, 2022, and 2023, all Project activities were implemented, albeit to differing extent, by Project participants. The AgreeenaCarbon platform is used to collect climatic data and data from Project participants, including land ownership, fuel use, PAI boundaries, historic farming practices (5-year lookback), soil type (sand, silt, clay), crop-types, tillage practise, residue management, cover/catch crop implementation and fertiliser inputs. The platform gathers and monitors data during farmer outreach, data collection, field inspections, soil sampling, internal data QA/QC, and remote sensing inspections, ensuring all data is accurate and correct for further use in modelling and quantification. Triangulating data sources supports high quality and consistency of measurement for the Project (see Section 5.3 Monitoring Plan of the AgreeenaCarbon PD v1.3).

In this reporting period, 40,571 PAIs covering 1,652,643.85 hectares reported their management practices across the vintage years 2021, 2022, and 2023. Both approved in QA/QC procedures by June 2024. The reported data went through the quality assurance process as described in section 4.3.1 of this document. Following the verification of these data, GHG emissions were calculated. Table 3-1 below summarises the main findings concerning the implementation status of Project activities across the monitoring period, represented in terms of their calendar year vintage.

Based on Table 3-1, it can be concluded that the main Project Activities implemented were reduced tillage and mulching of crop residues. An increase in other practices' implementation is expected in the coming years, as Project participants progress in their transition towards more regenerative practices.

Table 3-1. Implementation Status of Project Activities in 2021, 2022 & 2023.

Project Activity		% of Total Hectares		
		2021 Vintage	2022 Vintage	2023 Vintage
Tillage	No tillage	10.66%	20.85%	13.40%
	Reduced tillage	74.12%	77.73%	60.35%
	Conventional tillage	15.22%	1.41%	26.24%
	Mulched	100.00%	96.02%	94.71%

¹³⁹ FAO, 2021. Regenerative Agriculture: good practices for small-scale producers.
<https://www.fao.org/publications/card/en/c/CB6018EN/>

Residue Management	Removed	0.00%	3.98%	5.29%
Cover Crop Adoption	Catch crops	2.32%	0.90%	0.63%
	Cover crop until spring	2.09%	1.74%	2.06%
	Cover crop until winter	1.68%	2.17%	0.57%
	None	93.92%	95.19%	96.75%
Fertiliser application	No fertiliser	0.00%	8.10%	8.23%
	Organic only	0.00%	1.54%	1.52%
	Mixed	4.09%	4.81%	4.92%
	Synthetic only	95.91%	85.55%	85.33%

3.1.1 Carbon Stocks losses and reversals

During this monitoring period, no carbon stocks losses or reversals occurred. AgreeenaCarbon regularly reviews and aligns internally to meet the VCS Standards and *Registration and Issuance Process* requirements for dealing with emissions reversals. Being a grouped AFOLU project, The Project works to ensure no gaps between Monitoring Reports, and that an AFOLU pooled buffer account, containing non-tradable buffer credits, shall be set in place to compensate for eventual reversals at first VCU issuance.

3.2 Methodology Deviations

There are two methodology deviations with respect to VM0042 (v2.0). According to VM0042 guidance, Project data must be quantified using one of the three accepted Quantification Approaches, and it must be sourced as per Box 1 in VM0042 v2.0. Box 1 in VM0042 v2.0 outlines accepted sources of qualitative and quantitative data to be used for the Projects' baseline parameters.

3.2.1 Liming

The Project utilises Box 1 for the emission parameter 'Liming' in both baseline and Project activity ("field actuals"). The approach strictly applies the principle of conservativeness in sourcing field actuals, including for Liming.

Under normal circumstances, Project participants would answer qualitative questions about on-farm activity data during the contracted year for each field enrolled and registered in the AgreeenaCarbon platform. Qualitative questions include inquiries about the dominant ALM practices

implemented for each field or sampling unit on the farm. In the absence of farmer-reported data, Project activity emissions are quantified by the Project using the regional data provided by countries for the National Inventory Reports, which is 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, which utilises the most up-to-date methodologies established by the IPCC National Inventory Guidelines and Good Practice Guidelines.¹⁴⁰ The standardisation of reporting amongst different nations (i.e. the Common Reporting Format or CRF tables) ensures greater comparability of emissions and transparency on calculation estimates - i.e., the reported numerical information about national GHG fluxes.

Countries submit data on the quantity of lime (MLimestone,bsl,i,t MDolomite,bsl,i,t as well as MLimestone,wp,i,t MDolomite,wp,i,t), the emission factors (t CO₂-C/t) and the total emissions (kt CO₂e) from liming activity for the agricultural sector (Table 3.G-J). The CO₂ emissions from liming (CO₂_limebsl as well as CO₂_limewp; equation 9 in VM0042 v2.0) are calculated by dividing the total emissions (kt CO₂e) by the actual agricultural land area, referred to here as the “Cropland remaining Cropland” category (k ha, Table 4.B) to obtain the CO₂ emissions per unit area for each country (t CO₂e/ha).

As such, the regional figures for these parameters in the NIs have been reliably verified and validated by national authorities before being published. A second advantage of this approach for determining baseline scenarios is that it avoids gaps in data, and includes all emissions associated with the activity. This method for calculating activity emissions is therefore more robust and accurate in comparison to an alternative method of estimating lime CO₂ emissions under hypothetical scenarios. The principles of conservativeness and accuracy are applied to ensure no overestimation of GHG emission reductions and removals.

3.2.2 Potential leakage from diversion of biomass residues

The second deviation is associated with leakage from diversion of biomass residues such that the Project does not collect this information directly from the farmer but uses public data sources. With the VM0042 methodology, a project is required to estimate leakage due to diversion of biomass residues from other applications in year y ($LE_{BR,Div,y}$). Leakage here is quantified due to diversion of biomass residues to the Project to be 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

¹⁴⁰ Lokupitiya, E., & Paustian, K. (2006). Agricultural soil greenhouse gas emissions: a review of national inventory methods. *Journal of Environmental Quality*, 35(4), 1413-1427.

will be calculated according to Equation 15 in CDM Methodological Tool: Project and leakage emissions from biomass¹⁴¹. The quantification approach is further detailed in Appendix 6.

$$LE_{BR,Div,y} = EF_{CO2,LE} \times \sum_n BR_{PJ,n,y} \times NCV_{n,y} \quad \text{Equation (15)}$$

Where:

$LE_{BR,Div,y}$	= Leakage emissions due to the diversion of biomass residues from other applications in year y (t CO ₂ e)
$EF_{CO2,LE}$	= 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

3.2.3 Proposed monitoring plan for future harvest years

The Project going forward will collect qualitative and quantitative data from Project participants on how they utilise biomass residue. This will support the validation of how farmers have historically used crop residue produced on their fields (feed, animal bedding, burned, energy etc.) and what effect mulching has on use and fate of this residue. By collecting the biomass residue parameter (BR,PJ,n,y), in fields which had residue removed in the baseline and fields which reported mulched in the actuals, it is possible to estimate the potential leakage from diversion of biomass residue due to the implementation of mulching as a project activity.

3.2.4 Project Description Deviations

There are no Project Description Deviations for this verification period.

¹⁴¹ <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-16-v5.0.pdf>

3.3 Grouped Projects

Being the first Monitoring Report since Project inception and Validation, the PAIs included in this verification period are those that cover both the PAIs presented during validation, covering Vintages 2021 and 2022, as well as the addition of Vintage 2023 as this falls within the monitoring period and monitoring cycle of the Project. The addition of new PAIs in the Monitoring Report, relative to the Initial PAIs in the PD, are introduced in a sequential order, meaning that the new PAIs joined the project after the initial PAIs and report practices implemented earliest on Vintage 2023. The date of the new PAIs have therefore a date same or later than the grouped project start date. (See spreadsheet “VCS MR_AgreenaCarbon 4022_List of AgreenaCarbon Eligible Fields_5AUG2025_CommerciallySensitive”).

The PAIs that cover this verification period (Vintages 2021, 2022, and 2023) fulfil the same eligibility criteria as the ones set for initial PAIs laid out in Section 1.4.1 of the PD and Section 3.6.16 of the VCS Standard v4.7 for inclusion of new PAIs. This report demonstrates that these PAIs underwent the full assessment of the eligibility criteria and verified that all new PAIs are subject to the baseline scenario determined in the project description according to section 3.4 of the PD, and that all new activities are the same or alter than the grouped project start date (See “VCS MR_AgreenaCarbon 4022_List of AgreenaCarbon Eligible Fields_5AUG2025_CommerciallySensitive” spreadsheet provided as a separate attachment). Furthermore, all PAI have undergone the QA/QC process according to Section 5.3 of the PD and monitoring cycle as required by VCS v4.7. Every PAI annexed to the Project area throughout the monitoring period has been evaluated according to the Project eligibility criteria (see Figure 1-2 and Table 1-4 in the PD), and as the first instances outlined in the PD were assessed. The eligibility criteria have been developed in alignment to the VCS standard and VM0042 requirements.

For a prospective Project participant to be admitted in the Project, the PAI(s) they wish to enroll must meet the following eligibility criteria:

- 1) Must be located in one of the 10 eligible countries/geographic areas (GAs): Bulgaria; Denmark; Estonia; Latvia; Lithuania; Moldova; Romania; Spain; Ukraine; United Kingdom. These countries have been assessed against the 3-step additionality test prescribed by VM0042 and detailed fully in the PD. The outcome of the Common Practice Test also determines which Project-supported practices are additional in each GA, as explained in criteria (5). GA-level data (e.g., from national statistics) supplements missing field-level data for setting PAI-specific baseline and Schedule of Activities (SoA). The KML file showcases the exact geographic coordinates for all PAIs included throughout the three Vintage years, as detected by remote sensing models. Based on the eligibility check for PAIs entering the Project, the number of PAIs that were outside of the Project geography was 4389 PAIs (See “VCS MR_AgreenaCarbon

4022_List of AgreeenaCarbon Eligible Fields_5AUG2025_CommerciallySensitive” spreadsheet provided as a separate attachment).

- 2) Must comprise only historical farmland where no land use conversion took place for, at a minimum, the 10 years prior. Ensuring that no native ecosystem conversion occurred in the PAIs for at least 10 years as required under VM0042. AgreeenaCarbon verifies that no ecosystem conversion has occurred in the past 10 years or more in any of the PAIs included via remote-sensing models. This process has been described in detail in Section 4.3.1.7 as well as under 2.3.1 Ecosystem Conversion. Fields were assessed for no deforestation and no clearing of native ecosystems using separate datasets. The result of this assessment deemed 41 PAIs and 166 PAIs non-eligible for deforestation and native ecosystems, respectively (See “VCS MR_AgreeenaCarbon 4022_List of AgreeenaCarbon Eligible Fields_5AUG2025_CommerciallySensitive” spreadsheet provided as a separate attachment).
- 3) Must present distinct field boundaries from any other PAI included in the Project area. Analysts check every PAI’s geometries to ensure there is no overlapping of field boundaries, and the size of prospective PAIs is confirmed through remote sensing through field boundary detection. 536 PAIs were deemed non-eligible due to the field boundary check with the field boundary detection model (See “VCS MR_AgreeenaCarbon 4022_List of AgreeenaCarbon Eligible Fields_5AUG2025_CommerciallySensitive” spreadsheet provided as a separate attachment).
- 4) Must be able to implement at least one additional Project activity. The Common Practice Test, conducted at the GA-level, determines which ALM activities are additional for a given PAI. During onboarding, prospective Project participants are informed which practices they would have to adopt in order to be eligible for VCUs issuance. In Ukraine, Latvia and Lithuania, all Project-support practices are additional. In Denmark, Romania, Spain, and Moldova, organic fertiliser application is a common practice, so prospective participants located in these countries have to transition to at least one other Project activity. In Bulgaria and Estonia, reduced tillage is non-additional, whereas in the UK both reduced tillage and organic fertiliser use are non-additional. The full overview and results of the Common Practice Test can be found in Section 3.5.3 of the Project Description (PD). The eligibility check associated with one additional practice covers point (5) below as well and resulted in 6006 PAIs deemed non-eligible for participation (See “VCS MR_AgreeenaCarbon 4022_List of AgreeenaCarbon Eligible Fields_5AUG2025_CommerciallySensitive” spreadsheet provided as a separate attachment).
- 5) Must be implementing at least one improved practice compared to SoA and compatible with local GA additionality. If the PAI-specific historical SoA already includes an additional farming practice, the PAI-manager must adopt a further improved practice(s) to generate ERRs eligible for VCUs issuance. The implementation of Project activities is monitored and verified every harvest year as detailed in section 4.3 Monitoring Plan of the MR. See point (4) above.

- 6) Must not be participating in another carbon credit program. AgreeenaCarbon avoids the risk of double issuance by requesting prospective participant's declarations, demonstrations of land ownership and tenure for the area through remote-sensing imagery as well as internal checks to avoid any form of double-counting. No farmers are participating in another credit program and this is confirmed by farmer contracts declaring the same.
- 7) Must pass and be approved by the Quality Assurance (QA) and Quality Control (QC) flagging processes, detailed in sections 4.3.1.6, 4.3.1.7 and 4.3.1.8 of the MR. The goal of these processes is to not only assure eligibility as per VCS requirements, but also check the reliability of the data participants provide throughout the Monitoring Period, avoiding under-/over-estimation of ERRs. 360 PAIs were non-eligible as they did not undergo QA/QC processes (See "VCS MR_AgreeenaCarbon 4022_List of AgreeenaCarbon Eligible Fields_5AUG2025_CommerciallySensitive" spreadsheet provided as a separate attachment).

The PAIs presented in this verification period are within the estimate of overall growth for the Project. The relative estimate of VCU per hectare remains within the lines of the estimates presented in the initial instances. For more information on the estimates of ERRs for these PAIs please see Section 5.4.6 of this report.

During future verification cycles, additional PAIs, prospective participants, and respective country context will be assessed against the guidelines, requirements and standards set out by Verra before inclusion in the Project, so to ensure that all eligibility criteria are met.

3.4 Baseline Reassessment

Did the project undergo baseline reassessment during the monitoring period?

☐ Yes ☒ No

4 DATA AND PARAMETERS

See below the outlined parameters available at Validation, the parameters included during the monitoring, and the parameters which are not applicable to this verification period (included in a sub-section 'Not applicable for 2022 & 2023 Verification Period'). Non-applicable parameters are included for their potential inclusion in future reporting periods. The Project provides accompanying ERRs calculation inputs and outputs that apply the parameters below. The ERRs include a 'key' tab that connects the relevant parameters to the column headings within the ERR sheet. The ERRs are also uploaded to the Verra Registry as required by the VCS Standard v4.7.

4.1 Data and Parameters Available at Validation

The VM0042 (v2.0) parameters relevant to the Project are listed here. The data for these parameters are collected during the validation stage to calculate PAI baseline data. The parameters that are not relevant to Project, yet are included in the VM0042 methodology, are listed in Table 4-1.

Data / Parameter	AR				
Data unit	Percent				
Description	Weighted mean adoption rate				
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	12.31%	1.48%	6.13%	1.45%

	Kingdom				
	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 the project. (See Table 3-10 of AgreeenaCarbon PD v1.3).					
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 of AgreeenaCarbon PD v1.3. 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
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 3-9 of AgreeenaCarbon PD v1.3)						
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. AgreeenaCarbon 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
Source of data	The area is determined based on detected field size, per remote sensing field boundary detection model.
Value applied	Hectares Value is corrected after monitoring of input data to the most conservative value. The QC procedure for determining area uses satellite imagery to check field boundaries and is expanded on in Section 4.3 Monitoring Plan of this document.
Justification of choice of data or description of measurement methods and procedures applied	For each country in the AgreeenaCarbon 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.

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 AgreeenaCarbon Project it is possible to stack practices as described in VM0042 v2.0. Therefor 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
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	At verification, the qualitative data is refined to use 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
Source of data	Box 1, option 4 in VM0042 v2.0. Peer-reviewed published data ^{142, 143, 144}
Value applied	Average consumption amount per ha for each fuel type in all the PAIs in the baseline in AgreeenaCarbon Project Diesel: 98.2 ± 6.2 l/ha
Justification of choice of data or description of measurement methods and procedures applied	For ex-post baseline 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 AgreeenaCarbon PD v1.3. Peer-reviewed published data are used to determine baseline fuel consumption which matches the baseline tillage system types. The values from reference ¹⁴⁵ were chosen for FFC _{bsl} as a conservative

¹⁴² 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.

¹⁴³ 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>

¹⁴⁴ 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.

¹⁴⁵ 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>

	midpoint between the minimum and maximum values (72-161 l/ha) estimated in the extensive EU studies^{146, 147, 148}. At verification, for current and future project instances, qualitative data on the tillage system type were refined using farmer reported data for every PAI i, and quantitative information of fuel consumption amounts are 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 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.						
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 AgreeenaCarbon Project <table border="1"> <thead> <tr> <th>Fossil fuel type (i)</th><th>FFC_{wp} (l/ha)</th></tr> </thead> <tbody> <tr> <td>Diesel</td><td>50 ± 18</td></tr> <tr> <td>Gasoline</td><td>70 ± 0</td></tr> </tbody> </table>	Fossil fuel type (i)	FFC_{wp} (l/ha)	Diesel	50 ± 18	Gasoline	70 ± 0
Fossil fuel type (i)	FFC_{wp} (l/ha)						
Diesel	50 ± 18						
Gasoline	70 ± 0						

¹⁴⁶de 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>

¹⁴⁷ 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.

¹⁴⁸ 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>

Justification of choice of data or description of measurement methods and procedures applied	For the ex-post 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>i</i> .
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	$EF_{CO2,j, bsl} / EF_{CO2,j, wp}$
Data unit	t CO ₂ e/l
Description	Emission factor for the type of fossil fuel <i>j</i> (gasoline or diesel) combusted
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” ¹⁴⁹ .
Value applied	Where <i>j</i> = gasoline, $EF_{CO2,j} = 0.002810$ t CO ₂ e per liter. Where <i>j</i> = diesel, $EF_{CO2,j} = 0.002886$ t CO ₂ e 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. ¹⁵⁰

¹⁴⁹ IPCC (2019). <https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol2.html>

¹⁵⁰ IEA (2004). Energy statistics manual. IEA. Available at: <https://www.iea.org/reports/energy-statistics-manual-2>

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
Source of data	Section 11.3, Chapter 11, Volume 4 in the 2019 Refinement to the 2006 IPCC National Greenhouse Gas Inventories ¹⁵¹
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

¹⁵¹ https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf

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 ¹⁵² . 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 scenario period is set as 2021.			
Value applied	Regional data for the application rates (t/ha) of limestone / dolomite			
	Country	2016-2020 (Baseline)		2021 (Project scenario)
		$M_{Limestone, bsl, i, t}$	$M_{Dolomite, bsl, i, t}$	$M_{Limestone, wp, i, t}$
	Bulgaria	55817	0	55994
	Denmark	498705	5	616005
	Estonia	33330	3125	50848
	Latvia	59510	23910	119000
	Lithuania	35029	4618	128725
	Moldova*	109920	5002	150368
	Romania	109920	5002	150368
				260

¹⁵² National Inventory submissions for Annex countries were obtained from the UNFCCC website <https://unfccc.int/ghg-inventories-annex-i-rties/2023>

	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 in Chapter 3.6 of AgreeaCarbon PD v1.3. The amount of calcitic limestone and dolomite applied to the PAI <i>i</i> in year <i>t</i> is calculated by multiplying the regional application rates (t/ha) of calcitic limestone and dolomite by the area size (ha) of the PAI <i>i</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 Reports¹⁵³. 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 CO₂ 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				

¹⁵³ National Inventory submissions for Annex I countries were obtained from here <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

	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 UNFCCC. However, the NIR submitted by Moldova to the UNFCCC in 2023 does not contain information on CO₂ emissions from liming. The Project has 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 Ukraine¹⁵⁴ 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

¹⁵⁴ 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>).

	t/ha) ^{155, 156} were calculated to be 25-30% of the rates used in Romania (5-9 t/ha) ^{157, 158} . 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 of AgreeCarbon PD v1.3 for additional information).
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Data / Parameter	EL_{bsl} / EL_{wp}		
Data unit	ktCO2e		
Description	CO ₂ emissions from liming to PAI <i>i</i> in year <i>t</i> .		
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 ¹⁵⁹		
Value applied	CO ₂ emissions from liming in each country (ktCO2e)		
	Country	2016-202 (Baseline)	202 (Project scenario)
	Bulgaria	123	123
	Denmark	1097	1355
	Estonia	81	142

¹⁵⁵ 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>.

¹⁵⁶ Zapko, Yuriy, Karina Desyatnik, and Yuriy Dmytruk. "Assessment of changes of some functions of Ukrainian acid soils after chemical amelioration." Soil Science Annual 65.3 (2014): 111.

¹⁵⁷ 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.

¹⁵⁸ Nita, L., Grozav, A., & Rogobete, G. (2019). Natural and Anthropogenic Soil Acidification in the West of Romania. Jurnal revista de Chimie Volumul, 70, 2237-2240.

¹⁵⁹ National Inventory submissions for Annex I countries were obtained from the UNFCCC website <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

	Latvia	188	369
	Lithuania	88	285
	Moldova*	254	331
	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.			
Justification of choice of data or description of measurement methods and procedures applied	See the methodology deviation for liming emissions in Chapter 3.6 of AgreeCarbon PD v1.3.		
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 <i>MLimestone,bsl,i,t</i> and <i>MDolomite,bsl,i,t</i> / <i>MLimestone,wp,i,t</i> and <i>MDolomite,wp,i,t</i> .		

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
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 ¹⁶⁰																																			
Value applied	<table><tr><td>Country</td><td>A_{bsl}</td><td>A_{wp}</td></tr><tr><td>Bulgaria</td><td>3161</td><td>3174</td></tr><tr><td>Denmark</td><td>2669</td><td>2631</td></tr><tr><td>Estonia</td><td>924</td><td>922</td></tr><tr><td>Latvia</td><td>1299</td><td>1291</td></tr><tr><td>Lithuania</td><td>1282</td><td>1334</td></tr><tr><td>Moldova*</td><td>NA</td><td>NA</td></tr><tr><td>Romania</td><td>4793</td><td>4139</td></tr><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>			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	Spain	17507	17272	Ukraine	34759	34756	United Kingdom	3601	3550
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																																		
Spain	17507	17272																																		
Ukraine	34759	34756																																		
United Kingdom	3601	3550																																		
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Justification of choice of data or description of measurement methods and procedures applied	See the methodology deviation for liming emissions in Chapter 3.6 of AgreeaCarbon PD v1.3.																																			
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 <i>MLimestone,bsl,i,t</i> and <i>MDolomite,bsl,i,t</i> / <i>MLimestone,wp,i,t</i> and <i>MDolomite,wp,i,t</i> .																																			
Data / Parameter	<i>FSN_{bsl,i,t}</i>																																			
Data unit	t N																																			

¹⁶⁰ National Inventory submissions for Annex I countries were obtained from the UNFCCC website <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

Description	N inputs from N containing synthetic fertiliser applied for PAI <i>i</i> in year <i>t</i> in the baseline		
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 v1.0 ¹⁶¹ and Eurostat (<i>lan_lcv_ovw</i>) ¹⁶² databases.		
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

¹⁶¹

https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772

¹⁶² https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw_custom_12738492/default/table

	Cumulative N inputs from N containing synthetic fertiliser in all the PAIs in the baseline per year (t N/ year) in AgreeenaCarbon 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	At verification, for current and future project instances, the data was 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 were 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 of AgreeenaCarbon PD v1.3).	
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, mean values collected in the project area	
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 v1.0 ¹⁶³ and Eurostat (<i>lan_lcv_ovw</i>) ¹⁶⁴ databases.																																							
Value applied	Regional data for baseline application rates of organic fertiliser (tN/ha): <table><tr><th>Country</th><th>Organic fertiliser application rate (tN/ha) if only organic fertiliser is applied</th><th>Organic fertiliser application rate (tN/ha) if mixed fertiliser is applied</th></tr><tr><td>Bulgaria</td><td>0.104</td><td>0.052</td></tr><tr><td>Denmark</td><td>0.144</td><td>0.072</td></tr><tr><td>Estonia</td><td>0.104</td><td>0.052</td></tr><tr><td>Latvia</td><td>0.104</td><td>0.052</td></tr><tr><td>Lithuania</td><td>0.104</td><td>0.052</td></tr><tr><td>Moldova</td><td>0.104</td><td>0.052</td></tr><tr><td>Romania</td><td>0.1049</td><td>0.052</td></tr><tr><td>Spain</td><td>0.1541</td><td>0.077</td></tr><tr><td>Ukraine</td><td>0.104</td><td>0.052</td></tr><tr><td>United Kingdom</td><td>0.1697</td><td>0.085</td></tr></table> Cumulative N inputs from N containing organic fertiliser in all the PAIs in the baseline per year (t N/ year) in AgreenaCarbon Project <table><tr><th>Fertiliser type</th><th>$FON_{bsl,t}$</th></tr><tr><td>Only organic</td><td>4260</td></tr><tr><td>Mixed</td><td>308</td></tr></table>	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	Fertiliser type	$FON_{bsl,t}$	Only organic	4260	Mixed	308
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																																						
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Fertiliser type	$FON_{bsl,t}$																																							
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¹⁶³https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772

¹⁶⁴https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw_custom_12738492/default/table

	Only synthetic	0
Justification of choice of data or description of measurement methods and procedures applied	At verification, for current and future project instances, the data was 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 of AgreeaCarbon PD v1.3).	
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 fertilizer applied for sample unit i in the project scenario from the initial project instances, mean values collected in the project area	
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-post 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>i</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>i</i> in the project scenario from the initial project instances, the mean values are collected in the project area.								
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) <table border="1"> <tr> <td>Fertiliser type</td><td>$FON_{wp,i,t}$</td></tr> <tr> <td>only organic</td><td>797</td></tr> <tr> <td>mixed</td><td>1908</td></tr> <tr> <td>only synthetic</td><td>0</td></tr> </table>	Fertiliser type	$FON_{wp,i,t}$	only organic	797	mixed	1908	only synthetic	0
Fertiliser type	$FON_{wp,i,t}$								
only organic	797								
mixed	1908								
only synthetic	0								
Justification of choice of data or description of	At verification, for current and future project instances, the data is refined using farmer reported data for every PAI <i>i</i> .								

measurement methods and procedures applied	
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	OF_{bsl} / OF_{wp}
Data unit	Dimensionless
Description	Type of organic N fertilizer
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 (<i>faostat_esb</i>). 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	At verification, the qualitative data is refined using farmer reported data for every PAI <i>i</i> .
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$M_{bsl,OF,i,t}$
------------------	------------------

Data unit	t fertilizer								
Description	Mass of N-containing organic fertiliser type OF applied to PAI <i>i</i> in year <i>t</i> in the baseline								
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), average value collected in the project area <table border="1"> <tr> <td>Fertiliser type</td><td>$M_{bsl,OF,i,t}$</td></tr> <tr> <td>only organic</td><td>1528462</td></tr> <tr> <td>mixed</td><td>106983</td></tr> <tr> <td>only synthetic</td><td>0</td></tr> </table>	Fertiliser type	$M_{bsl,OF,i,t}$	only organic	1528462	mixed	106983	only synthetic	0
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	At verification, for current and future project instances, the data is 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 was 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 of AgreeenaCarbon PD v1.3).								
Purpose of Data	Calculation of baseline emissions								
Comments	None								

Data / Parameter	$M_{wp,OF,i,t}$
Data unit	t fertilizer
Description	Mass of N-containing organic fertiliser type OF applied in the project for PAI <i>i</i> in year <i>t</i> in the project scenario from the initial project instances

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) <table> <tr> <td>Fertiliser type</td><td>$M_{wp,OF,i,t}$</td></tr> <tr> <td>only organic</td><td>91412</td></tr> <tr> <td>mixed</td><td>359491</td></tr> <tr> <td>only synthetic</td><td>0</td></tr> </table>	Fertiliser type	$M_{wp,OF,i,t}$	only organic	91412	mixed	359491	only synthetic	0
Fertiliser type	$M_{wp,OF,i,t}$								
only organic	91412								
mixed	359491								
only synthetic	0								
Justification of choice of data or description of measurement methods and procedures applied	At verification, the data is refined using farmer reported data for every PAI i .								
Purpose of Data	Calculation of project emissions								
Comments	None								

Data / Parameter	$NC_{OF,bsl} / NC_{OF,wp}$
Data unit	t N/t fertilizer
Description	N fraction of organic fertilizer OF
Source of data	Peer-reviewed published data (see listed references). ¹⁶⁵

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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 fertilizer 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.

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
	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	

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., Albuquerque, 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.

Data / Parameter	$GWP_{N2O,bsl} / GWP_{N2O,wp}$
Data unit	t CO ₂ e / t N ₂ O
Description	Global warming potential for N ₂ O
Source of data	IPCC Fifth Assessment Report ¹⁶⁶
Value applied	265
Justification of choice of data or description of measurement methods and procedures applied	See source of data above. N ₂ O 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 N ₂ O-N/t N applied
Description	Emission factor for direct nitrous oxide emissions from N additions from synthetic fertilizers, organic amendments and crop residues
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 ₂ O-N emissions from the addition from synthetic and organic fertilisers plus crop residue across multiple regions that is time-invariant.

¹⁶⁶ 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.

Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$EF_{Nvolat,bsl} / EF_{Nvolat,wp}$
Data unit	t N ₂ O-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
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 ₂ O-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 ₂ O-N/t N leached and runoff
Description	Emission factor for nitrous oxide emissions from leaching and runoff
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 ₂ O-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	$Frac_{GASF,I,S,bsl} / Frac_{GASF,I,S,wp}$
Data unit	Dimensionless
Description	Fraction of all synthetic N added to soils that volatilizes as NH ₃ and NO _x
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 ₂ O-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	$Frac_{GASM,I,S,bsl} / Frac_{GASM,I,S,wp}$
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
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	$Frac_{LEACH,i,S,bsl} / Frac_{LEACH,i,S,wp}$
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
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
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 (<i>faostat_qcl</i>) ¹⁶⁷ and Eurostat (<i>apro_cp</i> ; <i>apro_acs</i>) ¹⁶⁸ 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) <table><tr><td><i>MB</i></td><td><i>MB_{g,bsl,i,t}</i></td><td><i>MB_{g,wp,i,t}</i></td></tr><tr><td><i>Above-ground</i></td><td>17212</td><td>111020</td></tr><tr><td><i>Below-ground</i></td><td>45048</td><td>50817</td></tr></table>	<i>MB</i>	<i>MB_{g,bsl,i,t}</i>	<i>MB_{g,wp,i,t}</i>	<i>Above-ground</i>	17212	111020	<i>Below-ground</i>	45048	50817
<i>MB</i>	<i>MB_{g,bsl,i,t}</i>	<i>MB_{g,wp,i,t}</i>								
<i>Above-ground</i>	17212	111020								
<i>Below-ground</i>	45048	50817								
Justification of choice of data or description of measurement methods and procedures applied	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, 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-post 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 AgreeenaCarbon PD v1.3; 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.									

¹⁶⁷ <https://www.fao.org/faostat/en/#data/QCL>

¹⁶⁸

https://ec.europa.eu/eurostat/databrowser/view/apro_cpshr/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.apro_cpshr

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
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 (<i>faostat_qcl</i>). 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-post 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 AgreeaCarbon PD v1.3; 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.
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
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
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 (<i>faostat_qcl</i>) ¹⁶⁹ and Eurostat (<i>apro_cp</i> ; <i>apro_acs</i>) ¹⁷⁰ databases.

¹⁶⁹ <https://www.fao.org/faostat/en/#data/QCL>

¹⁷⁰

https://ec.europa.eu/eurostat/databrowser/view/apro_cpshr/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.apro_cpshr

	$P_{wp,p}$: 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-post 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 (<i>faostat_qcl</i>) and Eurostat (<i>apro_cp</i> ; <i>apro_acs</i>) databases, covering the 5-year baseline SoA preceding the Project start date, from 2017 to 2021.
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
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 (<i>fao_all_data_prod</i>) ¹⁷¹ and complemented by

¹⁷¹ <https://www.fao.org/faostat/en/#data/QCL>

	datasets provided by Eurostat (<i>apro_cshr</i>) ¹⁷² . The annual crop yield data is sourced from farmer-reported data.
Value applied	Baseline data: Box 1, option 4 in VM0042 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>I declare that the information I have provided about my fields is true and correct</i> ”
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
Source of data	Farmer collected data prior to validation which is checked during QA against remote sensing data.
Value applied	479,834.1 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 4.3 Monitoring Plan of this document.

¹⁷²

https://ec.europa.eu/eurostat/databrowser/view/apro_cpshr/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.p.apro_cpshr

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 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.
Equations	Equation 6 (VM0042)
Source of data	The carbon pools are derived from direct soil measurements for the ex-post calculations. Mean soil carbon pools in project area:

Value applied	Carbon pool	Baseline (tC/ha)	Project (tC/ha)
	DPM	0.41	0.50
	RPM	7.52	7.83
	BIO	1.04	1.07
	HUM	41.32	41.37
	IOM	4.73	4.73
	Justification of choice of data or description of measurement methods and procedures applied		
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)
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 (<i>ef_mp_soil</i> ; <i>sc_cov_intcr</i>).										
	<i>Green cover_{wp, l, t}</i> : Farm attestation										
Value applied	<table border="1"> <thead> <tr> <th>Cover crop adoption</th><th>Green cover months</th></tr> </thead> <tbody> <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> </tbody> </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;	Cover crop adoption	Green cover months	none	4 months	winter	5 months	spring	9 months	catch	10 months
Cover crop adoption	Green cover months										
none	4 months										
winter	5 months										
spring	9 months										
catch	10 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-post 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 (<i>ef_mp_soil</i>; <i>sc_cov_intcr</i>) as described in Table 3-4 of AgreeenaCarbon PD v1.3.										
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	k_{bsl} / k_{wp}
Data unit	Unitless
Description	The parameter k_s 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.
Source of data	The k_s 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 ^{173, 174} .
Value applied	$k_{DPM} = 10$ $k_{RPM} = 0.3$ $k_{BIO} = 0.66$ $k_{HUM} = 0.02$ $k_{IOM} = 0$
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	ln_{bsl} / ln_{wp}
Data unit	tC/ha

¹⁷³ Sierra, C. A., Müller, M., and Trumbore, S. E. (2012). Models of soil organic matter decomposition: the SoilR package, version 1.0. Geoscientific Model Development, 5, 1045–1060. <https://doi.org/10.5194/gmd-5-1045-2012>

¹⁷⁴ Coleman, K., and Jenkinson, D. S. (1996). RothC-26.3 – A Model for the turnover of carbon in soil. In Powlson, D. S., Smith, P., and Smith, J. U. (eds.), Evaluation of Soil Organic Matter Models Using Existing Long-Term Datasets, NATO ASI Series I, vol. 38, Springer, Berlin, Heidelberg, pp. 237–246. https://doi.org/10.1007/978-3-642-61094-3_17

Description	The parameter 'In' represents the annual input of organic carbon to the soil. This includes carbon inputs from mulching plant residues.
Source of data	Farmer attestations
Value applied	$In_{bsl} : 0.13 \pm 0.34 \text{ tC/ha}$ $In_{wp} : 0.59 \pm 0.42 \text{ tC/ha}$
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 ¹⁷⁵ 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.
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.		
Source of data	Farm attestations		
Value applied	The mean 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

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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)

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:

$$FYM = Mo_{F,i,t} \times CC_{oF,i,t}$$

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
Source of data	SoilGrids
Value applied	$clay_{bsl} : 30.9 \pm 9.8\%$ $clay_{wp} : 30.9 \pm 9.8\%$
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).
Source of data	The values used for DR are the default parameters based on foundational studies ^{176, 177} conducted at Rothamsted Research for the development of the RothC model.

¹⁷⁶ https://journals.lww.com/soilsci/abstract/1977/05000/the_turnover_of_soil_organic_matter_in_some_of_the.5.aspx

¹⁷⁷ 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.

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	$Temperature_{bsl} / Temperature_{wp}$																			
Data unit	°C																			
Description	Monthly average surface temperature																			
Source of data	The monthly average temperature data comes from synthetic weather stations located within 50 km of the modeled 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 modeling applications.																			
Value applied	<table border="1"> <thead> <tr> <th>Months</th><th>$Temperature_{bsl}$ (°C)</th><th>$Temperature_{wp}$ (°C)</th></tr> </thead> <tbody> <tr> <td>January</td><td>-2.70 ± 3.78</td><td>-2.70 ± 3.78</td></tr> <tr> <td>February</td><td>-1.21 ± 3.47</td><td>-1.21 ± 3.47</td></tr> <tr> <td>March</td><td>3.26 ± 2.69</td><td>3.26 ± 2.69</td></tr> <tr> <td>April</td><td>9.19 ± 2.12</td><td>9.19 ± 2.12</td></tr> <tr> <td>May</td><td>15.04 ± 2.59</td><td>15.04 ± 2.59</td></tr> </tbody> </table>		Months	$Temperature_{bsl}$ (°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
Months	$Temperature_{bsl}$ (°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 ¹⁷⁸ project, is chosen for its high resolution, global consistency, and confiability 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 _{bsl} / Precipitation _{wp}
Data unit	mm
Description	Monthly precipitation

¹⁷⁸ 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.

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	$Precipitation_{bsl}$ (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
	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														
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	<table><tr><th>Months</th><th><i>Evapotranspiration_{,bsl}</i> (mm)</th><th><i>Evapotranspiration_{, wp}</i> (mm)</th></tr><tr><td>January</td><td>0.43 ± 1.70</td><td>0.43 ± 1.70</td></tr><tr><td>February</td><td>0.97 ± 3.32</td><td>0.97 ± 3.32</td></tr><tr><td>March</td><td>5.40 ± 6.73</td><td>5.40 ± 6.73</td></tr></table>			Months	<i>Evapotranspiration_{,bsl}</i> (mm)	<i>Evapotranspiration_{, wp}</i> (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
Months	<i>Evapotranspiration_{,bsl}</i> (mm)	<i>Evapotranspiration_{, wp}</i> (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.								
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 et al (2022). ¹⁷⁹								
Value applied	<table border="1"> <thead> <tr> <th>Tillage</th><th>TRM</th></tr> </thead> <tbody> <tr> <td>Conventional tillage</td><td>1</td></tr> <tr> <td>Reduced tillage</td><td>0.93</td></tr> <tr> <td>No tillage</td><td>0.95</td></tr> </tbody> </table>	Tillage	TRM	Conventional tillage	1	Reduced tillage	0.93	No tillage	0.95
Tillage	TRM								
Conventional tillage	1								
Reduced tillage	0.93								
No tillage	0.95								
Justification of choice of data or description of measurement methods and procedures applied	The projections for the ex-post 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 were reported by the farmers followed by a signed attestation for every PAI <i>i</i> .								
Purpose of Data	Calculation of baseline and project emissions								
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 sample unit <i>i</i> in year <i>t</i> under the baseline and Project scenarios

¹⁷⁹ 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>

Source of data	Modeled and measured in the project area
Value applied	$SOC_{bsl,i,t} : 55.07 \pm 17.30 \text{ t C/ha}$ $SOC_{wp,i,t} : 55.27 \pm 17.33 \text{ t C/ha}$
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. $SOC_{i,t} = fSOC_{i,t}(t, DPM_{i,t}, RPM_{i,t}, BIO_{i,t}, HUM_{i,t}, IOM_{i,t}, \text{Cover Crop adoption}_{i,t}, Ks_{i,t}, In_{i,t}, FYM_{i,t}, \text{clay}_{i,t}, Temp_{i,t}, Prec_{i,t}, \text{Evap}_{i,t}, TRM_{i,t})$ <i>Where:</i> $SOC_{i,t}$: Modeled carbon dioxide emissions from soil organic carbon pool in the project scenario for PAI <i>i</i> at time <i>t</i> (tC /ha) $fSOC_{i,t}$: Functional representation of the RothC model for PAI <i>i</i> and time <i>t</i>. $DPM_{i,t}$: Decomposable Plant Material for PAI <i>i</i> at time <i>t</i>. $RPM_{i,t}$: Resistant Plant Material for PAI <i>i</i> at time <i>t</i>. $BIO_{i,t}$: Microbial Biomass for PAI <i>i</i> at time <i>t</i>. $HUM_{i,t}$: Humified Organic Matter for PAI <i>i</i> at time <i>t</i>. $IOM_{i,t}$: Inert Organic Matter for PAI <i>i</i> at time <i>t</i>. $\text{Cover Crop adoption}_{i,t}$: Adoption of cover crops for PAI <i>i</i> at time <i>t</i>. $Ks_{i,t}$: Soil organic carbon decomposition rate for PAI <i>i</i> at time <i>t</i>. $In_{i,t}$: Plant biomass carbon inputs for PAI <i>i</i> at time <i>t</i>. $FYM_{i,t}$: Application of farmyard manure for PAI <i>i</i> at time <i>t</i>. $\text{clay}_{i,t}$: Clay content in the soil for PAI <i>i</i> at time <i>t</i>. $Temp_{i,t}$: Temperature for PAI <i>i</i> at time <i>t</i>. $Prec_{i,t}$: Precipitation for PAI <i>i</i> at time <i>t</i>. $Evap_{i,t}$: Evaporation for PAI <i>i</i> at time <i>t</i>. $TRM_{i,t}$: Tillage rate modifier unit <i>i</i> at time <i>t</i>. 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 7 of AgreeCarbon PD v1.3 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	$M_{OA_{wp,i,t}}$
Data unit	tonnes
Description	Mass of organic amendment applied as fertilizer on the project area in year t
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-post calculations, the mass of organic amendment is determined by the organic amendment mass of the initial project instances for the first year in the project obtained 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	$CC_{bsl,i,t} / CC_{wp,i,t}$
Data unit	%

Description	Carbon content of organic amendment applied as fertilizer in the project area in year t											
Source of data	Carbon content of manure is derived from peer-reviewed published data (see reference list ¹⁸⁰).											
Value applied	<table><tr><td>Manure</td><td>Carbon content (%)</td></tr><tr><td>Broiler/Turkey litter</td><td>22.78</td></tr><tr><td>Cattle Digestate - 0.26%N</td><td>0.83</td></tr><tr><td>Cattle digestate - 0.6% N</td><td>5.9</td></tr><tr><td>Cattle manure</td><td>9.26</td></tr></table>		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
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											

¹⁸⁰ 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 fertilizer 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

	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
	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 CO ₂ / GJ		
Description	Emission factors of coal, oil and natural gas		
Source of data	Table 2.2, Chapter 2, Volume 2 in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories ¹⁸¹ . National energy statistics for each country were obtained from the International Energy Agency ¹⁸² .		
Value applied	For coal, $EF_{coal} = 0.0946$ t CO ₂ / GJ; for oil, $EF_{oil} = 0.0741$ t CO ₂ / GJ; for natural gas, $EF_{gas} = 0.0561$ t CO ₂ / GJ		
Justification of choice of data or description of measurement methods and procedures applied	Countries	Most common fossil fuel source	Emission factor (tCO ₂ e/GJ)

¹⁸¹ https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

¹⁸² <https://www.iea.org/countries>

	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
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.
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	The amount of biomass residues for each sampling unit is calculated using equations in the IPCC (2019) Refinement

measurement methods and procedures applied	guidelines ¹⁸³ applied over the average crop yields for each baseline scenario. For the ex-post calculations, the values are calculated by averaging the reported crop yields of farmers for the first year of the project for every PAI <i>i</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
Source of data	Teagasc Agriculture and Food Development Authority ¹⁸⁴ ; Danish Energy Agency ¹⁸⁵
Value applied	14.425
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

¹⁸³ 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)

¹⁸⁴ https://www.teagasc.ie/media/website/publications/2010/868_StrawForEnergy-1.pdf

¹⁸⁵ https://ens.dk/sites/ens.dk/files/Statistik/metode_halm.pdf

Comments	None
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Not Applicable Parameters

There are several parameters that are not applicable in the AgreeenaCarbon Project, due to the fact that the Project does not include livestock in the project boundaries.

Table 4-1. Parameters not included in the current iteration and first verification period of the AgreeenaCarbon Project, but that might be nonetheless added in later verification periods depending on Project and guidelines updates.

Parameter	Not Applicability Condition
EF _{ent,l}	These parameters are not applicable in the AgreeenaCarbon Project as it does not incorporate livestock emissions or accept farmers that own livestock. Livestock farmers may include in future iterations and verification periods.
Pop _{wp,l,i,P}	
Pop _{bsl,l,i,P}	
I, 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 _{N20,md,l,S}	

N_{exi}	
$MS_{bsl,i,t}$	
$N2O_{md_{bsl,i,t}}$	
GWP_{CH4}	
CF_c	
$EF_{c,CH4}$	These parameters are not applicable in the AgreeenaCarbon Project as the Project does not allow participants to conduct any burning of residues in entering the Project.
$MB_{wp,c,i,t}$	
$EF_{c,N2O}$	
$\Delta C_{SHRUB,bsl,i,t}$	
$\Delta C_{TREE,wp,i,t}$	Not applicable as these parameters are not included in the AgreeenaCarbon Project and is not measured as the only eligible vegetation in the program are arable fields. Woody biomass is not included in the baseline (see Section 4.1 of the PD)
$\Delta C_{SHRUB,wp,i,t}$	
$f(N2O_{soil,bsl,i,t})$	Not applicable as nitrogen fluxes are calculated using approach 3.
$f(CH4_{soil,bsl,i,t})$	Methane fluxes from soil methanogenesis are not included in the project boundary.
SF	These parameters are not applicable in the AgreeenaCarbon 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 AgreeenaCarbon Project. Instead, the N amount of synthetic fertilizer 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.
NC_{SF}	
$M_{bsl,SF,i,t}$	
$M_{wp,SF,i,t}$	

4.2 Data and Parameters Monitored

The VM0042 v2.0 parameters that are relevant to the Project and collected during Monitoring Periods are listed in the section below. The parameters that are not applicable for this verification period, yet are listed in the VM0042 v2.0 methodology, are listed in Table 4-2 below.

Data / Parameter	MDD
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Data unit	tCO ₂ e /ha
Description	Minimum detectable difference in SOC stocks between two points in time
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. The data is monitored at the project start or within +/- 5 years from the start date of the project start.
Value monitored	Cumulative SOC stock (0-30 cm)
Monitoring equipment	N/A
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 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.
Calculation method	Follows the method described in Equation (2) & (3), Section 8.2.1.6 in VM0042 v2.0.0
Comments	None
Data / Parameter	S

Data unit	Dimensionless
Description	Standard deviation of the difference in SOC stocks between t0 and t1
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.
Value monitored	17.8553 tC/ha
Monitoring equipment	N/A
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 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.
Calculation method	Follows the method described in Equation (2) & (3), Section 8.2.1.6 in VM0042 v2.0
Comments	None

Data / Parameter	n
Data unit	Dimensionless

Description	Estimated number of samples required to detect specified (minimum) difference in SOC stock between resampling.
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.
Value monitored	2159
Monitoring equipment	NA
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 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.
Calculation method	Follows the method described in Equation (2) & (3), Section 8.2.1.6 in VM0042 v2.0.0
Comments	None

Data / Parameter	$n-1$
Data unit	Dimensionless
Description	Degrees of freedom for the relevant t-distribution

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.
Value monitored	2158
Monitoring equipment	NA
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 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.
Calculation method	Follows the method described in Equation (2) & (3), Section 8.2.1.6 in VM0042 v2.0.0
Comments	None

Data / Parameter	$t_{\frac{\alpha}{2},v}, t_{1-\beta,v}$
Data unit	Dimensionless
Description	Values of the t-distribution, with v degrees-of-freedom, at a given significance level (α) and power level ($1 - \beta$).

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 v is sufficiently large, typically $v > 30$. $t_{\alpha/2} = 1.96$ $t_{1-\beta} = 0.84$
Frequency of monitoring/recording	The data is monitored prior to each verification event.
Value monitored	As v is larger than 30 (in this instance it is equal to $n - 1$ or 2158), we use the large sample approximation stated above: $t_{\alpha/2} = 1.96$ $t_{1-\beta} = 0.84$
Monitoring equipment	NA
QA/QC procedures to be applied	Further guidance was taken from FAO (2019) ¹⁸⁶
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.
Calculation method	Follows the method described in Equation (2) & (3), Section 8.2.1.6 in VM0042 v2.0.0
Comments	None

Data / Parameter	$M_{n,dl,SOC}$
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Data unit	kg/ha	
Description	SOC mass in soil sample <i>n</i> in depth layer <i>dl</i>	
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 4.3. and 4.3.2	
Frequency of monitoring/recording	The data is monitored prior to each verification event.	
Value monitored	Depth layer (<i>dl</i> , cm)	Average SOC mass (kg/ha)
	0-15	31431.52
	15-30	27871.65
	30-60	32022.08
	See supplementary material "soil-sampling-strata-soc-stock-sheet", tab "soil-samples-raw-all-properties" for further details.	
Monitoring equipment	Wintex 2000 automatic soil sampler	
QA/QC procedures to be applied	The soil sampling plan follows the VM0042 v2.0 requirements and is outlined in more detail in Section 4.3 Monitoring Plan.	
Purpose of Data	Calculation of project emissions	
Calculation method	Follows the method described in Equation (4), Section 8.2.1.6 in VM0042 v2.0.	
Comments	None	

Data / Parameter	$M_{n,dl,Sample}$	
Data unit	g	
Description	Soil mass in sample n in depth layer dl	
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.	
Frequency of monitoring/recording	The data is monitored prior to each verification event.	
Value monitored	Depth layer (dl , cm)	Average mass of soil sample (g)
	0-15	139.72
	15-30	158.74
	30-60	289.37
	See supplementary material "soil-sampling-strata-soc-stock-sheet", tab " soil-samples-raw-all-properties" for further details.	
Monitoring equipment	Wintex 2000 automatic soil sampler.	
QA/QC procedures to be applied	The soil sampling plan follows the VM0042 v2.0 requirements and is outlined in more detail in Section 4.3 Monitoring Plan in Section 4.3.3.	
Purpose of Data	Calculation of the parameter $SOC_{bsl,i,t}$	
Calculation method	Follows the requirements of soil depth increments presented in various peer-reviewed studies.	

	Follows the method described in Equation (4), Section 8.2.1.6 in VM0042 v2.0.0
Comments	None

Data / Parameter	D
Data unit	mm
Description	Inside diameter of probe or auger
Source of data	Measured as part of project monitoring
Description of measurement methods and procedures to be applied:	Not applicable
Frequency of monitoring/recording	The data is monitored at project start or within +/- 5years from the start date of the project start.
Value monitored	36, 49, and 50
Monitoring equipment	Wintex 2000 automatic soil sampler, stainless steel corer and Gildings hydraulic corer.
QA/QC procedures to be applied	The soil sampling plan follows the VM0042 v2.0 requirements and is outlined in more detail in Section 4.3 Monitoring Plan.
Purpose of Data	Calculation of the parameter $SOC_{bsl,i,t}$
Calculation method	Not applicable
Comments	None

Data / Parameter	N
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Data unit	Unitless
Description	Number of cores sampled
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 4.3 Monitoring Plan in Section 4.3.3 Soil Sampling Monitoring Plan
Frequency of monitoring/recording	The data is monitored prior to each verification event.
Value monitored	8,341 core samples See supplementary material "soil-sampling-strata-soc-stock-sheet", tab " soil-samples-raw-all-properties" for further details.
Monitoring equipment	Wintex 2000 automatic soil sampler.
QA/QC procedures to be applied	The soil sampling plan follows the VM0042 v2.0 requirements and is outlined in more detail in Section 4.3 Monitoring Plan.
Purpose of Data	Calculation of the parameter $SOC_{bsl,i,t}$
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
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 4.3 Monitoring Plan and 4.3.3.	
Frequency of monitoring/recording	The data is monitored prior to each verification event.	
Value monitored	Depth Layer (<i>dl</i> , cm)	Average OC (%)
	0-15	1.83
	15-30	1.50
	30-60	1.06
	See supplementary material “soil-sampling-strata-soc-stock-sheet”, tab " soil-samples-raw-all-properties" for further details.	
Monitored equipment	Eltra CS580A elemental analyser (GmbH, Germany).	
QA/QC procedures to be applied	Outliers in the data are detected using the modified z score. Where OC values are deemed outliers (high or low values), the soil sampling partner is contacted to corroborate the findings (e.g., visual assessment of the soil core or reports from the analytical laboratory).	
Purpose of Data	Calculation of the parameter $SOC_{bsl,i,t}$	
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)
Source of data	Measured in the project area

Description of measurement methods and procedures to be applied:	Determined from the volume of the core following ISO 11272:2017 methodology. 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 4.3 Monitoring Plan and 4.3.3.	
Frequency of monitoring/recording	The data is monitored prior to each verification event.	
Value monitored	Depth layer (d_l , cm)	Average corrected bulk density (g/cm^3)
	0-15	1.21
	15-30	1.31
	30-60	1.37
	See supplementary material "soil-sampling-strata-soc-stock-sheet", tab "soil-samples-raw-all-properties" for further details.	
Monitoring equipment	Wintex 2000 automatic soil sampler.	
QA/QC procedures to be applied	See Section 4.3 Monitoring Plan for further information.	
Purpose of Data	Calculation of the parameter $\text{SOC}_{bsl,i,t}$	
Calculation method	Fine soil fraction mass minus mass proportion of the coarse fragments	
Comments	None	

Data / Parameter	d
Data unit	cm
Description	Soil depth

Source of data	Measured in the project area.
Description of measurement methods and procedures to be applied:	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 (See Appendix 2 for further information).
Frequency of monitoring/recording	The data is monitored prior to each verification event.
Value monitored	0-15, 15-30 and 30-60cm
Monitoring equipment	Wintex 2000 automatic soil sampler.
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information.
Purpose of Data	Calculation of the parameter $SOC_{bsl,i,t}$
Calculation method	Not applicable
Comments	None

Data / Parameter	i
Data unit	Dimensionless
Description	PAI, defined area that is selected for measurement or monitoring such as a field.
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. The images are collected 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 images are collected from over the entire growing season and use the model to estimate the field boundaries at each time step.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
Value monitored	Not applicable
Monitoring equipment	Models using remote sensing data from Sentinel-1 and Sentinel-2
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 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 fields 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) ¹⁸⁷ 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 are used in the PD. The equations listed here are all the equations from VM0042 v2.0.

¹⁸⁷ [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.](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
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.
Monitoring equipment	Sentinel-1 and Sentinel-2
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 fields 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 A_i .

Data / Parameter	j_{bsl} / j_{wp}															
Data unit	Dimensionless															
Description	Type of fossil fuel combusted															
Source of data	Determined in sample unit i															
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 as data is received.															
Frequency of monitoring/recording	The data is monitored prior to each verification event.															
Value monitored	Type of fossil fuel combusted in the baseline: Diesel															
	<table><tr><td>j_{bsl}</td><td>Field Number</td></tr><tr><td>Diesel</td><td>40571</td></tr></table>	j_{bsl}	Field Number	Diesel	40571											
	j_{bsl}	Field Number														
	Diesel	40571														
	Type of fossil fuel combusted in the project scenario:															
<table><tr><td>j_{wp}</td><td>2021</td><td>2022</td><td>2023</td></tr><tr><td>Diesel</td><td>421</td><td>12197</td><td>40560</td></tr><tr><td>Gasoline</td><td>0</td><td>1</td><td>5</td></tr><tr><td>Bioethanol</td><td>0</td><td>0</td><td>6</td></tr></table>	j_{wp}	2021	2022	2023	Diesel	421	12197	40560	Gasoline	0	1	5	Bioethanol	0	0	6
j_{wp}	2021	2022	2023													
Diesel	421	12197	40560													
Gasoline	0	1	5													
Bioethanol	0	0	6													

Monitoring equipment	Digital farmer attestation
QA/QC procedures to be applied	Fossil fuel type is requested and confirmed through internal field inspections. If necessary, the information is checked and confirmed by contacting farmers.
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	Signed farmer attestation on the platform with the wording “ <i>I declare that the information I have provided about my fields is true and correct</i> ”

Data / Parameter	$FFC_{bsl,j,i,t}$
Data unit	Litre/hectare
Description	Consumption of fossil fuel type j (gasoline or diesel) for sample unit i in year t in the baseline
Source of data	The qualitative data of tillage practices are directly collected from farmer reported data for every sample unit i. The quantitative information of fuel consumption amounts is estimated according to Box 1, option 4 in VM0042. Peer-reviewed published data: AGROVI, 2019¹⁸⁸, de Visser et al., 2012¹²¹, Paris et al., 2022¹²²

¹⁸⁸AGROVI (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.

Description of measurement methods and procedures to be applied:	The qualitative data of tillage practices are directly collected from farmer reported data for every sample unit i. The quantitative information of baseline fuel consumption amounts, which matches the baseline tillage system types, is derived from regional (sub-national) 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 (AGROVI, 2019, de Visser et al., 2012, Paris et al., 2022).					
Frequency of monitoring/recording	The data is monitored prior to each verification event.					
Value monitored	Consumption of fossil fuel in the baseline <table><tr><td>jbsl</td><td>FFCbsl (l/ha)</td></tr><tr><td>Diesel</td><td>98.2 ± 6.1</td></tr></table>		jbsl	FFCbsl (l/ha)	Diesel	98.2 ± 6.1
jbsl	FFCbsl (l/ha)					
Diesel	98.2 ± 6.1					
Monitoring equipment	Digital farmer attestation					
QA/QC procedures to be applied	Outline of collection of data and QA/QC is in alignment with VM0042 and is presented in the Monitoring Plan. The qualitative data are requested and confirmed through internal field inspections. If necessary, the information is checked and confirmed by contacting farmers.					
Purpose of Data	Calculation of baseline emissions.					
Calculation Method	The quantitative information of fuel consumption amounts is estimated based on the baseline tillage system types. The values from Agrovi (2019) were chosen for FFCbsl as a conservative midpoint between the minimum and maximum values (72-161 l/ha) estimated in the extensive EU studies ¹⁸⁹ , ¹⁹⁰ , ¹⁹¹ . <table><tr><td>Baseline Tillage</td><td>Fuel Consumption Amounts (l/ha)</td></tr></table>		Baseline Tillage	Fuel Consumption Amounts (l/ha)		
Baseline Tillage	Fuel Consumption Amounts (l/ha)					

¹⁸⁹de 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>

¹⁹⁰ 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.

¹⁹¹ 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>

	Conventional tillage	100
	Reduced tillage	80
	No tillage	60
Comments	None	

Data / Parameter	$FFC_{wp,j,i,t}$			
Data unit	Liters/hectare			
Description	Consumption of fossil fuel type j in the project for sample unit i in year t in the project scenario			
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			
Value monitored	Consumption of fossil fuel FFC_{wp} (l/ha) in the project scenario			
	Fossil fuel type (i)	2021	2022	2023
	Diesel	49.5 ± 17.8	50.2 ± 18.3	53.9 ± 21.2
	Gasoline	0	70	50.0 ± 25.2

	<table><tr><td>Bioethanol</td><td>0</td><td>0</td><td>53.7 ± 14.5</td></tr></table>	Bioethanol	0	0	53.7 ± 14.5
Bioethanol	0	0	53.7 ± 14.5		
Monitoring equipment	Digital farmer attestation				
QA/QC procedures to be applied	Outline of collection of data and QA/QC is in alignment with VM0042 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, 2019).				
Comments	None				

Data / Parameter	$EF_{CO2,j}$
Data unit	t CO ₂ e/liter
Description	Emission factor for the type of fossil fuel <i>j</i> (gasoline or diesel) combusted
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). The emission factor or bioethanol was obtained from the online database (https://www.climateq.io/data).
Description of measurement methods to be applied	See source of data above.
Frequency of monitoring	Checks for updated emission factors will be made prior to every verification period

Value monitored	Where j = gasoline, $EF_{CO_2,j} = 0.002810$ t CO ₂ e per liter. Where j = diesel, $EF_{CO_2,j} = 0.002886$ t CO ₂ e per liter. Where j = bioethanol, $EF_{CO_2,j} = 0.000008887$ t CO ₂ e per liter.
Monitoring equipment	Not applicable
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) ¹⁹²

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 .
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-J of the UNFCCC National Inventory Reports ¹⁹³ .
Description of measurement methods and procedures to be applied:	See source of data above.

¹⁹² IEA (2004). Energy statistics manual. IEA. Available at: <https://www.iea.org/reports/energy-statistics-manual-2>

¹⁹³ National Inventory submissions for Annex countries were obtained from the UNFCCC website <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

Frequency of monitoring/recording	The data is monitored prior to each verification event.																																																														
Value monitored	Regional data for the application rates (t/ha) of limestone / dolomite <table border="1"> <thead> <tr> <th rowspan="2">Country</th><th colspan="2">Baseline</th><th colspan="2">Project scenario</th></tr> <tr> <th>$M_{Limestone,bsl,i,t}$</th><th>$M_{Dolomite,bsl,i,t}$</th><th>$M_{Limestone,wp,i,t}$</th><th>$M_{Dolomite,wp,i,t}$</th></tr> </thead> <tbody> <tr> <td>Bulgaria</td><td>55846</td><td>0</td><td>55456</td><td>0</td></tr> <tr> <td>Denmark</td><td>521500</td><td>0</td><td>558300</td><td>0</td></tr> <tr> <td>Estonia</td><td>37672</td><td>5193</td><td>75849</td><td>5592</td></tr> <tr> <td>Latvia</td><td>78380</td><td>27960</td><td>134000</td><td>39700</td></tr> <tr> <td>Lithuania</td><td>55577</td><td>3802</td><td>106566</td><td>3315</td></tr> <tr> <td>Moldova *</td><td>117483</td><td>3793</td><td>147051</td><td>242</td></tr> <tr> <td>Romania</td><td>117483</td><td>3793</td><td>147051</td><td>242</td></tr> <tr> <td>Spain</td><td>72383</td><td>356</td><td>59527</td><td>340</td></tr> <tr> <td>Ukraine</td><td>355130</td><td>0</td><td>249900</td><td>0</td></tr> <tr> <td>United Kingdom</td><td>2068997</td><td>312280</td><td>2460805</td><td>205216</td></tr> </tbody> </table> * Moldova is a non-Annex I country; thus, no data on liming was available. As Moldova is most similar to Romania in size and geography, we assume that the liming application in Moldova is the same as Romania. Therefore, we apply the liming data of Romania to indicate the liming application in Moldova.				Country	Baseline		Project scenario		$M_{Limestone,bsl,i,t}$	$M_{Dolomite,bsl,i,t}$	$M_{Limestone,wp,i,t}$	$M_{Dolomite,wp,i,t}$	Bulgaria	55846	0	55456	0	Denmark	521500	0	558300	0	Estonia	37672	5193	75849	5592	Latvia	78380	27960	134000	39700	Lithuania	55577	3802	106566	3315	Moldova *	117483	3793	147051	242	Romania	117483	3793	147051	242	Spain	72383	356	59527	340	Ukraine	355130	0	249900	0	United Kingdom	2068997	312280	2460805	205216
Country	Baseline		Project scenario																																																												
	$M_{Limestone,bsl,i,t}$	$M_{Dolomite,bsl,i,t}$	$M_{Limestone,wp,i,t}$	$M_{Dolomite,wp,i,t}$																																																											
Bulgaria	55846	0	55456	0																																																											
Denmark	521500	0	558300	0																																																											
Estonia	37672	5193	75849	5592																																																											
Latvia	78380	27960	134000	39700																																																											
Lithuania	55577	3802	106566	3315																																																											
Moldova *	117483	3793	147051	242																																																											
Romania	117483	3793	147051	242																																																											
Spain	72383	356	59527	340																																																											
Ukraine	355130	0	249900	0																																																											
United Kingdom	2068997	312280	2460805	205216																																																											
Monitoring equipment	Not applicable																																																														

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 (2017-2021) are downloaded from Tables 3.G-J and 4.B the UNFCCC National Inventory Reports¹⁹⁴. 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 “Cropland remaining Cropland” area (ha) with the assumption that the CO₂ 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 average 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. 2022).
Comments	See Section 3.2 Methodology Deviations.

Data / Parameter	EL _{bsl} / EL _{wp}
Data unit	ktCO ₂ e

¹⁹⁴ National Inventory submissions for Annex I countries were obtained from here <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

Description	CO2 emissions from liming in sample unit i in year t.																						
Source of data	Box 1, option 4 in VM0042 is used including regional average values for historic CO2 emissions from liming. Regional data are derived from Tables 3.G-J of the UNFCCC National Inventory Reports ¹⁹⁵ . The baseline period is set as 2017-2021 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 field. The project period is set as 2022.																						
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.																						
Value monitored	CO2 emissions from liming in each country																						
	<table border="1"> <thead> <tr> <th>Country</th><th>2017-2021 (Baseline, ktCO2e/yr)</th><th>2022 (Project scenario, ktCO2e/yr)</th></tr> </thead> <tbody> <tr> <td>Bulgaria</td><td>25</td><td>24</td></tr> <tr> <td>Denmark</td><td>229</td><td>246</td></tr> <tr> <td>Estonia</td><td>19</td><td>36</td></tr> <tr> <td>Latvia</td><td>47</td><td>78</td></tr> <tr> <td>Lithuania</td><td>26</td><td>49</td></tr> <tr> <td>Moldova*</td><td>54</td><td>65</td></tr> </tbody> </table>		Country	2017-2021 (Baseline, ktCO2e/yr)	2022 (Project scenario, ktCO2e/yr)	Bulgaria	25	24	Denmark	229	246	Estonia	19	36	Latvia	47	78	Lithuania	26	49	Moldova*	54	65
Country	2017-2021 (Baseline, ktCO2e/yr)	2022 (Project scenario, ktCO2e/yr)																					
Bulgaria	25	24																					
Denmark	229	246																					
Estonia	19	36																					
Latvia	47	78																					
Lithuania	26	49																					
Moldova*	54	65																					

¹⁹⁵ National Inventory submissions for Annex I countries were obtained from here <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

	Romania	54	65
	Spain	32	26
	Ukraine	156	110
	United Kingdom	1059	1181
	* Moldova is a non-Annex I country; thus, no data on liming was available. As Moldova is most similar to Romania in size, language, and geography, we assume that the liming application in Moldova is the same as Romania. Therefore, we apply the liming data of Romania to indicate the liming application in Moldova.		
Monitoring equipment	See source of data above.		
QA/QC procedures to be applied	See source of data above.		
Purpose of Data	Calculation of baseline and project emissions		
Calculation method	The average of the total emissions (kt CO₂e/year) from liming activity from 2017 to 2021 for each country is considered as the total emissions (kt CO₂e/year) from liming in the baseline. Total emissions (kt CO₂e/year) from liming activity in 2022 for each country are considered as the total emissions (kt CO₂e/year) 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 is proposed that a more transparent and fair approach to quantifying liming CO₂ 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 CO₂ emissions in VM0042 v2.0 occurred after the farmers joined the AgreenaCarbon		

	program 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 v2.0 and a further explanation for the applied approach has been provided in Chapter 3.2 Methodology Deviations.
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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
Source of data	Section 11.3, Chapter 11, Volume 4 in the 2019 Refinement to the 2006 IPCC National Greenhouse Gas Inventories ¹⁹⁶
Description of measurement methods and procedures to be applied:	See source of data above.
Frequency of monitoring/recording	Checks for updated emission factors will be made prior to every verification period.
Value monitored	For calcitic limestone, $EF_{Limestone} = 0.12$ t C/t limestone; For dolomite, $EF_{Dolomite} = 0.13$ t C/t dolomite.
Monitoring Equipment	Not applicable
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable

¹⁹⁶ https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf

Comments	None
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Data / Parameter	Country actual agricultural land area (A_{bsl} / A_{wp})		
Data unit	k ha		
Description	Area of country in Table 4.B of the National Inventory Reports		
Source of data	Box 1, option 4 in VM0042 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 ¹⁹⁷		
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.		
Value monitored	Agricultural land area for each country		
	Country	A_{bsl} (k ha)	A_{wp} (k ha)
	Bulgaria	3358	3331
	Denmark	2682	2652
	Estonia	927	926

¹⁹⁷ National Inventory submissions for Annex I countries were obtained from the UNFCCC website <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

	Latvia	1296	1289
	Lithuania	1305	1366
	Moldova*	NA	NA
	Romania	4574	3960
	Spain	17429	17188
	Ukraine	34756	34756
	United Kingdom	3589	3528
* Moldova is a non-Annex I country; thus, no data on liming was available. As Moldova is most similar to Romania in size, and geography, we assume that the liming application in Moldova is the same as Romania. Therefore, we apply the liming data of Romania to indicate the liming application in Moldova.			
Monitoring equipment	See source of data above.		
QA/QC procedures to be applied	See source of data above.		
Purpose of Data	Calculation of baseline and project emissions		
Calculation method	The average of the “Cropland remaining Cropland” area from 2017 to 2021 for each country is considered as the regional average agricultural land area in the baseline (Absl). The value of the “Cropland remaining Cropland” area in 2022 for each country is considered as the regional agricultural land area in the project scenario (Awp).		
Comments	See the methodology deviation for liming emissions in Chapter 3.2 Methodology Deviations.		

Data / Parameter	FSN _{bsl,i,t}							
Data unit	t N							
Description	N inputs from N containing synthetic fertilizer applied for sample unit i in year t in the baseline							
Source of data	The qualitative data of baseline fertilizer types are collected from farm attestation in sample unit i. The quantitative data for application rates (t N/ha) of synthetic fertilizer are retrieved based on regional default values as per Box 1, option 4 in VM0042 v2.0. The regional average values for historic synthetic fertilizer application are derived from the EuropeAgriDB v1.0 ¹⁹⁸ and Eurostat (lan_lcv_oww) databases ¹⁹⁹ .							
Description of measurement methods and procedures to be applied:	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, regional average default 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 (Box 1, option 4) are used to cover the 5-year baseline SoA.							
Frequency of monitoring/recording	The data is monitored prior to every verification event.							
Value monitored	Synthetic fertilizer application in the baseline <table border="1"> <thead> <tr> <th>Country</th><th>Synthetic fertiliser application rate (tN/ha) if only synthetic fertiliser is applied</th><th>Synthetic fertiliser application rate (tN/ha) if mixed fertiliser is applied</th></tr> </thead> <tbody> <tr> <td>Bulgaria</td><td>170.0</td><td>85</td></tr> </tbody> </table>		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	170.0	85
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	170.0	85						

¹⁹⁸
https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772
¹⁹⁹ https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_oww_custom_12738492/default/table

	Denmark	200.0	100							
	Estonia	170.0	85							
	Latvia	170.0	85							
	Lithuania	170.0	85							
	Republic of Moldova	170.0	85							
	Romania	124.5	62							
	Spain	138.5	69							
	Ukraine	170.0	85							
	United Kingdom	230.7	115							
	Cumulative N inputs from N containing synthetic fertiliser in all the PAIs in the baseline per year (t N/ year) in AgreeenaCarbon Project									
	<table><tr><td>Fertiliser type</td><td>FSNbsl,t (tN/yr)</td></tr><tr><td>Only synthetic</td><td>228947</td></tr><tr><td>Mixed</td><td>985</td></tr><tr><td>Only organic</td><td>0</td></tr></table>			Fertiliser type	FSNbsl,t (tN/yr)	Only synthetic	228947	Mixed	985	Only organic
Fertiliser type	FSNbsl,t (tN/yr)									
Only synthetic	228947									
Mixed	985									
Only organic	0									
Monitoring equipment	Digital farmer attestation									
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. The qualitative data about fertilizer application (only synthetic, only organic or mixed fertilizer) is received through direct contact with the farmer by the project and uploaded to the platform. This data received from farmers 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 are checked and confirmed by contacting farmers.									
Purpose of Data	Calculation of baseline emissions									

Calculation method	The N inputs from synthetic fertilizer applied are calculated by multiplying the application rates (t N/ha) of synthetic fertilizer by the area size A_i (ha) of the sample unit i . Where farm attestation is missing the application rates (t N/ha) of synthetic fertilizer, then regional average default values are used.
Comments	None

Data / Parameter	FSN _{wp,i,t}																			
Data unit	t N																			
Description	N inputs from N containing synthetic fertilizer applied for sample unit i in year t in the project scenario																			
Source of data	Determined in sample unit i																			
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.																			
Value monitored	Cumulative N inputs from N containing synthetic fertilizer in all the PAIs in project scenario (FSN _{wp,i,t} , tN) <table><tr><td>Fertiliser type</td><td>2021</td><td>2022</td><td>2023</td></tr><tr><td>only synthetic</td><td>1885</td><td>35477</td><td>121673</td></tr><tr><td>mixed</td><td>28</td><td>1815</td><td>7071</td></tr><tr><td>only organic</td><td>0</td><td>0</td><td>0</td></tr></table>				Fertiliser type	2021	2022	2023	only synthetic	1885	35477	121673	mixed	28	1815	7071	only organic	0	0	0
Fertiliser type	2021	2022	2023																	
only synthetic	1885	35477	121673																	
mixed	28	1815	7071																	
only organic	0	0	0																	
Monitoring equipment	Digital farmer attestation																			
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. This data received from farmers 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 are 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	$FON_{bsl,i,t}$
Data unit	t N
Description	N inputs from N containing organic fertilizer applied for sample unit i in year t in the baseline
Source of data	The qualitative data of baseline fertilizer types are collected from farm attestation in sample unit i. The quantitative data are retrieved based on Box 1, option 4 in VM0042. The regional average values for historic organic fertilizer application are derived from the EuropeAgriDB v1.0 ²⁰⁰ , FAOSTAT (<i>faostat_esb</i>) ⁱ and Eurostat (<i>lan_lcv_ovw</i>) databases ²⁰¹ .
Description of measurement methods and procedures to be applied:	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, regional average default 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 (Box 1, option 4) are used to cover the 5-year baseline SoA.

²⁰⁰

https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropl_and_and_grassland_1961-2019/5320772

²⁰¹ https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw_custom_12738492/default/table

Frequency of monitoring/recording	The data is monitored prior to every verification event.							
Value monitored	Country	Organic fertiliser application rate (kgN/ha) if only organic fertiliser is applied	Organic fertiliser application rate (kgN/ha) if mixed fertiliser is applied					
	Bulgaria	104.0	52					
	Denmark	144.0	72					
	Estonia	104.0	52					
	Latvia	104.0	52					
	Lithuania	104.0	52					
	Republic of Moldova	104.0	52					
	Romania	104.9	52					
	Spain	154.1	77					
	Ukraine	104.0	52					
	United Kingdom	169.7	85					
	Cumulative N inputs from N containing organic fertiliser in all the PAIs in the baseline per year (t N/ year) in AgreeaCarbon Project							
	<table><tr><td>Baseline Fertilizer Type</td><td>FONbsl (tN/yr)</td></tr><tr><td>Only Organic</td><td>31657</td></tr><tr><td>Mixed</td><td>685</td></tr></table>			Baseline Fertilizer Type	FONbsl (tN/yr)	Only Organic	31657	Mixed
Baseline Fertilizer Type	FONbsl (tN/yr)							
Only Organic	31657							
Mixed	685							
Monitoring equipment	Digital farmer attestation							
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. The qualitative data about fertilizer application (only synthetic, only organic or mixed fertilizer) is received through direct contact with the farmer by the project and uploaded to the platform. This data received from farmers 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 are checked and confirmed by contacting farmers.
Purpose of Data	Calculation of baseline emissions
Calculation method	The N inputs from organic fertilizer applied are calculated by multiplying the application rates (t N/ha) of organic fertilizer by the area size A_i (ha) of the sample unit i . Where farm attestation is missing the application rates (t N/ha) of organic fertilizer, then regional average default values are used.
Comments	None

Data / Parameter	FONwp,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																			
Source of data	Farm attestation																			
Frequency of monitoring/recording	The data is monitored prior to every verification event.																			
Value monitored	Cumulative N inputs from N-containing organic fertiliser in all the PAIs in project scenario (FONwp,i,t, tN): <table><tr><td>Fertiliser type</td><td>2021</td><td>2022</td><td>2023</td></tr><tr><td>only organic</td><td>0</td><td>797</td><td>2599</td></tr><tr><td>mixed</td><td>117</td><td>1914</td><td>8521</td></tr><tr><td>only synthetic</td><td>0</td><td>0</td><td>0</td></tr></table>				Fertiliser type	2021	2022	2023	only organic	0	797	2599	mixed	117	1914	8521	only synthetic	0	0	0
Fertiliser type	2021	2022	2023																	
only organic	0	797	2599																	
mixed	117	1914	8521																	
only synthetic	0	0	0																	
Monitoring equipment	Digital farmer attestation																			
Purpose of Data	Calculation of baseline emissions																			

Calculation method	The N inputs from organic fertilizer applied are calculated by multiplying the application rates (t N/ha) of organic fertilizer by the area size A_i (ha) of the sample unit i . Where farm attestation is missing the application rates (t N/ha) of organic fertilizer, then regional average default values are used.
Comments	None

Data / Parameter	$M_{bsl,OF,i,t}$								
Data unit	t fertilizer								
Description	Mass of N-containing organic fertiliser type OF applied to PAI i in year t in the baseline								
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), average value collected in the project area <table border="1"> <tr> <td>Fertiliser type</td><td>$M_{bsl,OF,i,t}$</td></tr> <tr> <td>only organic</td><td>11811375</td></tr> <tr> <td>mixed</td><td>242508</td></tr> <tr> <td>only synthetic</td><td>0</td></tr> </table>	Fertiliser type	$M_{bsl,OF,i,t}$	only organic	11811375	mixed	242508	only synthetic	0
Fertiliser type	$M_{bsl,OF,i,t}$								
only organic	11811375								
mixed	242508								
only synthetic	0								
Justification of choice of data or description of measurement methods and procedures applied	At verification, for current and future project instances, the data is 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 was 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 of AgreeaCarbon PD v1.3).								

Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	OF_{bsl}																						
Data unit	Dimensionless																						
Description	Type of organic N fertilizer in the baseline																						
Source of data	Determined in sample unit i																						
Description of measurement methods and procedures to be applied:	The type of organic fertilizers 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. Where farm attestation is missing the type of organic fertiliser is chosen based on regional statistics derived from the FAOSTAT database (<i>faostat_emn</i>).																						
Frequency of monitoring/recording	The annual data is monitored prior to each verification event.																						
Value monitored	<table border="1"> <thead> <tr> <th>Country</th><th>Type of Organic N fertilizer</th></tr> </thead> <tbody> <tr><td>Bulgaria</td><td>cattle</td></tr> <tr><td>Denmark</td><td>pig</td></tr> <tr><td>Estonia</td><td>cattle</td></tr> <tr><td>Latvia</td><td>cattle</td></tr> <tr><td>Lithuania</td><td>cattle</td></tr> <tr><td>Republic of Moldova</td><td>cattle</td></tr> <tr><td>Romania</td><td>cattle</td></tr> <tr><td>Spain</td><td>pig</td></tr> <tr><td>Ukraine</td><td>cattle</td></tr> <tr><td>United Kingdom</td><td>cattle</td></tr> </tbody> </table>	Country	Type of Organic N fertilizer	Bulgaria	cattle	Denmark	pig	Estonia	cattle	Latvia	cattle	Lithuania	cattle	Republic of Moldova	cattle	Romania	cattle	Spain	pig	Ukraine	cattle	United Kingdom	cattle
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Republic of Moldova	cattle																						
Romania	cattle																						
Spain	pig																						
Ukraine	cattle																						
United Kingdom	cattle																						
Monitoring equipment	Digital farmer attestation																						

QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information. This data received from farmers go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the information are 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>I declare that the information I have provided about my fields is true and correct</i> ”

Data / Parameter	OF_{wp}			
Data unit	Dimensionless			
Description	Type of organic N fertilizer in the project scenario			
Source of data	Determined in sample unit i			
Description of measurement methods and procedures to be applied:	The type of organic fertilizers 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.			
Value monitored	Types of organic N fertilizer in the project scenario (PAI number)			
	OF_{wp}	2021	2022	2023
	Broiler/Turkey litter	0	90	181

	Cattle Digestate - 0.26%N	0	48	286
	Cattle digestate - 0.6% N	0	37	254
	Cattle manure	1	149	524
	Cattle slurry	1	67	426
	Compost (fully aerated production)	0	22	0
	Compost (non-fully aerated production)	0	0	122
	Compost (zero emissions)	0	64	262
	Horse manure	0	4	8
	Pig digestate - 0.36% N	1	96	343
	Pig digestate - 0.7% N	1	29	114
	Pig manure	0	46	90
	Pig slurry	45	495	1020
	Poultry layer digestate	0	78	478
	Poultry layer manure	1	59	630

	Separated pig slurry (liquid part)	0	16	118
	Sheep digestate	0	4	39
	Biosolid	0	0	146
	Horse digestate	0	0	2
	Separated pig slurry (solid part)	0	0	18
	Sheep manure	0	0	51
Monitoring equipment	Not applicable			
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information. This data received from farmers go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the information are 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	$M_{wp,OF,i,t}$
Data unit	t fertilizer
Description	Mass of N containing organic fertilizer applied in the project for sample unit i in year t in the project scenario
Source of data	Determined in sample unit i

Description of measurement methods and procedures to be applied:	Mass of N containing organic fertilizer 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.			
Value monitored	Mass of N in organic fertiliser can be found in the fertiliser manual as an attachment to the monitoring report			
	Cumulative mass of N containing organic fertilizer applied in all the PAIs in the project scenario Mwp,OF,i,t (t fertiliser):			
	Fertiliser type	2021	2022	2023
	Only organic	0	90269	324848
Mixed	22826	195205	250315	
Monitoring equipment	Digital farmer attestation			
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information. This data go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data are 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	$NCOF_{bsl} / NCOF_{wp}$
Data unit	t N/t fertilizer
Description	N fraction of organic fertilizer OF
Source of data	Peer-reviewed literature, per VM0042 v2.0 allowance to use peer-reviewed published literature. Peer-reviewed published data: CFT, Palma 2019, Chambers et al., 1999, Cravotta et al., 1997, Nobile et al., 2022, Delin et al., 2013, Thongnan et al., 2016, Aboutayeb et

	al., 2014, López-Cano et al., 2016, Delin et al., 2012, Fouda et al., 2014, Fouda et al., 2013 ²⁰²																		
Description of measurement methods and procedures to be applied:	The N fractions of different organic fertilizers derived from peer-reviewed papers as shown above.																		
Frequency of monitoring/recording	The data is monitored prior to each verification event.																		
Value monitored	<table border="1"> <thead> <tr> <th>NCOF_{bsl} / NCOF_{wp}</th><th>Nitrogen Content (%)</th></tr> </thead> <tbody> <tr> <td>Broiler/Turkey litter</td><td>3.4</td></tr> <tr> <td>Cattle Digestate - 0.26%N</td><td>0.26</td></tr> <tr> <td>Cattle digestate - 0.6% N</td><td>0.6</td></tr> <tr> <td>Cattle manure</td><td>0.6</td></tr> <tr> <td>Cattle slurry</td><td>0.26</td></tr> <tr> <td>Compost (fully aerated production)</td><td>1</td></tr> <tr> <td>Compost (non-fully aerated production)</td><td>1</td></tr> <tr> <td>Compost (zero emissions)</td><td>1</td></tr> </tbody> </table>	NCOF _{bsl} / NCOF _{wp}	Nitrogen Content (%)	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	Compost (non-fully aerated production)	1	Compost (zero emissions)	1
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²⁰² 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 fertilizer 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., Albuquerque, 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 fertilizer 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.

	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
Monitoring equipment	Not applicable	
QA/QC procedures to be applied	Not applicable	
Purpose of Data	Calculation of baseline and project emissions	
Calculation method	Not applicable	
Comments	The fertilizer table has been updated during the verification period compared to the validation period.	

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 sample unit i in year t in the baseline or project scenario
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 (<i>faostat_qcl</i>) ²⁰³ and Eurostat (<i>apro_cp</i> ; <i>apro_acs</i>) ²⁰⁴ databases. Crop yield data in the project scenario are from farm attestation.
Description of measurement methods and procedures to be applied:	The baseline data on N-fixing species and their productivity data 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, regional average default 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 (Box 1, option 4) are used to cover the 5-year baseline SoA. The annual N-fixing species and their productivity data in the project scenario 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.

²⁰³ <https://www.fao.org/faostat/en/#data/QCL>

²⁰⁴

https://ec.europa.eu/eurostat/databrowser/view/apro_cpshr/default/table?lang=en&category=agr.apro.apro_crop.apro_cp.apro_cpshr

Value monitored	Cumulative annual dry matter above-ground residues $MB_{ag, wp}$ (t dm/year) and below-ground residues $MB_{bg, wp}$ (t dm/ year) in the baseline and project scenario <table><tr><td>MB</td><td>$MB_{g, bsl, i, t}$</td><td colspan="2">$MB_{g, wp, i, t}$</td></tr><tr><td>Above-ground</td><td>71744</td><td colspan="2">537062</td></tr><tr><td>Below-ground</td><td>148382</td><td colspan="2">241781</td></tr></table> Cumulative annual dry matter above-ground residues $MB_{ag, wp}$ (t dm/year) and below-ground residues $MB_{bg, wp}$ (t dm/year) in the project scenario <table><tr><td>MB</td><td>2021</td><td>2022</td><td>2023</td></tr><tr><td>Above-ground</td><td>1204</td><td>108384</td><td>427475</td></tr><tr><td>Below-ground</td><td>493</td><td>49171</td><td>192117</td></tr></table>				MB	$MB_{g, bsl, i, t}$	$MB_{g, wp, i, t}$		Above-ground	71744	537062		Below-ground	148382	241781		MB	2021	2022	2023	Above-ground	1204	108384	427475	Below-ground	493	49171	192117
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Below-ground	493	49171	192117																									
Monitoring equipment	Digital farmer attestation																											
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information. The crop productivity data go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data are checked and confirmed by contacting farmers.																											
Purpose of Data	Calculation of project emissions																											
Calculation method	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, 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. 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 AgreeaCarbon PD v1.3; the annual dry matter of N-fixing species in the project scenario is calculated based on data collected from farm attestation.																											

Comments	Signed farmer attestation on the platform with the wording “ <i>I declare that the information I have provided about my fields is true and correct</i> ”
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Data / Parameter	g_{wp}			
Data unit	Dimensionless			
Description	Type of N-fixing species			
Source of data	Determined in sample unit i			
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	The annual data is monitored prior to each verification event.			
Value monitored	Type of N-fixing species in the project scenario (PAI number)			
	g_{wp}	2021	2022	2023
	ALFALFA	0	96	285
	ALFALFA-SEED-HARVEST	0	0	6
	BEAN-DRY-FORAGE-HARVEST	0	0	9
	BEAN-FAVA-FORAGE-HARVEST	0	0	34
	BEAN-FAVA-SEED-HARVEST	0	0	320
	BEAN-FAVA-WINTER-FORAGE-HARVEST	0	0	18
	BEAN-FAVA-WINTER-SEED-HARVEST	0	0	157
	CLOVER	0	37	0
	CLOVER-CRIMSON-FORAGE-HARVEST	0	0	3

	CLOVER-RED-FORAGE-HARVEST	0	0	50
	CLOVER-RED-SEED-HARVEST	0	0	26
	CLOVER-WHITE-FORAGE-HARVEST	0	0	14
	CLOVER-WHITE-SEED-HARVEST	0	0	24
	DRY-BEAN	0	29	28
	GRASS-CLOVER-MIX	0	37	0
	GRASS-CLOVER-MIX-FORAGE-HARVEST	0	0	148
	HORSEBEANS	2	152	209
	LENTIL-SEED-HARVEST	0	0	28
	LUPINE-SEED-HARVEST	0	0	5
	OTHER-LEGUME	0	29	50
	OTHER-N-FIXING-FORAGE	0	21	23
	PEA-COW-SEED-HARVEST	0	0	13
	PEA-SPRING-FORAGE-HARVEST	0	0	22
	PEA-SPRING-SEED-HARVEST	0	0	327
	PEA-WINTER-FORAGE-HARVEST	0	0	13
	PEA-WINTER-SEED-HARVEST	0	0	137
	PEAS	0	98	45
	SOYABEAN	18	914	2867
	SOYBEAN-FORAGE-HARVEST	0	0	5
	VETCH-FORAGE-HARVEST	0	0	25
	VETCH-SEED-HARVEST	0	0	90
Monitoring equipment	Digital farmer attestation			

QA/QC procedures to be applied	Type of N-fixing species is requested and confirmed through internal field inspections. If necessary, the information are 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
Source of data	<i>Farmer reported data from farm attestation</i>
Description of measurement methods and procedures to be applied:	Crop product p to be used in the calculation of $P_{bsl,p}$ and $P_{wp,p}$ described in Equations (35) and (36). A list of crop products reported in the Project are now provided in Appendix 7 "Assessment of Productivity between the Baseline and Project Years (P_{wp},P)"
Frequency of monitoring/recording	The data is monitored prior to each verification event.
QA/QC procedures to be applied	See Section 4.3 for further information. Field data collection is conducted via internal field inspections and data is checked and described in the Agreea 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
Source of data	Determined in sample unit i
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 each verification event.
Value monitored	Average values by crop and vintage of $P_{wp,p}$, are now provided in Appendix 7 "Assessment of Productivity between the Baseline and Project Years (Pwp,P)"
Monitoring equipment	Digital famer attestation
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information. This data received from farmers go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data are checked and confirmed by contacting farmers.
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
Source of data	Regional productivity data from government (e.g., USDA Actual Production History data), industry, published, academic or international organization (e.g., FAO) sources.
Description of measurement methods and procedures to be applied:	Regional productivity will be calculated in conjunction with $P_{wp,p}$ (Equation 36) to account for leakage due to productivity declines (see Appendix 7 "Assessment of Productivity between the Baseline and Project Years ($P_{wp,P}$)")
Frequency of monitoring/recording	Every 10 years
Value monitored	Values found in public databases
Monitoring equipment	Digital farmer attestation
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	$DPM_{bsl,i,t}$, $RPM_{bsl,i,t}$, $HUM_{bsl,i,t}$, $BIO_{bsl,i,t}$, $IOM_{bsl,i,t}$ $DPM_{wp,i,t}$, $RPM_{wp,i,t}$, $HUM_{wp,i,t}$, $BIO_{wp,i,t}$, $IOM_{wp,i,t}$
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

	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.		
Source of data	The carbon pools are derived from direct SOC measurements following the soil sampling methodology for the ex-post calculations.		
Description of measurement methods and procedures to be applied:	The Project employs a stratified soil sampling plan across the PAIs to address spatial and temporal variability in SOC stocks. Direct soil samples, retaken every five years, guide model initialization and calibration to fulfil VM0042 v2.0 requirements. PAIs are clustered using soil, climate, management, and geopolitical data.		
Frequency of monitoring/recording	The data is monitored prior to each verification event.		
Value monitored	Carbon pool	Baseline (tC/ha)	Project (tC/ha)
	DPM	0.41 ± 0.12	0.50 ± 0.14
	RPM	7.52 ± 1.69	7.83 ± 1.72
	BIO	1.04 ± 0.24	1.07 ± 0.24
	HUM	41.32 ± 9.42	41.37 ± 9.43
	IOM	4.73 ± 1.25	4.73 ± 1.25
Monitoring equipment	N/A		

QA/QC procedures to be applied	The Project's model runs only on data that has passed the QA and QC checks outlined in Sections 4.3.1.7 and 4.3.1.8.
Purpose of Data	Calculation of baseline and project soil carbon emissions
Calculation method	Model Spin up as detail in the MVR in accordance with VMD0053 V2.
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 sample unit i in year t under the baseline and project scenarios
Source of data	For monitoring purposes, SOC stocks are measured at the field level. To achieve higher resolution in the analysis, we now rely on field-level soil sample measurements for the initial time step ($SOC_{i,t-1}$), following the soil sampling stratification.
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 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. $SOC_{i,t} = f(SOC_{i,t}(t, DPM_{i,t}, RPM_{i,t}, BIO_{i,t}, HUM_{i,t}, IOM_{i,t}, \text{Cover Crop adoption}_{i,t}, Ks_{i,t}, In_{i,t}, FYM_{i,t}, clay_{i,t}, Temp_{i,t}, Prec_{i,t}, Evap_{i,t}, TRM_{i,t}))$ 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)

$fSOC_{i,t}$: 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 .

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 are 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 are 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 ($< 40^{\circ}\text{C}$) 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 fields are carried out every five

	years. A stratified random sampling strategy is utilised to quantify the SOC stocks for fields that are representative of each baseline scenario (see Appendix 2 for further information).
Frequency of monitoring/recording	The Modeled SOC are calculated on a yearly basis, while SOC measurements are repeated at 5-year intervals.
Value monitored	A Complete breakdown of values for $SOC_{bsl,i,t}$, $SOC_{wp,i,t}$ by strata and vintage have been provided in supplementary material "2025-05-15_soil-sampling-strata-soc-stock-sheet.xlsx", tab "soc-per-strata-summary-all-vintages".
Monitoring equipment	Soil carbon model
QA/QC procedures to be applied	Field data collection is conducted via internal field inspections and data is checked and described in the Agreea 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.
Calculation method	For the modeled SOC values see section "Description of measurement methods and procedures to be applied" in this table.
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 sample unit, the soil organic carbon stocks in the baseline scenario must be documented at intervals not exceeding five years.
Data / Parameter	$Green\ Cover_{bsl,i,t} / Green\ cover_{wp,i,t}$

Data unit	Number of green cover months / year			
Description	This parameter represents the number of months that an area is covered by green vegetation throughout the year.			
Source of data	Farmer 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 through the utilization of satellite images in our MRV process.			
Frequency of monitoring/recording	The annual data is monitored prior to each verification event.			
Value monitored	Number of green cover months in the project scenario ($Green\ cover_{wp, i, t}$)			
	Green cover months	PAI number in WP 2021	PAI number in WP 2022	PAI number in WP 2023
	4 months	355	11149	37609
	5 months	14	358	430
	9 months	25	519	1945
	10 months	27	172	587
	Number of green cover months in the baseline ($Green\ Cover_{bls}$)			
	Green cover months	PAI number in BSL 2021	PAI number in BSL 2022	PAI number in BSL 2023

	4 months	417	11997	40065
	5 months	4	0	0
	9 months	0	201	506
	10 months	0	0	0
Monitoring equipment	Digital farmer attestation			
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information. The data goes through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data are checked and confirmed by contacting farmers.			
Purpose of Data	Calculation of baseline and project emissions			
Calculation method	Not applicable			
Comments	None			

Data / Parameter	$clay_{bsl} / clay_{wp}$
Data unit	%
Description	Clay content of the soil
Source of data	SoilGrids
Description of measurement methods and procedures to be 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.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
Value monitored	$clay_{bsl} : 30.4 \pm 9.9 \%$ $clay_{wp} : 30.4 \pm 9.9 \%$

Monitoring equipment	See Source of data above
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Clay content in percent is calculated by averaging the clay content in 3 soil layers (0-5, 5-15 and 15-30).
Comments	None

Data / Parameter	$Temperature_{bsl} / Temperature_{wp}$
Data unit	°C
Description	Monthly average surface temperature
Source of data	The monthly average temperature data comes from synthetic weather stations located within 50 km of the modeled 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 modeling applications.
Description of measurement methods and procedures to be applied:	The monthly average temperature data, sourced from NASA's POWER ²⁰⁵ project, is chosen for its high resolution, global consistency, and confiability in the source. It uses synthetic weather stations within 50 km of the modeled 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.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
Value monitored	$Temperature_{bsl} : 9.6 \pm 2.3 \text{ }^{\circ}\text{C}$ $Temperature_{wp} : 9.6 \pm 2.3 \text{ }^{\circ}\text{C}$
Monitoring equipment	See source of data above

²⁰⁵ 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.

QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Daily weather data is averaged into monthly values by calculating the mean of daily temperatures.
Comments	None

Data / Parameter	<i>Precipitation_{bsl}/ Precipitation_{wp}</i>
Data unit	mm
Description	Monthly precipitation
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.
Description of measurement methods and procedures to be 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.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
Value monitored	<i>Precipitation_{bsl}</i> : 51.4 ± 10.2 mm <i>Precipitation_{wp}</i> : 51.4 ± 10.2 mm
Monitoring equipment	See Source of Data above
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions

Calculation method	Daily precipitation data is averaged into monthly values by calculating the total of daily precipitation.
Comments	None

Data / Parameter	Evapotranspiration _{bsl} / Evapotranspiration _{wp}
Data unit	mm
Description	Monthly evapotranspiration
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.
Description of measurement methods and procedures to be 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.
Frequency of monitoring/recording	The data is monitored prior to each verification event.
Value monitored	Evapotranspiration _{bsl} : 30.9 ± 12.6 mm Evapotranspiration _{wp} : 30.9 ± 12.6 mm
Monitoring equipment	See Source of Data above
QA/QC procedures to be applied	Not applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Daily evapotranspiration data is averaged into monthly values by calculating the total of daily evapotranspiration.
Comments	None

Data / Parameter	TRM																
Data unit	Dimensionless																
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.																
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). 206																
Description of measurement methods and procedures to be applied:	The qualitative information of tillage practices is reported by the farmers followed by a signed attestation for every sample unit i.																
Frequency of monitoring/recording	The annual data is monitored prior to each verification event.																
Value monitored	<table><tr><th>Tillage</th><th>TRM</th><th>Field number in the baseline</th><th>Field number in the project year</th></tr><tr><td>Conventional tillage</td><td>1</td><td>9606</td><td>0</td></tr><tr><td>Reduced tillage</td><td>0.93</td><td>495</td><td>7129</td></tr><tr><td>No tillage</td><td>0.95</td><td>101</td><td>3073</td></tr></table>	Tillage	TRM	Field number in the baseline	Field number in the project year	Conventional tillage	1	9606	0	Reduced tillage	0.93	495	7129	No tillage	0.95	101	3073
Tillage	TRM	Field number in the baseline	Field number in the project year														
Conventional tillage	1	9606	0														
Reduced tillage	0.93	495	7129														
No tillage	0.95	101	3073														
Monitoring equipment	Digital farmer attestation																
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information. The qualitative information of tillage practices goes through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data are checked and confirmed by contacting farmers.																
Purpose of Data	Calculation of baseline and project emissions																

²⁰⁶ 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>

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.												
Source of data	Farmer attestations												
Description of measurement methods and procedures to be applied:	Project scenario and baseline plant carbon inputs (In_{bsl}, In_{wp}) are estimated at field 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. The table below presents the logical evaluation of crop residues as soil biomass 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 field level. The results from these comparisons serve as residue inputs for calculating the project scenarios. For instance, fields designated for removing crop residues in their baseline activities but shifting to incorporating these residues as mulching materials have these residues as biomass inputs in the project scenario. In contrast, fields that have consistently practiced mulching would record no additional biomass inputs in the project scenario, as this practice does not increase the carbon added to the soil beyond previous activities. <table><tr><th>Baseline</th><th>Project Scenario</th><th>Outcome at Project Scenario</th></tr><tr><td>Removed</td><td>Removed</td><td>No practice change. Zero biomass inputs.</td></tr><tr><td>Removed</td><td>Mulched</td><td>Residues added as biomass soil inputs</td></tr><tr><td>Mulched</td><td>Mulched</td><td>No practice change. Zero biomass</td></tr></table>	Baseline	Project Scenario	Outcome at Project Scenario	Removed	Removed	No practice change. Zero biomass inputs.	Removed	Mulched	Residues added as biomass soil inputs	Mulched	Mulched	No practice change. Zero biomass
Baseline	Project Scenario	Outcome at Project Scenario											
Removed	Removed	No practice change. Zero biomass inputs.											
Removed	Mulched	Residues added as biomass soil inputs											
Mulched	Mulched	No practice change. Zero biomass											

			inputs
	Mulched	Removed	Removed residues added as negative biomass soil inputs
Frequency of monitoring/recording	The annual data is monitored prior to each verification event.		
Value monitored	Average annual input of organic carbon per vintage year		
	Vintage year	In_{wp}	In_{wp}
	2021	0.62	5.43
	2022	0.72	4.13
	2023	0.83	4.61
Monitoring equipment	Digital farmer attestation		
QA/QC procedures to be applied	Field data collection is conducted via internal field inspections and data is checked and described in the Agreea 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 baseline and project emissions		
Calculation method	In is calculated 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		

	<i>Carbon Content</i> : 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.									
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. Baseline and project scenario <i>FYM</i> 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 in this table. The table below presents the logical evaluation of <i>FYM</i> 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 fertilizer would be considered as FYM inputs in the PAIs that apply only synthetic fertilizer in the baseline but shift to only organic fertilizer in the project scenario. In contrast, PAIs that have consistently applied organic fertilizer 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. <table><tr><th>Baseline</th><th>Project Scenario</th><th>Outcome at Project Scenario</th></tr><tr><td>Only Synthetic</td><td>Only Synthetic</td><td>No FYM inputs</td></tr><tr><td>Only Synthetic</td><td>Only Organic</td><td>FYM equals organic fertilizer</td></tr></table>	Baseline	Project Scenario	Outcome at Project Scenario	Only Synthetic	Only Synthetic	No FYM inputs	Only Synthetic	Only Organic	FYM equals organic fertilizer
Baseline	Project Scenario	Outcome at Project Scenario								
Only Synthetic	Only Synthetic	No FYM inputs								
Only Synthetic	Only Organic	FYM equals organic fertilizer								

	Only Synthetic	Mixed	FYM equals organic fertilizer 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												
Frequency of monitoring/recording	The annual data is monitored prior to each verification event.														
Value monitored	The amount of FYM in the baseline and project scenario <table><tr><td>Vintage year</td><td>FYMbsl</td><td>FYMwp</td></tr><tr><td>2021</td><td>79.17</td><td>129.51</td></tr><tr><td>2022</td><td>78.11</td><td>70.06</td></tr><tr><td>2023</td><td>128.12</td><td>86.89</td></tr></table>			Vintage year	FYMbsl	FYMwp	2021	79.17	129.51	2022	78.11	70.06	2023	128.12	86.89
Vintage year	FYMbsl	FYMwp													
2021	79.17	129.51													
2022	78.11	70.06													
2023	128.12	86.89													
Monitoring equipment	Digital farmer attestation														
QA/QC procedures to be applied	Field data collection is conducted via internal field inspections and data is checked and described in the Agreeana 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 baseline and project emissions														
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:														

	$FYM = M_{OF,i,t} \times CC_{OF,i,t}$
Comments	None

Data / Parameter	•
Data unit	Dimensionless
Description	Gas or pool
Source of data	Determined in sample unit i
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.
Value monitored	Not applicable
Monitoring equipment	Not applicable
QA/QC procedures to be applied	See Box 1, VM0042
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$\Delta \bullet_t$ and $\bullet_t$
Data unit	t CO2e/unit area
Description	Average emission reductions from pool or source $\bullet_t$, or stock of pool $\bullet_t$, in year t Note that this project uses quantification approach 1 for SOC stocks only, thus, as above, $\bullet_t$ will always refer to changes/stocks in SOC.

	Hence $\overline{\Delta \bullet}_t$ 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,	
Source of data	Calculated from modelled 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.	
Value monitored	Vintage	$\overline{\Delta \bullet}_t$ (tCO ₂ e/ha)
	2021	0.93
	2022	0.84
	2023	0.95
Monitoring equipment	Not applicable	
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 Validation and Calibration report VMD0053.	
Comments	None	
Data / Parameter	$Buffer_t$	
Data unit	tCO ₂ e	

Description	Number of buffer credits to be contributed to the AFOLU pooled buffer account in year t
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
Value monitored	Vintage 2021: 3,,147.94tCO ₂ e Vintage 2022: 70,898.16 tCO ₂ e Vintage 2023: 281,137.00tCO ₂ e
Monitoring equipment	Determined via the Non-Permanence Risk Tool
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 fertilizer on the project area in year t

Source of data	Farm attestation
Description of measurement methods and procedures to be applied:	Mass of organic amendment applied as fertilizer 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.
Value monitored	The same values are applied as $M_{wp,OF,i,t}$ as shown above.
Monitoring equipment	Digital farmer attestation
QA/QC procedures to be applied	See Monitoring Plan Section 4.3 for further information. This data go through automated flagging systems in the project quality assurance and quality control procedures. Mass of organic amendment applied as fertilizer 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	$CC_{i,t}$
Data unit	%
Description	Carbon content of organic amendment applied as fertilizer in the project area in year t
Source of data	Carbon content of manure is derived from peer-reviewed published data. Chambers et al., 1999, Delin et al., 2012, Fouda et al., 2014, Nobile et al., 2022, Rachadaporn et al., 2015, Aboutayeb et al.,

	2014, López-Cano et al., 2016, Delin et al., 2013, Palma, 2019, Cravotta et al., 1997. ²⁰⁷	
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	The data is monitored prior to each verification event.	
Value monitored	CC _{i,t}	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

²⁰⁷ 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 fertilizer 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

	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
	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
Monitoring equipment	Not applicable	
QA/QC procedures to be applied	Not applicable	
Purpose of Data	Calculation of project emissions and leakage from application of new organic amendments from outside of the project area	
Calculation method	Not applicable	
Comments	The fertilizer table has been updated during the verification period compared to the validation period.	
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
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.
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.
Value monitored	The same values are applied as I_{nwp} as shown above.
Monitoring equipment	Digital farmer attestation
QA/QC procedures to be applied	The crop productivity data go through automated flagging systems in the project quality assurance and quality control procedures. If necessary, the data are 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”.

Not Applicable Parameters

The following are parameters that are not applicable in the AgreeenaCarbon Project in the initial verification period.

Table 4-2. Parameters not applicable in the AgreeenaCarbon Project during this verification period.

Parameter	Not Applicability Condition
$EF_{ent,l}$	These parameters are not applicable in the AgreeenaCarbon 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	
$AWMS_{i,i,t,P,S}$	
$EF_{CH4,md,l}$	
S	
$VS_{rate,l}$	
$W_{wp,l,i,t}$	
$W_{bsl,l,i,t}$	
$CC_{prj,i,t}$	
$EF_{N2O,md,l,S}$	
Nex_i	
$MS_{bsl,l,i,t}$	
$N2O_{md_{bsl,i,t}}$	
GWP_{CH4}	These parameters are not applicable in the AgreeenaCarbon Project as the Project does not allow participants to conduct any burning of residues in entering the Project.
CF_c	
c	
$EF_{c,CH4}$	
$MB_{wp,c,i,t}$	
$EF_{c,N2O}$	
tz/x	

$\Delta C_{SHRUB,bsl,i,t}$	Not applicable as these parameters are not included in the AgreeenaCarbon Project and is not measured as the only eligible vegetation in the program are arable fields. Woody biomass is not included in the baseline (see Section 4.1 of the PD)
$\Delta C_{TREE,wp,i,t}$	
$\Delta C_{SHRUB,wp,i,t}$	
$f(N_{2O_soil,bsl,i,t})$	Not applicable as nitrogen fluxes are calculated using approach 3.
$f(CH_4_{soil,bsl,i,t})$	Methane fluxes from soil methanogenesis are not included in the project boundary.
SF	These parameters are not applicable in the AgreeenaCarbon 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 AgreeenaCarbon Project. Instead, the N amount of synthetic fertilizer 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.
NC_{SF}	
$M_{wp,SF,i,t}$	
$M_{bsl,SF,i,t}$	

4.3 Monitoring Plan

4.3.1 Overview of the Monitoring Plan

The data collection undergoes QA/QC checks through pattern analysis and remote sensing. The data and parameters flagged as non-conforming undergo a thorough communication process with the Project participant to understand where the flag is coming from and whether the PAI may need to be removed from the Project. The details of these processes are described in the sections below. Overall, 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
- Organisational Structure of the Monitoring Team
- Soil Sampling and Modelling Plan

4.3.1.1 Monitoring Tasks

Project participant data reporting occurs in a structured manner on the AgreeenaCarbon platform.²⁰⁸ 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 using a combination of standard values and remote sensing analytics. The process is fully integrated into the platform; outlier values are flagged and checked as depicted in Figures 4-2 and 4-3. Project participant data reporting, and Quality Assurance (QA)/ Quality Control (QC) occurs in the following order:

1. Project participant subscribes to the AgreeenaCarbon platform where they provide information on the number, location and size of PAIs under management, as well as a detailed description of soil characteristics and historical management practises for each PAI. During the ensuing validation meeting with a Customer Success manager of Agreeena, any data discrepancies are established and resolved, and the Project participant is briefed about the process, risks and rules of the Project.
2. Following the validation meeting the QA review process assesses the practices performed on the PAI during the last 5 years and ensures that an accurate baseline is established. Following QA review, baseline establishment, admission to the Project, and implementation of Project activities, the Project participant enters their annual harvest data on the platform after the following harvest. This data undergoes QC screening and is then utilised to calculate carbon sequestration and reductions on an annual basis. The parameters monitored are fertiliser application, yield, tillage practice, residue management, catch/cover cropping practices and fuel and crop protection usage.

Data is archived for retrospective assessments or auditing if required.

4.3.1.2 Monitoring Boundaries

The Project is organised and monitored on a PAI basis. and the boundaries of each are detected by a field boundary detection (FBD) remote sensing model based on pin locations provided by the

²⁰⁸ A platform where the project participants can enter their historical data and field actuals and where the verifying data is also separately uploaded.

Project participant. The Project sets accounting boundaries for carbon dioxide (CO₂) and nitrous oxide (N₂O) as described in Table 4-3.

Table 4-3. An outline of the monitoring of the Project boundaries

Greenhouse gas	Component	Activities
CO ₂	Carbon stock changes	Management practices
		Res. mgmt. (storage)
		Cover Crops
		Org. input (storage)
N ₂ O	Residue emissions	Res. mgmt. (emissions)
N ₂ O	Soil emissions	fertiliser emissions
CO ₂	Energy use	Soil management activity

4.3.1.3 Parameters Measured

The parameters subject to monitoring and QA/QC review are described in Section 4.1 and their quantification approach described in Table 4-4

Table 4-4. 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)

4.3.1.4 Data Collection

Project monitoring activities are aligned with European annual harvest cycles. Figure 4-1 depicts the usual periods when each monitoring activity occurs, following validation meetings and signing of contracts, historical data²⁰⁹ from Project participants undergoes QA during Q2 and Q3. QA is only performed once during the Project participant's first harvest year and will result in the establishment of each PAIs baseline for the next 10 years. After completion of QA, QC is carried out prior to each verification event, taking place during Q2 and Q3. QC is initiated when the Project participant has provided information on their PAI ²¹⁰ to the Project platform.

As the Project participants follow the harvest year, the Project 'year' is defined as the year of harvest data being fully complete. For Eastern Europe, harvest runs later into autumn and early spring, hence does not strictly follow a calendar year. Depending on geographical region the timing of QC

²⁰⁹ Data given for each PAI on a project proponents farm, covering the last 5 years. Field location, Soil characteristics and cultivation practices.

²¹⁰ Information on which Project Activities each PAI on a project participant's farm has been subjected to during the harvest year.

can therefore vary. The monitoring process however is continuous: from the point of receiving the first new PAI location and through to QC on annual data for the key parameters monitored.

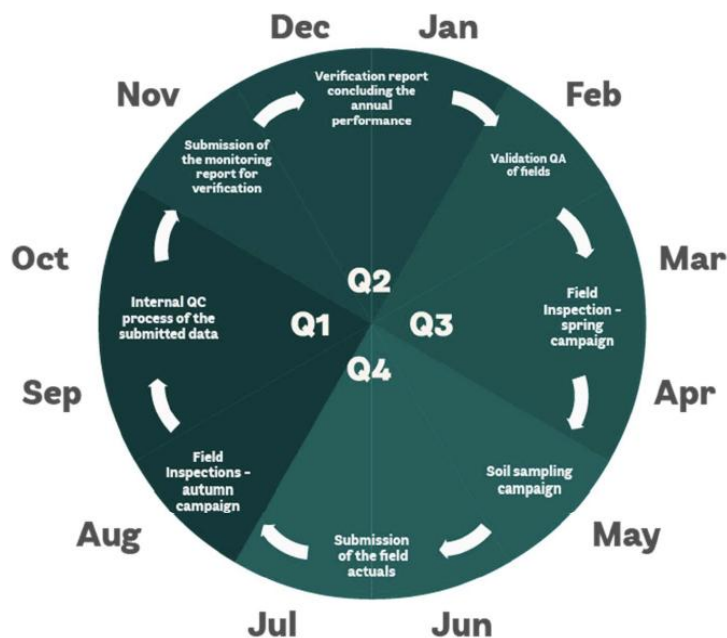


Figure 4-1. Annual cycle of monitoring plan overlaid with harvest year quarters. This adapts and changes depending on the country's harvest year.

The monitoring framework is designed for the Project and built upon in-house expertise and technologies. In addition to the monitoring process and the Project participants reported 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 PAIs, 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 PAIs to be inspected is determining 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 ERRs achieved. The outcomes of the inspections 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 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, how they report their data, and highlight areas that would result in changes to their reported data.

After the total no. of PAIs to inspect has been determined, the weighted average of each geography is applied to the number of PAIs to calculate the number of PAIs required for inspection in each geography. This should be done with a threshold of > 10% to initiate inspections, whereafter PAIs are selected at random. 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, and furthermore includes tillage, residue management, cover cropping, fertilisation and pesticide applications. Additional data points collected includes: seeding and termination/harvest dates for both cover and cash crops, types of cash crop (spring/winter), and additional machinery types. Customer satisfaction and Project understanding questions are likewise asked relating to the Project participants interaction with the platform, soil carbon knowledge, and understanding of the verification process.

The findings from the internal inspections are considered 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.

To train remote sensing models to detect practices 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 to ensure the model is trained across multiple climate zones, soil types and farm types. 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 Agreena relies on for this are selected on account of their agricultural knowledge. They are primarily

agronomists, farmers, or hold positions in the wider agricultural industry while collecting data for Agreena as part time work.

Ground truth collection frequency and Quality Control:

The quality control process of collected ground truthing data 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 is 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, with the majority occurring in autumn and spring, when the relevant Project activities (residue management, and cover/catch crops) can be identified. Once suitable quantities of data has 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 internal 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 issues occur, they are flagged red, and more checks are performed.

4.3.1.5 Baseline Control and Re-evaluation Plan

The baseline is established at the PAI-level from the historic look-back period of 5 years, with data provided by the Project participants, as well as default regional values where required (see Table 3-4). To ensure the validity of this data, a QA process is implemented utilising remotely sensed data

(see section 4.3.1.6 and 4.3.1.7). If inconsistencies between reported and measured data are identified, a technical recalculation of the baseline may occur. The initial baseline is valid for 10 years, and a second decade-long baseline will be established then to provide the required 20-year period. Thus, each 10-year period will have a separate Project baseline, to accurately account for the potential changes in key soil parameters caused by 10 years of implementing Project-supported farming practices. The baseline setting process is described in Section 3.4 “Baseline Scenario” of the AgreeenaCarbon Project PD, v1.3.

At the point of establishing the second decade long baseline (after the first 10-year period), the Project will utilise the data collected over the previous ten years to establish the updated PAI-specific baseline. Because this data will have already gone through the QC process described in this document and submitted as part of Project monitoring, it will already meet all standards and VCS requirements for data. 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 AgreeenaCarbon 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 chapter 3.4 of the PD. The baseline draft will be shared with the Project participant and the new baseline will be stated in the contract following approval.

4.3.1.6 Quality Assurance and Quality Control Procedures

To assure the validity of the data provided by the Project participant, a QA/QC process automatically flags data where a risk of overestimating GHG emissions is found, as shown in Figure 4-2 and in greater detail in Appendix 3.

Duplication	Field location	Flagged points from HB	Multiple points from HB	Field size	Field size (field level)	Field size (farm level)	Deforestation	Soil disturbance	Soil disturbance hb	Cover crop	Cover crop hb	QA status	settings
36.209768, 48.51418	no	no	no	166.11 ha	-1%	0.3%	no	reduced tillage	2021 no till, 2020 min till, 2019 conventional till, 2018 conventional till	no cover crop	2021 (0.5933, 0.4487, 0.3071, 0.3713, 0.6312) no, 2020 (0.4007, 0.3372, 0.4968, 0.3987, 0.4279) no, 2019 (0.3391, 0.1722, 0.4402, 0.4991, 0.6437) no, 2018 (0.1797, 0.1253, 0.1644, 0.0911, 0.1887) no	Approved	Actions
36.199151, 48.502731	no	no	no	216.8 ha	-3.4%	0.3%	no	reduced tillage	2021 no till, 2020 conventional till, 2019 no till, 2018 conventional till	no cover crop	2021 (0.4002, 0.3036, 0.1684, 0.2005, 0.3701) no, 2020 (0.5241, 0.4889, 0.4634, 0.6111, 0.691) no, 2019 (0.0404, 0.1043, 0.1754, 0.1775, 0.1821) no, 2018 (0.612, 0.4839, 0.5867, 0.3347, 0.7264) yes	Approved	Actions
36.179753, 48.507138	no	no	no	174.21 ha	-1.8%	0.3%	no	reduced tillage	2021 no till, 2020 conventional till, 2019 no till, 2018 conventional till	no cover crop	2021 (0.4428, 0.3518, 0.1641, 0.1947, 0.2999) no, 2020 (0.5182, 0.4366, 0.783, 0.5845, 0.6802) no, 2019 (0.1643, 0.1068, 0.1784, 0.18, 0.1773) no, 2018 (0.852, 0.8258, 0.7995, 0.6678, 0.8163) yes	Approved	Actions
36.194407, 48.614723	no	no	no	68.17 ha	-3.2%	2.9%	no	reduced tillage	2021 conventional till, 2020 conventional till, 2019 conventional till	no cover crop	2021 (0.249, 0.2001, 0.165, 0.2256, 0.2075) no, 2020 (0.4122, 0.3982, 0.2527, 0.3305, 0.4066) no, 2019 (0.0016, 0.0563, 0.2125, 0.2273, 0.2739, 0.3521) no	Approved	Actions
Fertiliser verifier	Crop	Yield	Soil disturbance actuals	Soil disturbance HB verifier	Field def	Fuel	Residue management	Cover crop verifier	Cover crop HB verifier	Cover crop HB data	settings		
organic, synthetic 159.0 kg N/ha	Winter wheat 12.0	7.0 t/ha	No till	HB: Conventional	Reduced tillage	50.0 l/ha	Removed	No	HB: no	(0.4013, 0.9916, 0.4233, 0.4669, 0.4659, 0.4601) no	Actions		
organic, synthetic 250.0 kg N/ha	Maize for silage 70.0	12.0 t/ha	Reduced tillage	HB: Conventional	Reduced tillage	70.0 l/ha	Removed	Until spring	HB: yes	(0.8194, 0.9972, 0.7426, 0.7237, 0.4947, 0.7257) yes	Actions		
synthetic, organic 343.0 kg N/ha	Grass-clover mix 70.0	9.0 t/ha	No till	HB: Conventional	Reduced tillage	90.0 l/ha	Removed	No	HB: yes	(0.8256, 0.9969, 0.7962, 0.7526, 0.4933, 0.7366) yes	Actions		
organic, synthetic 155.0 kg N/ha	Maize for silage 70.0	12.0 t/ha	Reduced tillage	HB: Conventional	Reduced tillage	90.0 l/ha	Removed	Until spring	HB: yes	(0.81, 0.9971, 0.7532, 0.8363, 0.4632, 0.6699) yes	Actions		
organic, synthetic 211.0 kg N/ha	Rapeseed (outdated) 7.0	4.0 t/ha	No till	HB: Conventional	Reduced tillage	50.0 l/ha	Mulched	No	HB: yes	(0.8515, 0.9981, 0.7228, 0.7605, 0.4981, 0.6767) yes	Actions		
synthetic 0.0 kg N/ha	Field beans 8.0	5.0 t/ha	No till	HB: Conventional	Reduced tillage	50.0 l/ha	Mulched	No	HB: no	(0.7876, 0.9975, 0.6636, 0.554, 0.2739, 0.3521) no	Actions		

Figure 4-2. A visualization of the A - Quality Assurance (QA) and B - Quality Control (QC) process of data within the Project platform. Each row represents a PAI. Columns are parameters monitored in the QA/QC process, as well as a record of any status change performed by the monitoring analysts. A more detailed version can be found in Appendix 3.

Data is organised within the QA/QC system with the flagging system shown in Figure 4-3. Green flags are always approvable for both QA and QC. Blue flags are also approvable, except for PAI 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, a Customer Success specialist contacts the Project 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”. The means of communication is happening through phone calls or emails and the information is captured in the form of excel sheet templates stored on the internal Google Drive.

Flag colour 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 4-3. Explanation of flag system used during QA and QC process.

4.3.1.7 Quality Assurance (QA):

Remote sensing is the principal means of verifying PAI historical data 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 crops

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 t, and QA continues for 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-compliance.”

PAI Area / Cumulative PAI Area

After assuring that PAI coordinates are correct, the area (boundary) associated with each PAI is evaluated. A PAI size is flagged blue if detected PAI size is larger than reported. In this case, there are two outcomes: (1) if the detected PAI size is <100% larger than the reported, the PAI size can be approved. (2) If the reported PAI size is >100% larger than the reported size, a Customer success specialist will consult the project participant for clarification (See Figure 5-3). A PAI size can be flagged yellow if: PAI size is detected as being smaller than the reported. In the instance of a yellow flag, two things can happen. (1) If the cumulative PAI 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 cumulative PAI size is yellow the process is equal to the one performed if a PAI is flagged blue >100% (Figure 5-3).

An additional check for the PAIs onboarded in HY2023 was introduced to better account for potentially overlapping boundaries with new and existing PAIs, which may result in over-issuance of VCUs. The few extra data points allow to improve the PAI location and associated area (boundary) QA checks.

Duplication	Field size >	Intersection (%) >
24.5204, 5...	-61.4 % 15.22 ha 5.87 ha	98.45
24.5811, 57...	118.4 % 5.99 ha 13.08 ha	46.68
25.828462...	28.0 % 10.09 ha 12.92 ha	20.34

Figure 4-4. Visualization of the extra parameter added to the Quality Assurance (QA) of the location and size of each PAI. The Intersection (%) column relates to cases where two or more PAI areas overlap with one another. (For more detailed information of the table see section 4.3.1.6 and Appendix 3).

In the instance of a blue, yellow, orange or red flag, a Customer Success specialist consults the Project participant and require shapefiles or similar depictions of each impacted PAI to be sent. An offline approach will be carried out by the monitoring analyst to ensure any necessary correction are made. PAIs marked other colours than green under the checks of field size and overlap (Intersection) following this process will be marked “non-compliance”.

Clearing of native ecosystems (and deforestation)

Following approval of the location plus field and PAI size, checks are performed to identify any clearing of natural ecosystems. The loss of forest canopy cover over 20 years and that of natural ecosystems over the course of 10 years are both checked during the QA process. If more than 0.5 ha of contiguous forest canopy cover²¹¹ has been lost from a PAI in the last 20 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

²¹¹ 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>

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, as the PAI will be marked as non-compliant.

Checks for deforestation, native ecosystem and wetland clearing are performed using datasets produced by the Global Land Analysis and Discovery (GLAD) laboratory²¹², 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 (20 years for deforestation).

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, and possible outcomes are as described in section 4.3.1.6 (see Appendix 8 of the AgreeCarbon PD for complete description of the model development for tillage detection and the application of the model for monitoring and verification).

Cover/Catch crops

The cover crop parameter is sorted into four categories (1) No cover crops (2) Catch crops (3) Cover crops up until winter (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 several vegetation indices, 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, and if deemed acceptable the parameter is approvable. If there's discrepancy between the NDVI and the reported data, the Project participant is consulted, and possible outcomes are as described in section 4.3.1.6. Additional information about the differentiation between NDVI results is elaborated in the description below.

When all parameters described in this section are approvable, the PAI undergoes a status change to "approved".

²¹² 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>

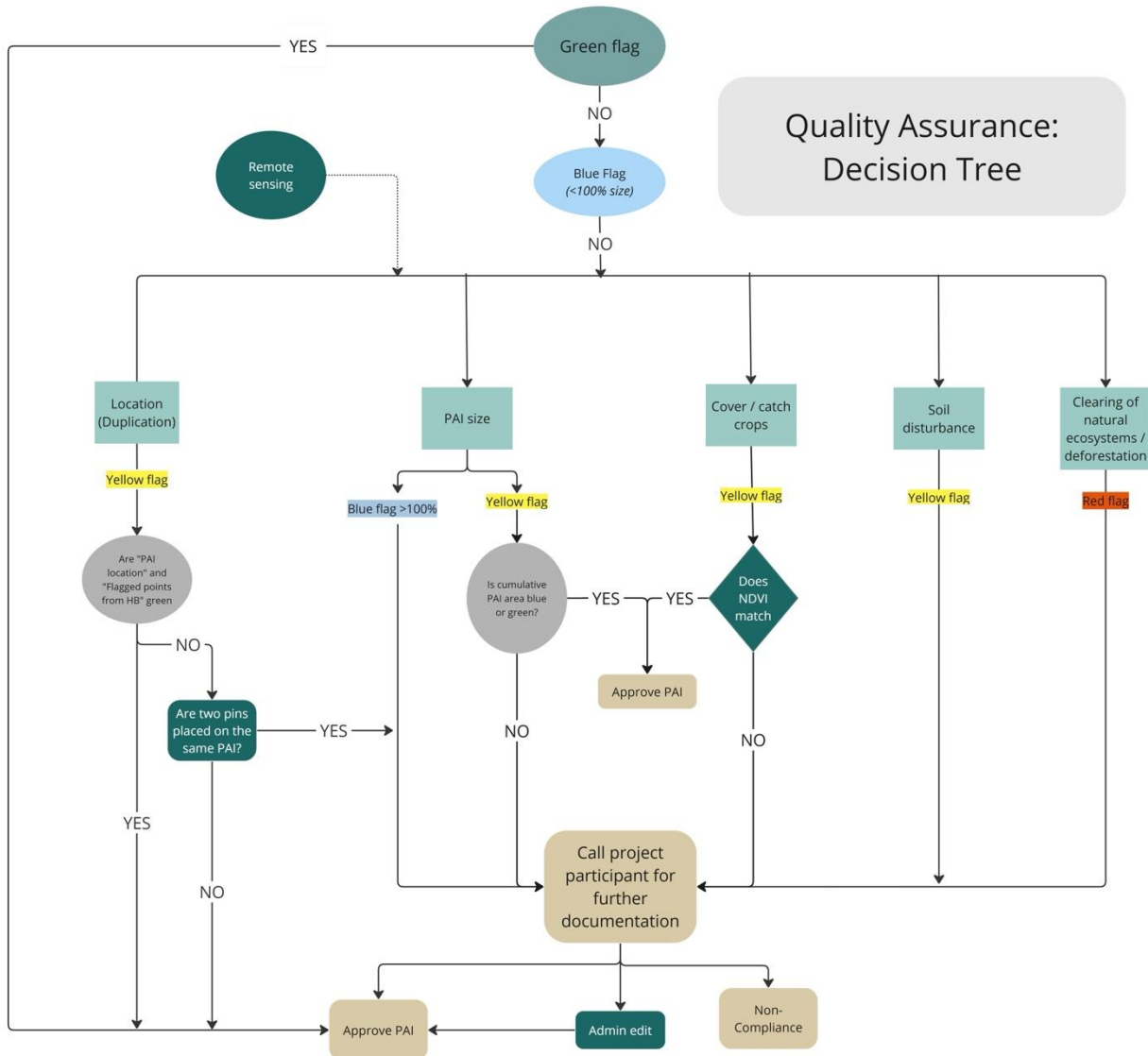


Figure 4-5. Overview of the Project's quality assurance (QA) process and how decisions are made, with the following five parameters being assessed: Location (Duplication), PAI size, soil disturbance, clearing of natural ecosystems (and deforestation) and cover crops. Dotted lines represent the data source 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 4-3). All flags either result in a PAI approval, admin edit followed by approval, or a status change to non – compliance.

The PAIs will undergo QA one time during the first harvest year after the Project participant has enlisted in the Project.

4.3.1.8 Quality Control (QC):

After the PAIs have been QA approved, PAIs undergo QC, which happens once a year at the end of each harvest cycle. 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 the Project participant. The means of communication is happening through phone calls or emails and the information is captured in the form of excel sheet templates, and sometimes management plans, which is stored on the internal google drive and Hubspot Communication site which is used for all Project participants.

Fertiliser

Crop specific literature ranges for reported fertiliser application rates gives 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 (N) fixing crop type, then the parameter is deemed approvable. (2) If the crop is not N-fixing, 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. Here further documentation is likewise necessary. When documentation has been received, the possible outcomes are as described in section 4.3.1.6

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 (i.e., monitoring of the Project activities), the Project participant will be asked to present a fertiliser management plan if there is a flag – that is to say, if there is a discrepancy between the Project participants reported data and

the average fertiliser range for that given crop. In the instance that the Project participants does not have any available documentation in the form of fertiliser management plans then the real value is confirmed through emails or over the phone to cross-check. 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. Possible outcomes are as described in section 4.3.1.6

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 3). Possible outcomes are as described in section 4.3.1.6.

QC procedures for Actuals data were improved in 2023 for fuel usage calculations. In 2022, this information was used as a secondary verifier to soil disturbance, but in 2023, it became an independent data point with its flag. Since 2023, the soil disturbance flag is determined solely by remote sensing tillage predictions, while the fuel usage flag is based on the reported soil disturbance practice.

Residue management

Monitoring of residue management is done 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 (e.g. forage crops cannot have mulched residue) the PAI is admin edited and deemed approvable afterwards. Yellow flags come in the case that (1) if 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 a consultation with the Project participant, and the possible outcomes are as described in section 4.3.1.6

Liming

The Project has brought forward a methodology deviation (see Section 3.2.1) 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 farmer 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.²¹³ 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 cultivated 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. 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 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 PAI actuals. The parameter is approvable. (2) The crop type matches the reported cover crop practise, 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. An admin edit is performed followed by an approval of the parameter (4) The NDVI match, but the growing period of the crop

²¹³ Lokupitiya, E., & Paustian, K. (2006). Agricultural soil greenhouse gas emissions: a review of national inventory methods. *Journal of Environmental Quality*, 35(4), 1413-1427.

type is not clear. 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 here.

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 a cover/catch crop was present for a given PAI and 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, monthly NDVI values help determine a timeline of vegetation cover, for example indicating if vegetation was present up until winter or up until spring.

Furthermore, several improvements have been made to the QC Project platform processes, now able to distinguish nitrogen fixing crop types as well as crops for forage harvests - and thereby flag accordingly to avoid increased manual processing. Actions for each flag colour are the same as the 2022 ones described in section 4.3.1.8.

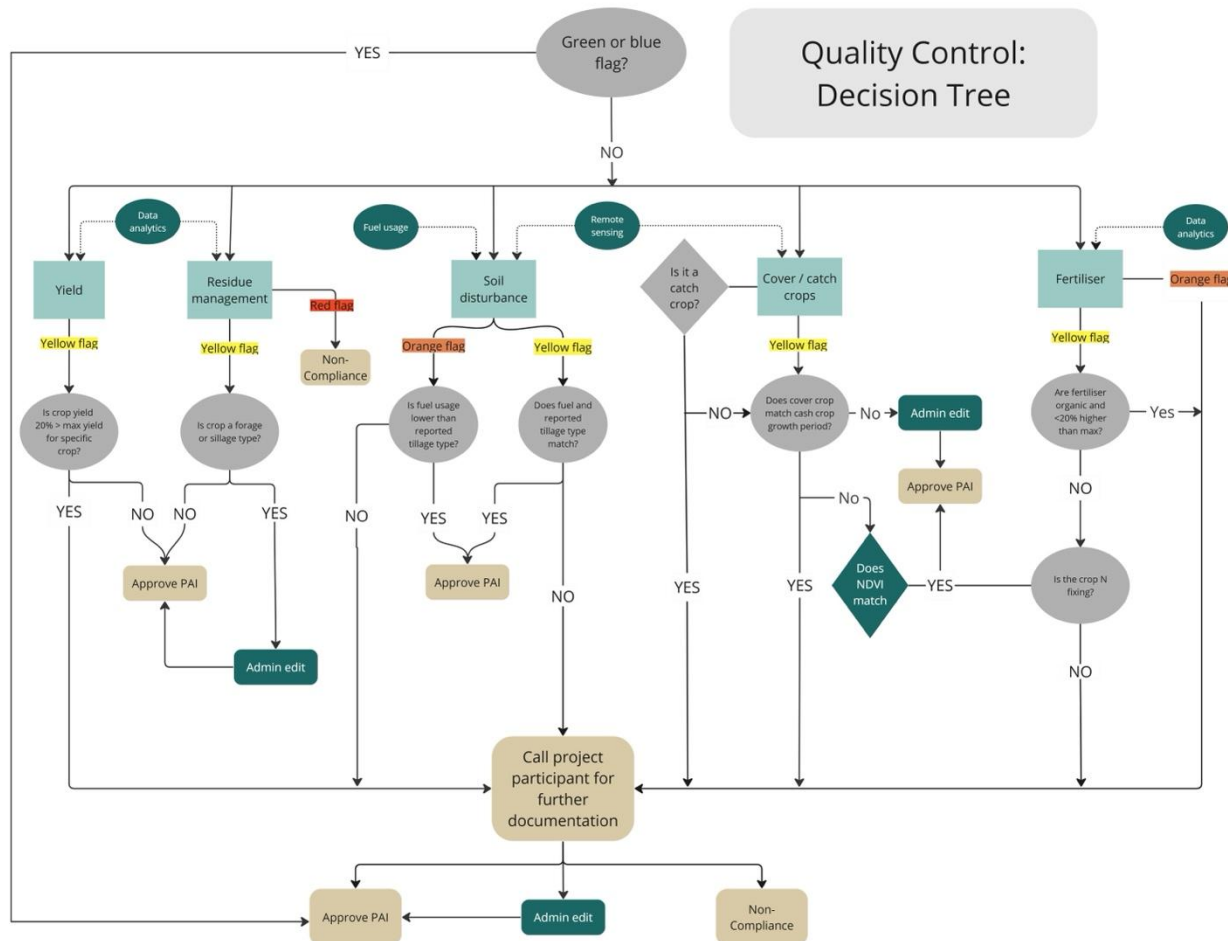


Figure 4-6. Shows an overview of the Project Quality Control (QC) process and how decisions are made, with the following five parameters being assessed; yield, residue management, soil disturbance, cover/catch crops, and fertiliser. Dotted lines represent the data sources for the verification method feeding into the five parameters. Each verifier triggers a certain flag depending on whether it deviates from set standards (Figure 4-3). 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.

4.3.1.9 Leakage

As presented in Section 4.3 of VM0042 v2.0, leakage must be considered 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 to capture potential leakage that could result from the Project.

Every year, as part of the gathering of information from Project participants, any Project participant that reports organic amendments amongst their Project activities, but did not do so in their baseline, are identified and further examined. Equation 34 is applied in cases where leakage could be identified, and for each PAI included in the leakage analysis, the leaked CO₂e is calculated. Following this, the effect is summed for all 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 such analysis can be seen.

According to VM0042 v2.0, it is also necessary to capture the productivity related to leakage every ten years. As such, the following procedure will be completed under monitoring procedures:

Step 1: When using yield data, Equation 35 will be used to calculate the average productivity of each product to average pre-Project productivity of the same crop. 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%, then Step 2 must be completed.

Step 2: Determine whether it is a short-term change in productivity: repeat Step 1 but exclude data input from the first three years of Project implementation. If the decline is still greater than 5%, then Step 3 must be undertaken.

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 caused the decline, then the combination of factors must be removed for future iterations of that PAI.

In this reporting period leakage was in 2021 equal to 698.76 t CO₂e, in 2022 equal to 19,875.6 t CO₂e and in 2023 equal to 76,040.96 t CO₂e.

4.3.2 Harvest Year 2022 and 2023 QC Procedure Outcome

While the Project comprises three vintage years, the quality assurance and quality control process (QA/QC) is conducted based on reported data based on harvest year. Therefore, the QC process was conducted twice over the verification period, to cover HY2022 (2021-2022) and HY2023 (2022-2023). As a result of the QC Decision Tree procedures, 73% of PAIs in HY2022 and 40% in HY2023 had reported actuals edited/corrected in at least one category. 32,881 edits were made across 8,703 PAIs in HY2022 and 11,380 edits were made across 13,675 PAIs in HY2023.

In total, 3,496 PAIs (127,201.47 ha) in HY2022 and 26,807 (993,463.94 ha) in HY2023 could be approved without further consultations or admin edits made to the reported PAI actual practices. The data reported for these PAIs were reasonable and there were no discrepancies between the reported data and expected/acceptable values. For further description of the review process, see the Quality Control Decision Tree (Figure 4-5).

In total, 281 Project participants were consulted during the QC process in HY2022 and 537 in HY2023. They were contacted through e-mail, HubSpot or phone-based consultation carried out by the Customer Success department in order to obtain further documentation to support the reported data.

Table 4-5 shows a summary of the outcome from the QA and QC procedures completed, specifying the changes made either as a direct result of the control or after consultations and documentation were provided by Project participants.

Table 4-5. Quality Control flags, procedures and monitoring outcomes for HY 2022 and 2023.

	2022		2023	
Reason for approval	No. of fields	Hectares	No. of fields	Hectares
Approved without further action - (Green/Blue)	3,496	127,201.47	26,807	993,463.94
Yield corrected	6,381	271,593.75	497	32,311.27
Residue management corrected	6,324	270,018.3	6	214.15
Tillage practice corrected	6,368	270,166.13	5,797	309,760.55
Fuel level corrected	270	11,392.4	2,707	137,592.85

Cover crop or catch crop practice corrected	7,198	288,808.33	2,303	53,015
Nitrogen levels corrected	5,821	253,283.46	1,710	57,498.9
Total Edits ²¹⁴	32,881	N/A	11,380	N/A
Total PAIs	12,198	471,872	40,571	1,652,644

4.3.2.1 Non - compliance

PAIs not adhering to the Projects set standards, are marked as in non-compliance. This encompasses the following instances:

- Duplicated PAIs / wrongly added PAIs
- PAIs where a clearance of the natural ecosystem or deforestation has happened in the last 10 years
- PAIs where crop residue has been burned
- PAIs where additionality is not fulfilled

A PAI marked as non-compliance will not generate certificates.

In this Verification Period there were non-compliant PAIs which were detected during additionality and native ecosystem tests. The common practice test found that 998 PAIs associated with 10,239.45 ha were not additional based on the common practice in the relevant region, i.e. implementing only one Project activity with an adoption rate higher than 20%. It was found that 221 PAIs were linked with ecosystem clearance in the past 10 years, for a total of 3381.88 ha. Datasets were adjusted accordingly, excluding non-compliant PAIs from ERRs calculations and GHG sequestration claims.

²¹⁴ Please note: PAIs can have had multiple reasons for edits)

4.3.2.2 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.

4.3.2.3 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, it is 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 utilised, 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.

4.3.2.4 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 4-6 below.

Table 4-6. 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 • To mitigate risks and discrepancies
Data Monitoring Analysts	• QGIS • Excel • Agricultural expertise	• To process data required for Project monitoring • To oversee flagging system for data • To identify risks to data quality and

	• Data analytics • Quicksight	address • To approve compliant information • To forward questions and flagged data for confirmation to the Customer Success team
Remote Sensing specialists	• Data Science • Machine learning • Remote sensing model capabilities	• To assess PAI boundaries, and management practices from received PAI location data • To train and model remote sensing tools to provide accurate reading of PAIs
Customer Relations/Success managers	• Customer relations • Excel • Quicksight • Agricultural expertise	• To onboard new participants and PAIs into the Project, sourcing necessary data from each Project participant. • To follow up with Project participants on data discrepancies • To manage Project participants' data inputs, additions and annual data

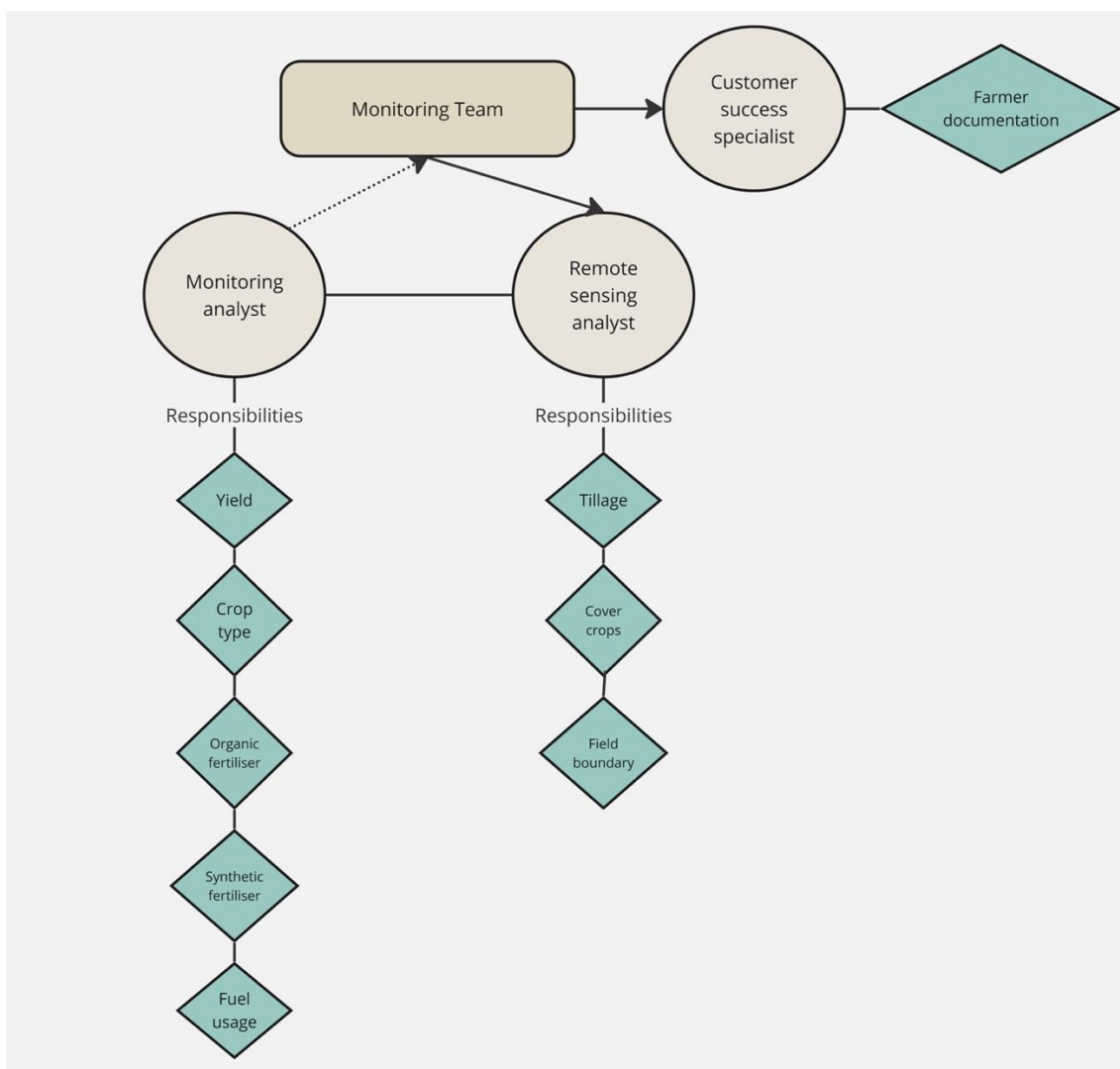


Figure 4-5. A structural overview of the monitoring team.

4.3.3 Soil Sampling Monitoring Plan

The VM0042 v2.0 guidelines require the Project to sample soil from PAIs within the Project area. Soil organic carbon 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, whose regions present varying climate, geology, and topography. The soil sampling plan

has been designed and developed for measuring PAI-level SOC stocks and the calculated uncertainty, accounting for the heterogeneous landscapes of Europe.

The Project aims to estimate changes in SOC stocks, as a result of improved management practices, by running the aforementioned soil carbon model for PAIs within the 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 do soil sampling, 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 stratum are 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 minimises 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 area associated with a given PAI.

The monitoring period covers the first and second harvest years since the Projects start date, from 15th September 2021 to 31st December 2023. Project participants undergo a validation meeting prior to contracting followed by the QA process during the first two quarters (Q1/Q2). The QC process is initiated following PAI actuals submission in Q4 only when the Project participants submit their field actuals on the Project platform (Figure 4-1). Thus, soil sampling was conducted on QA/QC'd PAIs after the first HY which represents $t = 0$ in the baseline setting.

4.3.3.1 Project level stratification

PAIs are apportioned into suitably homogeneous strata using a clustering method that takes a combination of management, soil, climate, and geopolitical data as input. Specifically, the clustering process ingests for each PAI:

- The 5-year historical baseline 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 VMD0053 v2.0 and in the MVR (CZ/CFG/PC), 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).

The apportionment of PAIs to strata then proceeds via a hybrid hierarchical, k-means clustering algorithm²¹⁵, where a hierarchical clustering is split into k clusters to initialise a standard k-means clustering²¹⁶. The number of strata (clusters) is selected via cross-validation and gap statistic²¹⁷ 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 in the development of Project strata.

PAIs are randomly selected within each stratum 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. 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.

4.3.3.2 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 area associated with the PAI. Given such within PAI sub-strata, an appropriate number of cores per PAI are randomly allocated. As a default, there are nine coring locations per PAI, apportioned amongst the within PAI sub-strata.

²¹⁵ 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>

²¹⁶ Kassambara, A., & Mundt, F. (2020). *factoextra: Extract and visualize the results of multivariate data analyses* [Manual]. <https://CRAN.R-project.org/package=factoextra>

²¹⁷ 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>

4.3.3.3 Soil Sampling Analysis

Soil samples were taken from PAI locations in the United Kingdom, Denmark, Bulgaria, Romania, Spain, Lithuania, Moldova, and Ukraine between 3rd October 2022 and 14th December 2024 with a total of >8000 individual soil sampling points, amounting to over 25,000 samples.

Soil sampling is carried out by third party partners. Soil cores were extracted from three to five locations within each PAI sub-area using automatic corers. A Wintex 2000; ($L=1.0$ m; $D=36$ mm) corer was used in the United Kingdom, Denmark, Bulgaria, Romania, Spain, and Lithuania. A custom-made stainless-steel corer ($L=0.6$ m; $D=49$ mm) was used in Ukraine in 2023, and a Giddings hydraulic corer ($L=1.2$ m; $D=50$ mm) was used in Ukraine and Moldova in 2024. Across all countries, the intact soil core was split into three depth layer (dl) increments of 0-15, 15-30 and 30-60 cm. In shallower soils (<30 or <60 cm), cores were taken down to the bedrock or impeding layer. Throughout the United Kingdom, Denmark, Bulgaria, Romania, Spain, and Lithuania, the soil organic carbon concentration (OC; g/kg) in each depth increment was analysed by dumas dry combustion using an Eltra CS580A elemental analyser (GmbH, Germany). In Ukraine and Moldova, utilising the Walkley-Black method, soil organic carbon concentration was analysed through wet oxidation (DSTU 4289:2004). Bulk density (BD; g cm⁻³) was determined by dividing the total dry mass of the core ($M_{n,dl,Sample}$; g) by the volume of the core. The core volume was calculated by multiplying the cross-sectional area of the core (from D) by the core depth layer (dl). The corrected bulk density (BD_{corr} ; g cm⁻³) was obtained by accounting for the mass and volume of the coarse fraction (>2 mm) in the core. Thus, SOC concentration, bulk density and soil mass (excluding the coarse fraction) were obtained from the same sample core at each depth layer. The soil samples were stored in refrigeration ($<4^{\circ}\text{C}$) and shipped within five days of collection. The parameters monitored during soil sampling enable the calculation of SOC stocks by fixed depth or on an equivalent soil mass basis ^{218,219}, which is required to calculate SOC stock changes at resampling.

Once analysed, the soil sampling results are sent to the Project. The results are reviewed for outliers using a range of functions (e.g., interquartile ranges, modified z-scores or local outlier factors). Additionally, values of soil organic carbon and bulk density that exceeded typical ranges for mineral soils (e.g., >100 g/kg and $BD_{corr} >2.65$ g cm⁻³) are also deemed outliers and removed from the

²¹⁸ Wendt and Hauser (2013) doi:10.1111/ejss.12002

²¹⁹ Von Haden (2020) doi:10.1111/gcb.15124

analysis.^{220,221,222} Where outliers are observed, the georeferenced sample IDs are sent to the soil sampling partner who subsequently provides a visual assessment of the samples for clarification. A summary of the soil sampling protocol is described in Appendix 2.

4.3.3.4 Stratification and soil sampling results

The stratification algorithm described in Sections 4.3.3.1 and 4.3.3.2 is applied to PAIs entering the Project over the monitoring periods spanned by this report. Included are the 526 PAIs for which soil sampling results are available. This results in 27 distinct strata created in this verification period. For strata with soil sampling results, PAI-specific SOC stock model runs are initialised with the average measured SOC value. A summary of the strata, specifically their sizes and number of PAIs, as well as a summary of the subset that have been sampled is contained in Table 4-8.

The “stratification-by-clustering” supplement supplied alongside this report contains the information on the PAIs and data used to develop the stratification. The assignment of PAIs to specific strata is included (as a supplement) alongside the required, as per VM0042 8.2.1.2, spreadsheet of strata sizes and samples. This process is detailed in the “stratification-by-clustering” supplement, which also contains the derivation of strata-specific mean SOC stocks from soil sampling data. Raw soil sampling data used to calculate strata SOC stock means are available in the “soil-samples-sheet-for-mr” excel spreadsheet included as supplementary material.

Table 4-8 Strata and strata mean SOC stocks derived from soil sampling campaigns conducted during first verification period, covering vintages 2021, 2022 and 2023.

Strata ID		Strata Area (Ha)	Strata Mean SOC Stock (tC/ha)
X2	65,142.77		62.53
X6	51,577.89		65.02

²²⁰ [Feeney, C. J., Bentley, L., De Rosa, D., Panagos, P., Emmett, B. A., Thomas, A., & Robinson, D. A. \(2024\). Benchmarking soil organic carbon \(SOC\) concentration provides more robust soil health assessment than the SOC/clay ratio at European scale. *Science of The Total Environment*, 951, 175642.](#)

²²¹ [Schjønning, P., McBride, R. A., Keller, T., & Obour, P. B. \(2017\). Predicting soil particle density from clay and soil organic matter contents. *Geoderma*, 286, 83-87.](#)

²²² [van Wesemael, B., Abdelbaki, A., Ben-Dor, E., Chabrilat, S., d’Angelo, P., Demattê, J. A., ... & Žížala, D. \(2024\). A European soil organic carbon monitoring system leveraging Sentinel 2 imagery and the LUCAS soil data base. *Geoderma*, 452, 117113.](#)

X8	7,476.62	82.61
X11	65,253.88	76.27
X13	1,204,027.41	57.02
X15	1,469.56	57.02
X16	16,459.17	95.90
X17	5,362.58	48.62
X19	5.44	57.02
X21	79,301.03	95.90
X23	9,091.81	74.83
X24	6,440.62	67.774
X25	36,756.36	46.36
X26	7,168.48	45.94
X27	8,590.63	75.85
X28	55,354.244	75.69
X31	13,201.01	65.02
X33	10,499.60	72.79
X36	1,831.71	66.69
X39	7,633.04	87.36

4.3.4 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 4-1. 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 data 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 Spring following farmer submission of Project activity

data. The checking of the PAIs is happening on a continual basis and the new PAIs will be fed into the validated and calibrated model according to VMD0053. The ERRs achieved during more than one monitoring cycle/harvest year may be included in the Monitoring Reports for each VCS Verification event.

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 of the PD. All data fed into the model will be updated to reflect the most up to date climate, soil, and practice data across project area.

Use of Approved Model Version

The Project utilises 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 Independent Modelling Expert (IME) as per VM0042 v2.0 guidelines. The parameters can be found in the VMD0053 MVR report submitted as part of the validation process.

Quality Assurance/Quality Control (QA/QC) of Inputs Set up

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 section 4.3.1.7 and 4.3.1.8. 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 standardised 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.

5 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 AgreeenaCarbon Project, including the equation numbers consistently with VM0042 v2.0 for explicit references.

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: Tutorial for the leakage calculation
4. Supplementary_Material_4_Uncertainty: Tutorial for the uncertainty calculation

The ERR calculation spreadsheet shows the detailed calculation processes using Excel files that include data inputs, formulas, results and definitions of each column. Supplementary Material 1, 2, 3 & 4 provide data and PDF files to show the data inputs, calculation R codes and results. To reproduce the results interactively, the raw coding materials including R Markdown files, necessary R packages and environment are provided in the folder “raw_coding_materials_for_reproducing_results_interactively” (Detailed instruction files are also provided in this folder to show how to use R and reproduce the results by setting up the proper R environment and running R Markdown files). R Markdown files provide 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 from R markdown files are also shown in the corresponding PDF files in Supplementary_Material_1, 2, 3 & 4.

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 Chapter 4.

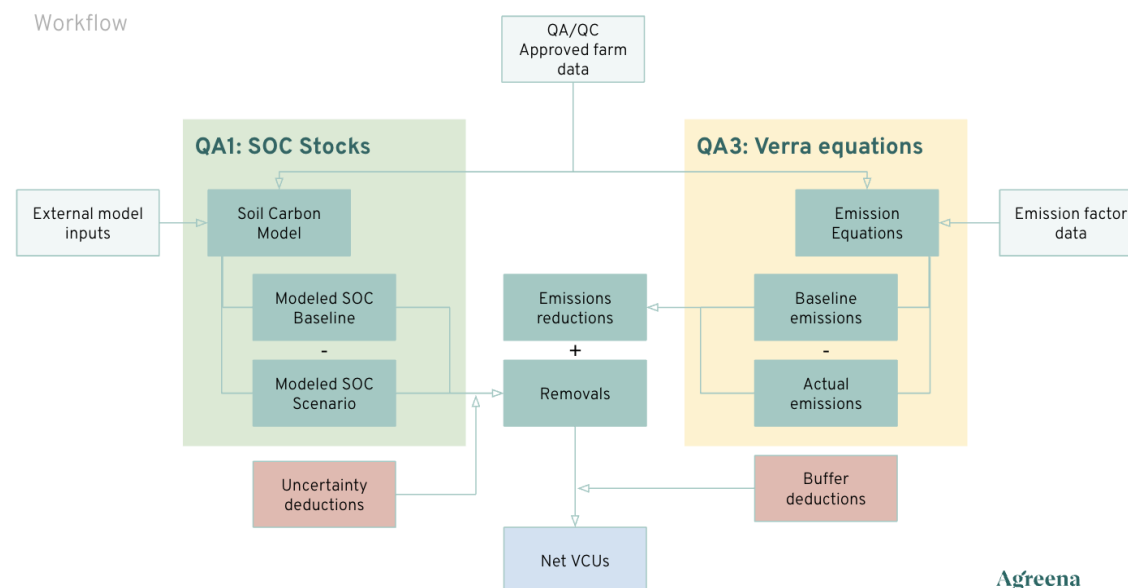


Figure 5-1. Flowchart of the ERR calculation process according to Verra’s Methodology for Improved Agricultural Land Management (VM0042 v2.0).

During the verification period, the total Emission Reductions and Removals (ERRs) for all PAIs amounted to 1,199,967.15 mtCO₂-eq emission reduction and 1,479,929.59 mtCO₂-eq emission removals; leakage is already subtracted from this value. The ERR result file (VCS MR_AgreenaCarbon_ERR_spreadsheet.xlsx) with data inputs and outputs is attached to the report. In the ERR result file, the “Key_for_Project_Level” and “Key_for_PAI_ERR_year” spreadsheets detail the information of data inputs or calculations for each column in this file.

5.1 Baseline Emissions

To estimate emissions under the baseline scenario for each PAI within the Project area, the Schedule of Activities (SoA) in the baseline is created as described in Section 3.4 of the PD is used to represent pre-Project ALM practices for each PAI.

The estimation of baseline SOC stocks is performed using Quantification Approach 1, while CO₂ and N₂O 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 — is 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 4.3.3 Soil Sampling Monitoring. 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 and section 4.1 and 4.2 of this document

5.1.1 Soil Organic Carbon (SOC)

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 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 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 5-1, RothC is initialized with inputs from multiple data sources. Climate inputs at the PAI level (temperature (°C), precipitation (mm), and evapotranspiration (mm)) are sourced from NASAPOWER. Soil clay content (%) is sourced from SoilGrids, and SOC are obtained from direct measurements. Farm management data for the PAIs (tillage regime, cover crop adoption, fertilization, and residue mulching) is obtained from the baseline SoA and processed into model inputs as detailed in Chapter 4.

In compliance with the requirements of Approach 1, SOC stock changes are modelled using measured SOC as the initial SOC in the RothC simulations. For ex-post calculations, SOC is measured according to the stratification strategy outlined in Section 5.3.2 of the PD (AgreenaCarbon v1.3) and it is 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 (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 rebaselining.

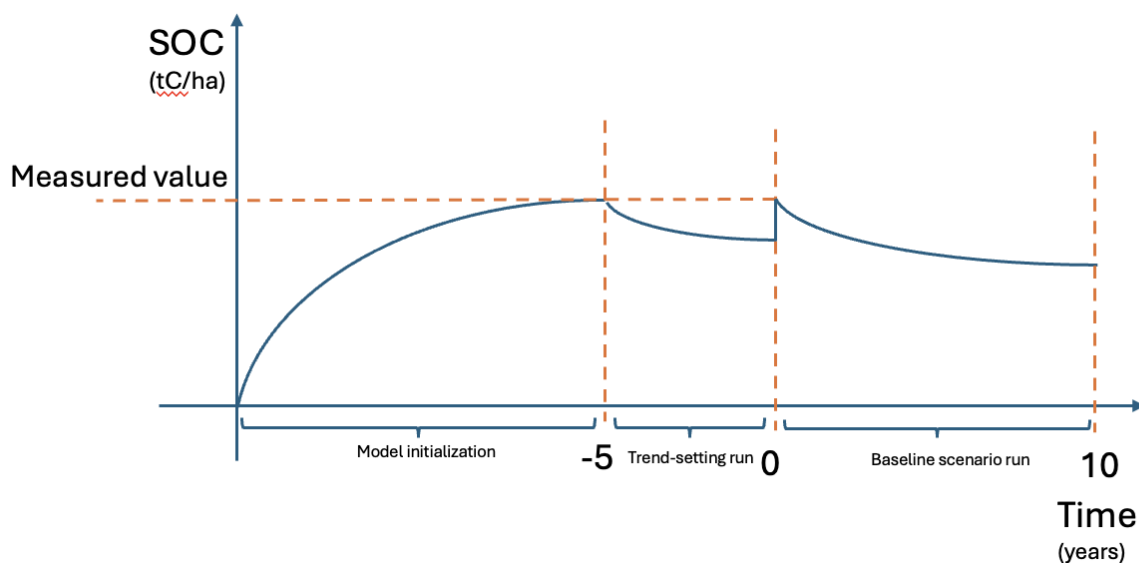


Figure 5-1. Schematic representation of the initialization, trend setting, and baseline scenario run processes with RothC.

Table 5-1. Collection of biophysical model inputs for the baseline scenarios.

Model Input Category	Timing	Approach
SOC content and bulk density to calculate SOC stocks (initial)	Determined <i>ex-ante</i> at Project start date and validated within +/- 5 years from the Project start date.	For ex post estimations the model is initiated using existing direct soil measurements. The input parameters of the model have been reviewed for this 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 <i>ex-ante</i>	Clay content is determined from published soil maps (e.g., SoilGrids). See parameter

		table Clay _i .
Climate variables (e.g., precipitation, temperature)	Determined <i>ex-ante</i>	Climate variables are collected daily, and a climate normal is determined for each 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 5-2a and Table 5-2b below show how the model is parameterized for the calculation of baseline scenario SOC values ($SOC_{bsl,i,t}$) for a sample PAI.

Table 5-2-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 5-2b. Model input values utilised to calculate O_t for $i = PAI\ ID\ 7627$, and $t = 0$

Parameter	Value	Unit	Description	Source
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Time step	1	years	Project time	Project description
DPM	0.00	t C/ha	Decomposable plant material	Calculated based on sampled soil data values
RPM	2.18	t C/ha	Resistant Plant Material	Calculated based on sampled soil data values
BIO	0.49	t C/ha	Microbial Biomass	Calculated based on sampled soil data values
HUM	57.0	t C/ha	Humified Organic Matter	Calculated based on sampled soil data values
IOM	6.89	t C/ha	Inert Organic Matter	Calculated based on sampled soil data values
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 Coleman et al. (1996) ²²³
In	0.093	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

²²³ 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.

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 Coleman et al. (1996) ²²⁴
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 Jordon et al. (2022) ²²⁵

The output of the model is described in Table 5-3.

Table 5-3. Model output values for $i = \text{PAI ID 7627}$, and $t = 1$

Parameter	Value	Unit	Description
DPM	0.00	t C/ha	Final decomposable plant material
RPM	1.54	t C/ha	Final resistant Plant Material

²²⁴ 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.

²²⁵ 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.

BIO	0.40	t C/ha	Final microbial Biomass
HUM	55.97	t C/ha	Final humified Organic Matter
IOM	6.89	t C/ha	Final inert Organic Matter

5.1.2 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 3.3.1 ²²⁶ and reported in the parameter table in section 4.1 of this document and 5.2 in the PD (AgreenaCarbon v1.3).

$$\overline{CO_2-f}_{bsl,i,t} = \left(\sum_{j=1}^J EFF_{bsl,j,i,t} \right) / A_i \quad (7)$$

Where:

- $\overline{CO_2-f}_{bsl,i,t}$ = Areal mean carbon dioxide emissions from fossil fuel combustion in the baseline scenario for sample unit i in year t (t CO₂e/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 CO₂e)
- 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:

$$EFF_{bsl,j,i,t} = FFC_{bsl,j,i,t} \times EF_{CO_2,j} \quad (8)$$

Where:

- $FFC_{bsl,j,i,t}$ = Consumption of fossil fuel type j for sample unit i in year t (liters)
- $EF_{CO_2,j}$ = Emission factor for combustion of fossil fuel type j (t CO₂e/liter)

²²⁶ 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).

Table 5-4. Data inputs and outputs for calculating CO₂ emissions from fossil fuel combustion for i = PAI id 7627

Parameter	Value in baseline SoAs					Unit	Description	Source
	2017	2018	2019	2020	2021			
J _{bsl}	Diesel	Diesel	Diesel	Diesel	Diesel	-	Fossil fuel type	Farm attestation, Baseline SoA
FFC _{bsl,j} (L/ha)	100	100	100	80	80	litre/ha	Consumption of fossil fuel type j	Literature and reports (Details in Section 4.2)
EF _{CO₂,j,bsl}	0.002886	0.002886	0.002886	0.002886	0.002886	tCO ₂ e/litre	Emission factor for combustion of fossil fuel type j	2019 IPCC Refinement ²²⁷ and Bureau of Transportation Statistics (US) Energy statistics manual ²²⁸
CO ₂ _ff _{bsl}	0.2886	0.2886	0.2886	0.23088	0.23088	tCO ₂ e/ha	CO ₂ emissions due to fuel consumption in each baseline SoA	Equation 7 and 8 (VM0042 v 2.0)
CO ₂ _ff _{bsl}	0.2655					tCO ₂ e/ha	Average CO ₂ emissions due to	Equation 7 and 8 (VM0042 v 2.0)

²²⁷ 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).

²²⁸ IEA (2004). Energy statistics manual. IEA. Available at: <https://www.iea.org/reports/energy-statistics-manual-2>

			fuel consumption in baseline SoAs	
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5.1.3 Carbon Dioxide Emissions from Liming

Carbon dioxide emissions caused by liming application are included in the AgreeaCarbon Project. CO₂ emissions from liming are calculated using the “Quantification approach 3: Default Factors” method following Equations 9 & 10 in VM0042 v2.0.

$$\overline{CO2_lime}_{bsl,t} = EL_{bsl,i,t} / A_i \quad (9)$$

Where:

$$\begin{aligned} \overline{CO2_lime}_{bsl,t} &= \text{Areal mean carbon dioxide emissions from liming in the baseline scenario for sample unit } i \text{ in year } t \text{ (t CO}_2\text{e/ha)} \\ EL_{bsl,i,t} &= \text{Carbon dioxide emissions from liming in the baseline scenario for sample unit } i \text{ in year } t \text{ (t CO}_2\text{e)} \end{aligned}$$

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

Where:

$$\begin{aligned} M_{Limestone,bsl,i} &= \text{Amount of calcitic limestone (CaCO}_3\text{) applied to sample unit } i \text{ in year } t \text{ (tonnes)} \\ EF_{Limestone} &= \text{Emission factor for calcitic limestone (0.12) (t C per t of limestone)} \\ M_{Dolomite,bsl,i} &= \text{Amount of dolomite (CaMg(CO}_3\text{)}_2\text{) applied to sample unit } i \text{ in year } t \text{ (tonnes)} \\ EF_{Dolomite} &= \text{Emission factor for dolomite (0.13) (t C per t of dolomite)} \\ 44/12 &= \text{Molar mass ratio of CO}_2 \text{ to C applied to convert CO}_2\text{-C emissions to CO}_2 \text{ emissions} \end{aligned}$$

The Project utilizes regional data²²⁹ to quantify CO₂ emissions from liming (see further details in Section 3.2.1, 4.1 and 4.2 in this document).

²²⁹ UNFCCC National Inventory Reports: <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

Table 5-5. 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	3589	k ha	Country actual agricultural land area	Table 4.B in 2024 National Inventory Report ²³⁰
M _{Limestone, bsl}	2068997	t/y	Average limestone application amount in the baseline	Table 3.G-J in 2024 National Inventory Report
M _{Dolomite, bsl}	312230	t/y	Average dolomite application amount in the baseline	Table 3.G-J in 2024 National Inventory Report
EF _{Limestone, bsl}	0.12	t C/t	Emission factor for the application of calcitic limestone	2019 IPCC Refinement
EF _{Dolomite, bsl}	0.13	t C/t	Emission factor for the application of dolomite	2019 IPCC Refinement
EL _{bsl}	1059	kt CO ₂ e/y	Average CO ₂ emissions from liming in the baseline (2017-2021)	Equation 10 (VM0042 v2.0); Table 3.G-J in 2024 National Inventory Report ²³¹
CO ₂ _lime _{bsl}	0.295	t CO ₂ e/ha	Areal mean CO ₂ emissions from liming in the baseline	Equation 9 (VM0042 v2.0)

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

²³¹ UNFCCC National Inventory Reports: <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

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

5.1.4 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 ₂ e/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 ₂ e/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 ₂ e/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 ₂ e/ha)

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 AgreeenaCarbon Project.

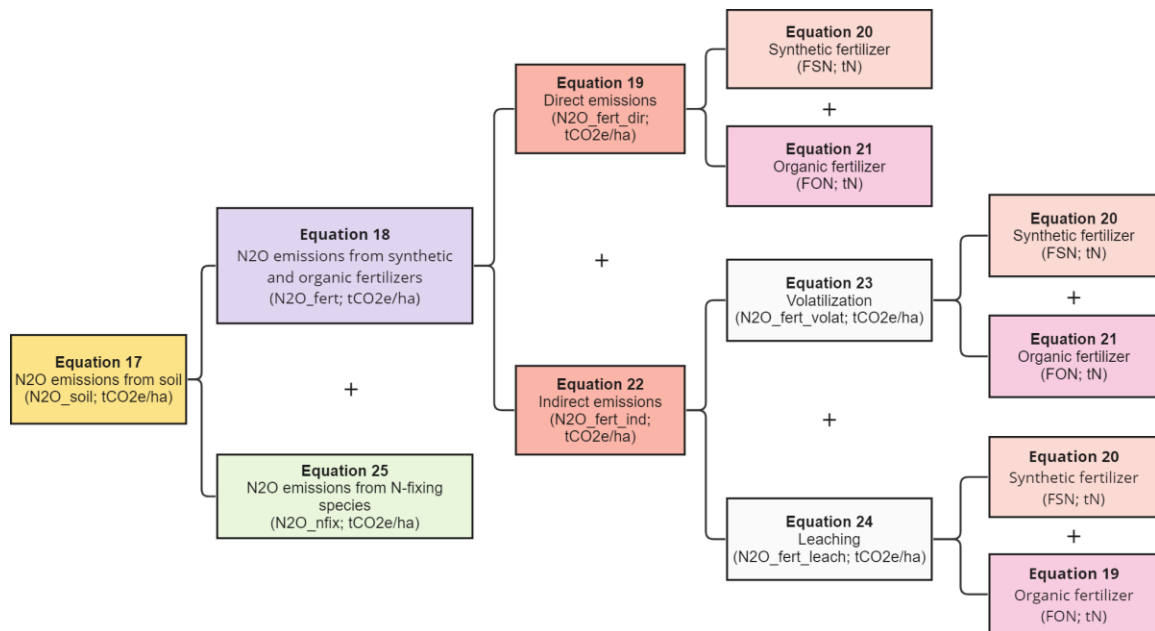


Figure 5-2. Flowchart of the calculations of N₂O emissions due to nitrogen inputs to soils in the AgreeCarbon Project according to Verra's Methodology for Improved Agricultural Land Management (VM0042 v2.0). All equations in the flowchart are from VM0042 v2.0.

5.1.4.1 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 CO₂e/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 CO₂e/ha)

Direct emissions due to fertiliser use

Direct N₂O-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 N₂O and emission to the atmosphere. N₂O emissions from fertiliser use are quantified in Equations 19–21.

$$\overline{N2O_{fert}}_{bsl,direct,i,t} = ((FSN_{bsl,i,t} + FON_{bsl,i,t}) \times EF_{Ndirect} \times 44/28 \times GWP_{N2O})/A_i \quad (19)$$

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

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

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 CO₂e/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 N₂O-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 N₂O to N applied to convert N₂O-N emissions to N₂O emissions

Indirect emissions due to fertiliser use

Fertiliser application also results in indirect N₂O emissions from volatilisation and leaching, which are quantified using Equations 22–24:

$$\overline{N2O_fert_{bsl,indirect,i,t}} = (N2O_fert_{bsl,volat,i,t} + N2O_fert_{bsl,leach,i,t})/A_i \quad (22)$$

$$N2O_fert_{bsl,volat,i,t} = \left[\frac{(FSN_{bsl,i,t} \times Frac_{GASF,l,S}) + (FON_{bsl,i,t} \times Frac_{GASM,l,S})}{(FSN_{bsl,i,t} + FON_{bsl,i,t})} \right] \times EF_{Nvolat} \times 44/28 \times GWP_{N2O} \quad (23)$$

$$N2O_fert_{bsl,leach,i,t} = \left(\frac{FSN_{bsl,i,t} + FON_{bsl,i,t}}{FON_{bsl,i,t}} \right) \times Frac_{LEACH,l,S} \times EF_{Nleach} \times \frac{44}{28} \times GWP_{N2O} \quad (24)$$

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>i</i> in year <i>t</i> (t CO ₂ e/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>i</i> in year <i>t</i> (t CO ₂ e)
$N2O_fert_{bsl,leach,i,t}$	= 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>i</i> in year <i>t</i> (t CO ₂ e)
$Frac_{GASF,l,S}$	= Fraction of all synthetic N added to soils that volatilizes as NH ₃ and NO _x for manure management system <i>S</i> and livestock type <i>I</i> (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 <i>S</i> and livestock type <i>I</i> (dimensionless)
EF_{Nvolat}	= Emission factor for nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces (t N ₂ O-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 <i>S</i> and livestock type <i>I</i> (dimensionless)
EF_{Nleach}	= Emission factor for nitrous oxide emissions from leaching and runoff (t N ₂ O-N/t N leached and runoff)

5.1.4.2 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 N₂ 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 N₂O emissions that needs to be quantified.

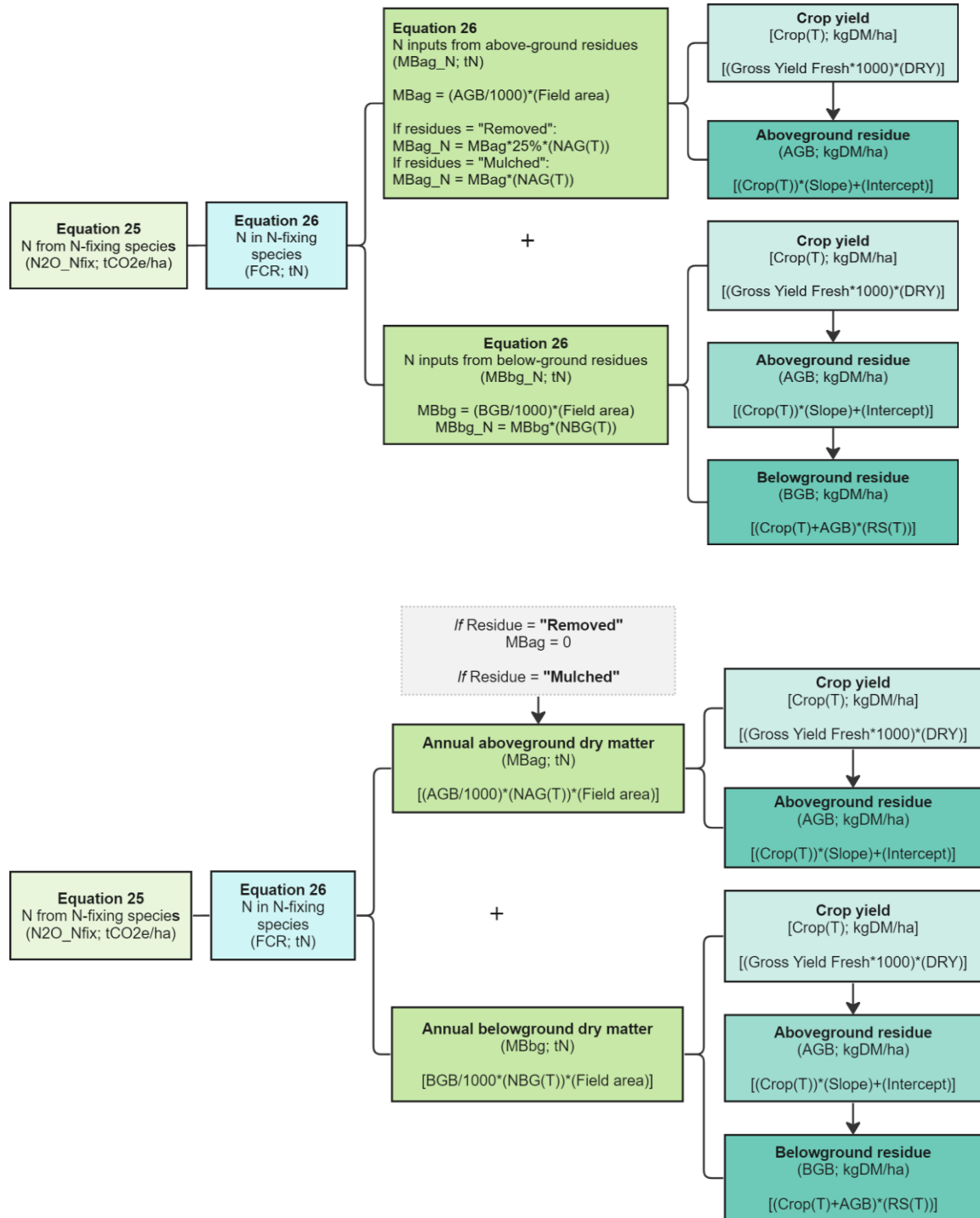


Figure 4-3. Flowchart for calculating N₂O emissions from nitrogen-fixing (N-fixing) species illustrating the additional steps for calculating dry crop yield [Crop(T)], above-ground crop residue (AGB), below-ground crop residue (BGB), above-ground (M_{Bag_N}) and below-ground (M_{Bbg_N}) N in dry matter returned to the soil. Equations 25 and 26 are from Methodology for Improved Agricultural Land Management VM0042 (v2.0). The equations and default values used for calculating Crop(T), AGB, BGB, M_{Bag_N} and M_{Bbg_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 Inventories²³². 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.

$$\overline{N2O_Nfix_{bsl,i,t}} = (F_{CR,bsl,i,t} \times EF_{Ndirect} \times \frac{44}{28} \times GWP_{N2O}) / A_i \quad (25)$$

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 CO₂e/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)

²³² 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)

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

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 ($MBbg_N$) are calculated individually and then summed (Figure 4-3). 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:

Multiply AGB by the PAI area and 25% (25% of residues are assumed to remain in soil) to get the annual dry matter above-ground residues ($MBag_{wp,i,t}$)
 - 2) IF residue is Mulched:

Multiply AGB by the PAI area to get the annual dry matter above-ground residues ($MBag_{wp,i,t}$) returned to the soil
4. Multiply $MBag_{wp,i,t}$ 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 ($MBbg_{wp,i,t}$) 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 (MB_{bg_N}) returned to the soil (Equation 26)

$$F_{CR,bsl} = M_{Bag_N} + M_{Bbg_N} \text{ (Equation 26)}$$

Table 5-6. 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	Values in baseline SoAs					Unit	Description	Source
Parameter	2017	2018	2019	2020	2021			
A_i	13.86					ha	PAI size in hectares	Farm attestation
FSN_{bsl}	3.198	3.198	3.198	0	3.198	t N	N inputs from synthetic fertiliser	EuropeAgriDB v1.0 ²³³ and Eurostat (<i>lan_lcv_ovw</i>) ²³⁴
$M_{bsl,OF}$	0	0	0	904	0	t	Mass of organic fertiliser OF	Baseline SoA
OF	None	None	None	Cattle slurry 0.26% N	None	-	Organic fertiliser name	Farm attestation Baseline SoA

²³³

https://springernature.figshare.com/collections/Crop_production_and_nitrogen_use_in_European_cropland_and_grassland_1961-2019/5320772

²³⁴ https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw__custom_12738492/default/table

$NC_{OF,bsl}$	0	0	0	0.0026	0	-	N content of organic fertiliser OF	-
FON_{bsl}	0	0	0	2.35	0	t N	N inputs from organic fertiliser	Equation 21 in VM0042 v 2.0
GWP_{N2O}	265	265	265	265	265	t CO ₂ e/t N ₂ O	Global warming potential for N ₂ O	Page 84 in VM0042 v 2.0
$EF_{Ndirect}$	0.01					t N ₂ O-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 N ₂ O-N/t N	Emission factor for N ₂ O emissions from atmospheric deposition of N on soils and water surfaces	Table 11.3 in 2019 IPCC Refinement*
Fra _{CLEACH}	0.24					-	Fraction of N that is lost through leaching and runoff	Table 11.3 in 2019 IPCC Refinement*
EF _{Nleach}	0.011					t N ₂ O-N/t N	Emission factor for N ₂ O emissions from leaching and runoff	Table 11.3 in 2019 IPCC Refinement*
N ₂ O_fert _{bsl,direct}	0.96	0.96	0.96	0.71	0.96	t CO ₂ e/ha	Areal mean direct N ₂ O emissions due to fertiliser use	Equation 19 in VM0042 v 2.0
N ₂ O_fert _{bsl,volat}	1.46	1.46	1.46	2.06	1.46	t CO ₂ e	Indirect N ₂ O emissions produced from atmospheric deposition of N volatilized	Equation 23 in VM0042 v 2.0

$N_{2O_fert_{bsl,leach}}$	3.52	3.52	3.52	2.59	3.52	t CO ₂ e	Indirect N ₂ O emissions produced from leaching and runoff of N	Equation 24 in VM0042 v 2.0
$N_{2O_fert_{bsl,indirect}}$	0.36	0.36	0.36	0.33	0.36	t CO ₂ e/ha	Areal mean indirect N ₂ O emissions due to fertiliser use	Equation 22 in VM0042 v 2.0
$N_{2O_fert_{bsl}}$	1.32	1.32	1.32	1.04	1.32	t CO ₂ e/ha	Areal mean N ₂ O emissions due to fertiliser use	Equation 18 in VM0042 v 2.0
g_{wpbsl}	None	None	None	None	None	-	Name of N-fixing species	Farm attestation Baseline SoA
MBg_{bsl} ($MBag_{bsl}$)	0	0	0	0	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	0	0	0	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	0	0	0	0	t CO2e/ha	Areal mean N ₂ O emissions due to use of N-fixing species	No N-fixing species are applied in the baseline scenarios.
N2O_soil _{bsl, SoA}	1.32	1.32	1.32	1.04	1.32	t CO2e/ha	Areal mean N ₂ O emissions from soil in each baseline SoA	Equation 17 in VM0042 v 2.0
N2O_soil _{bsl}	1.26					t CO2e/ha	Average areal mean N ₂ O emissions from soil in baseline SoAs	Equation 17 in VM0042 v 2.0

*Note: 2019 IPCC Refinement refers to 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories²³⁵.

5.1.5 Other Emissions

CO₂ from woody biomass:

Woody biomass is not included in the project boundary.

CH₄ from soil methanogenesis:

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

²³⁵ 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).

CH₄ from enteric fermentation:

Methane (CH₄) from enteric fermentation is not included in the project boundaries as the program 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 program 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 program 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 program 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 program does not allow for such practice.

5.2 Project Emissions

The quantification of GHG emissions and removals for each Project activity is conducted in accordance with Section 8 of VM0042 v2.0. The same GHG quantification approaches applied to baseline emissions (as outlined in Section 5.1) are also used for Project emissions. However, unlike the baseline emissions, which are modeled using the SoA, the Project emissions are calculated based on the actual reported and verified practices implemented at the PAI level 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.

5.2.1 Soil Organic Carbon

As in the baseline scenario, SOC stocks for the Project scenario (wp) are 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 reflect the actual practices reported and verified at the PAI during the Project period. These

practices are applied to SoilR (RothC implementation), with inputs such as climate data from NASAPOWER, soil properties from SoilGrids, and project-specific management practices.

Table 5-7. Collection of model inputs for the project scenario.

Model Input Category	Timing	Approach
SOC content and bulk density to calculate SOC stocks (initial)	Determined <i>ex-ante</i> at Project start date and validated within +/- 5 years from the Project start date.	For ex post estimations the model is initiated using existing direct soil measurements. The input parameters of the model have been reviewed for this 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 <i>ex-ante</i>	Clay content is determined from published soil maps (e.g., SoilGrids). See parameter table $Clay_i$.
Climate variables (e.g., precipitation, temperature)	Continuously monitored <i>ex-post</i>	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 <i>ex-post</i>	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.

5.2.2 Modelling of Soil Organic Carbon in the Project Scenario

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

Table 5-8 - 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	0.00	t C/ha	Initial decomposable plant material	Calculated from sampled soil data values
RPM	2.18	t C/ha	Initial resistant Plant Material	Calculated from sampled soil data values
BIO	0.49	t C/ha	Initial microbial Biomass	Calculated from sampled soil data values
HUM	57.05	t C/ha	Initial humified Organic Matter	Calculated from sampled soil data values
IOM	6.89	t C/ha	Initial inert Organic Matter	Calculated from sampled soil data values
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	-	A vector of length 5 containing the values of the decomposition	Standard values described in Coleman et al. (1996) ²³⁶

²³⁶ 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.

	k.BIO= 0.66 k.HUM= 0.02 k.IOM = 0		rates for the different carbon pools	
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 Coleman et al. (1996) ²³⁷
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

²³⁷ 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.

TRM	0.95	-	Tillage rate modifier	Value extracted from Jordon et al. (2022) ²³⁸
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Table 5-9. Model output values for $i = \text{PAI ID 7627}$, and $t = 1$

Parameter	Value	Unit	Description
DPM	0.03	t C/ha	Final decomposable plant material
RPM	1.83	t C/ha	Final resistant Plant Material
BIO	0.43	t C/ha	Final microbial Biomass
HUM	56.12	t C/ha	Final humified Organic Matter
IOM	6.89	t C/ha	Final inert Organic Matter

5.2.3 Carbon Dioxide Emissions from Fossil Fuel Combustion

The sole difference between the Project and baseline fuel combustion's emission calculations is that for the former the fuel amount consumed per hectare as reported by Project participants is applied. All the EFs and equations for the baseline emissions (see Section 4.1, 4.2) are applied for the Project emissions.

Table 5-10. Data inputs and outputs for calculating CO₂ emissions from fossil fuel combustion for the project emissions in the example PAI $i = \text{PAI ID 7627}$ for vintage 2022

Parameter	Value	Unit	Description	Source
j_{wp}	Diesel	-	Implementation status of energy sources	Farm attestation
$FFC_{wp,j}$ (L/ha)	99	litre/ha	Fuel consumption amount per hectare	Farm attestation

²³⁸ 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.

EF _{CO2,j,wp}	0.002886	tCO2eq/litre	Emission factor for combustion of fossil fuel type j	2019 IPCC Refinement ²³⁹ and Bureau of Transportation Statistics (US) ²⁴⁰
CO2 _{ff,wp}	0.2857	tCO2eq/ha	CO ₂ emissions due to fuel consumption	Equation 7 and 8 (VM0042 v 2.0)

5.2.4 Carbon Dioxide emissions from Liming

The data²⁴¹ of the lime application amounts and agricultural areas ("Cropland remaining Cropland") for each country in 2022 are applied to calculate CO₂ emissions from liming using the same calculation method for the baseline emissions (Section 5.1.3).

Table 5-11. Data inputs and outputs for calculating CO₂ emissions from liming for the project emissions in the example PAI *i* = PAI ID 7627

Parameter	Value	Unit	Description	Source
Country	United Kingdom	-	Country of the PAI	Farm attestation
A	3528	K ha	Country "Cropland remaining Cropland" area	Table 4.B-I in 2024 National Inventory Report ²⁴²
M _{Limestone, wp}	2460805	t/y	Limestone application amount in the project scenario	Table 3.G-J in 2024 National Inventory Report
M _{Dolomite, wp}	205216	t/y	Dolomite application amount in the project scenario	Table 3.G-J in 2024 National Inventory Report

²³⁹ 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).

²⁴⁰ Bureau of Transportation Statistics (US): <https://www.bts.gov/content/energy-consumption-mode-transportation-0>

²⁴¹ 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}	1181	kt CO ₂ e	CO ₂ emissions from liming in the project scenario	Equation 10 (VM0042 v 2.0); Table 3.G-J in 2023 National Inventory Report
CO ₂ _lime _{wp}	0.335	t CO ₂ e/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.

5.2.5 Nitrous Oxide emissions from Nitrogen fertilisers and nitrogen-fixing species

The project emission calculations follow 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 4.2. All the EFs and equations for N₂O emissions from soil due to use of fertiliser and N-fixing species in the baseline emission calculations (see Section 5.1.4) are applied for the project emission calculations.

Table 5-12. Data inputs and outputs for calculating N₂O emissions from nitrogen fertilisers and nitrogen-fixing species for the project emissions in the example PAI t = PAI ID 7627 for vintage 2022.

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 ²⁴³
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 CO ₂ e/t N ₂ O	Global warming potential for N ₂ O	Page 84 in VM0042 v 2.0
$EF_{Ndirect}$	0.01	t N ₂ O-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*
Fra_{CGASF}	0.11	-	Fraction of all synthetic N added to soils that volatilizes	Table 11.3 in 2019 IPCC Refinement*
Fra_{CGASM}	0.21	-	Fraction of all organic N added to soils that volatilizes	Table 11.3 in 2019 IPCC Refinement*
EF_{Nvolat}	0.01	t N ₂ O-N/t N	Emission factor for N ₂ O emissions from atmospheric deposition of N on soils and water surfaces	Table 11.3 in 2019 IPCC Refinement*
Fra_{CLEACH}	0.24	-	Fraction of N that is lost through leaching and runoff	Table 11.3 in 2019 IPCC Refinement*

²⁴³ Delin, S., Stenberg, B., Nyberg, A., & Brohede, L. (2012). Potential methods for estimating nitrogen fertilizer 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 N ₂ O-N/t N	Emission factor for N ₂ O 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*
$N_{content,g} (N_{AG(T)})$	0.008	-	N content of above-ground residues	Table 11.1A in 2019 IPCC Refinement*
$N_{content,g} (N_{BG(T)})$	0.008	-	N content of below-ground residues	Table 11.1A in 2019 IPCC Refinement*
$N_{2O_fert_{Lwp,direct}}$	0.396	t CO ₂ e/ha	Areal mean direct N ₂ O emissions due to fertiliser use	Equation 19 (VM0042 v 2.0)
$N_{2O_fert_{Lwp,volat}}$	1.151	t CO ₂ e	Indirect N ₂ O emissions produced from atmospheric deposition of N volatilized	Equation 23 (VM0042 v 2.0)

$N_{2O_fert_wp,leach}$	1.448	t CO ₂ e	Indirect N ₂ O emissions produced from leaching and runoff of N	Equation 24 (VM0042 v 2.0)
$N_{2O_fert_wp,indirect}$	0.188	t CO ₂ e/ha	Areal mean indirect N ₂ O emissions due to fertiliser use	Equation 22 (VM0042 v 2.0)
$N_{2O_fert_wp}$	0.58	t CO ₂ e/ha	Areal mean N ₂ O 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 ($MBbg_N_{wp}$)
$N_{2O_Nfix_wp}$	0.06	t CO ₂ e/ha	Areal mean N ₂ O emissions from crop residues of N-fixing species	Equation 25 (VM0042 v 2.0)
$N_{2O_soil_wp}$	0.64	t CO ₂ e/ha	Total N ₂ O 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.²⁴⁴

5.2.6 Other Emissions

CO₂ from woody biomass:

Woody biomass is not included in the project boundary.

CH₄ from soil methanogenesis:

Soil methanogenesis is not included in the project boundaries as the program 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 program 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 program 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 program 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 program 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 program does not allow for such practice.

5.3 Leakage Emissions

The Project does not cause GHG emissions to change outside of its geographic boundaries as a consequence of adopted practices and changes to existing practices. According to VM0042 v2.0,

²⁴⁴ 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).

the AgreeenaCarbon 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.

5.3.1 Accounting for Leakage from New Application of Organic Amendments from Outside the Project Area

When organic amendments 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 AgreeenaCarbon Project flags cases during the internal quality check process in which 1) the manure or compost applied is not produced on-site; 2) the manure is not from an uncontrolled anaerobic lagoon, pond, tank or pit; or 3) 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. According to the scope of the Project activities, only conditions 1 and 2 shall be applied.

$$LE_{OA,t} = \sum_i \left(M_{manure_{wp,l,t}} \times CC_{wp,l,t} \times 0.12 \times \frac{44}{12} \right) \quad (34)$$

Where:

$LE_{OA,t}$	= Leakage from organic amendments in year t (t CO ₂ e)
$M_{OA_{wp,l,t}}$	= 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

To calculate leakage, Project participants who implemented organic amendments during a harvest year belonging to the monitoring period, but did not implement organic amendments during their comparable pre-existing baseline harvest year were first flagged. This identified 289 of 860 participants, for which the calculation of manure leakage is potentially relevant.

Based on what the participants with flagged fields for potential leakage answered for the origin and storage of the applied fertiliser in each of their PAIs, the respective PAIs were either included or excluded for the leakage calculation. PAIs which had only received compost or digestate as organic fertiliser were excluded.

This yielded 200 participants which had leakage quantified. The analysis and related quantification are presented in the ERR spreadsheet.

Table 5-13. Data inputs and outputs for calculating leakage due to organic amendments for the sample unit i = PAI ID 7627

Parameter	Value	Unit	Description	Source
$M_{\text{manure}_{wp,i,t}}$	69.3	t	Tons of manure applied to PAI	Farm attestation
$CC_{wp,i,t}$	0.114	t C/t manure	Carbon content (wet)	Based on literature ²⁴⁵
$LE_{OA,t}$	3.48	t CO ₂ e	Leakage from organic amendments in year t	Equation 34 (VM0042 v 2.0)

5.3.2 Accounting for Leakage from Livestock Displacement

Livestock is not included in the Project boundary.

5.3.3 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 AgreeaCarbon Project has not run for ten years, so the calculation of leakage from productivity declines has not been undertaken yet. However, it will be calculated after ten years of data have been collected. Here are the quantification methods to follow 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.

²⁴⁵ 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 showed 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 led to the productivity decline, then the combination of factors must be removed for future crediting.

5.3.4 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 is calculated according to Equation 15 in CDM Methodological Tool: Project and leakage emissions from biomass.²⁴⁶

$$LE_{BR,Div,y} = EF_{CO_2,LE} \times \sum_n BR_{PJ,n,y} \times NCV_{n,y} \quad \text{Equation (15)}$$

Where:

$LE_{BR,Div,y}$	=	Leakage emissions due to the diversion of biomass residues from other applications in year y (t CO ₂ e)
$EF_{CO_2,LE}$	=	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

Table 5-14a. Data inputs and outputs for calculating the leakage from the diversion of biomass residues used for energy applications in the baseline scenario in UK and DK as the example countries (details in Appendix 6).

Parameter	Value #1	Value #2	Unit	Description	Source
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²⁴⁶ <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-16-v5.0.pdf>

Country	United Kingdom	Denmark	-	Country	Farm attestation
EF _{CO2,LE}	0.0561	0.0741	t CO ₂ / GJ	Emission factor of coal, oil and natural gas, respectively	Table 2.2 in 2019 IPCC Refinement ²⁴⁷ ; International Energy Agency ²⁴⁸
MB _{g,wp,country} (MB _{g,wp,country})	343,228	192,344	t dm	Dry matter above-ground residues returned to the soil in all the PAIs that have changed from Residue Removed to Residue Mulched in the country	Equations 11.6 and 11.7 and Table 11.2 in 2019 IPCC Refinement
BR _{pj,n,y}	76,883	0	t DM	22.4% and 0% of the mulched residues in the AgreeaCarbon Programme would have been available for energy production in the United Kingdom and Denmark, respectively. Quantity of residue: UK: 343,228 * 0.224 = 76,883 DK: 192344 * 0 = 0	See Chapter 3.2.2 Methodology Deviations
NCV _{n,y}	14.425	14.44	GJ / t	Net calorific value of residue	Teagasc Agriculture and

²⁴⁷ 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)

²⁴⁸ <https://www.iea.org/regions/europe/energy-mix>

					Food Development Authority ²⁴⁹ ; Danish Energy Agency ²⁵⁰
LE_BR,y	62,216	0	t CO2e	Leakage emissions in the country	Equation 67
Redistributed LE_BR,y,ha	0.0371	0.0371	t CO2e/ha	Areal mean leakage emissions across all the PAIs	See Chapter 3.2.2 Methodology Deviations

Table 5-14b. Data inputs and outputs for calculating the leakage from the diversion of biomass residues used for energy applications in the baseline scenario for the PAI ID 7627.

Parameter	Value	Unit	Description	Source
Country	United Kingdom	-	Country of the PAI	Farm attestation
Ai	13.86	ha	PAI size in hectares	Farm attestation
Redistributed LE_BR,y,ha	0.0371	tCO2e/ha	Areal mean leakage emissions across all the PAIs	Table 5-14a and Appendix 6
LE_BR,y,PAI	0.514	t CO2e	Leakage emissions in the PAI	Product of Redistributed LE_BR,y,ha and Ai

5.4 Calculation of Net GHG Emission Reductions and Removals and Verified Carbon Units

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

²⁴⁹ https://www.teagasc.ie/media/website/publications/2010/868_StrawForEnergy-1.pdf

²⁵⁰ https://ens.dk/sites/ens.dk/files/Statistik/metode_halm.pdf

5.4.1 Carbon Dioxide Emission Reductions and Removals

The Change in Soil Organic Carbon ($\Delta CO2_{soil}$) is determined using a validated model, as specified in Equation 40 from VM0042 v2.0. $\Delta CO2_{soil}$ is defined by establishing the differences in soil organic carbon concentrations between the Project scenario and the baseline scenario.

$$\Delta CO2_{soil}_t = \sum_{i=1}^n \left(\left(\overline{SOC_{wp,i,t}} - \overline{SOC_{wp,i,t-1}} \right) - \left(\overline{SOC_{bsl,i,t}} - \overline{SOC_{bsl,i,t-1}} \right) \right) \times \frac{44}{12} \times A_i \quad (40)$$

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 ₂ e /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 ₂ e/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 ₂ e/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 ₂ e/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 emissions.

$$\Delta CO2_{ff}_t = \sum_{i=1}^n \left(\overline{CO2_{ff_{wp,i,t}}} - \overline{CO2_{ff_{bsl,i,t}}} \right) \times A_i \quad (41)$$

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 ₂ e/ha)
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Carbon dioxide emission reductions from liming are quantified as the differences in CO₂ emissions from liming between the Project and the baseline emissions.

$$\Delta CO2_lime_t = \sum_{i=1}^n (\overline{CO2_lime_{wp,i,t}} - \overline{CO2_lime_{bsl,i,t}}) \times A_i \quad (44)$$

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 ₂ e/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 ₂ e/ha)

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

Table 5-15. 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 _{wp, t}	65.32	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}	66.63	t C/ha	Areal mean SOC in the Project scenario at the end of year t-1	Equation 6 (VM0042 v 2.0)
SOC _{bsl, t}	64.82	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}	66.63	t C/ha	Areal mean SOC in the baseline scenario at the end of year t-1	Equation 6 (VM0042 v 2.0)
ΔCO ₂ _soil _t	11.1	t CO ₂ e	Change in soil organic carbon in year t	Equation 40 (VM0042 v 2.0)
CO ₂ _ff _{wp}	0.2857	t CO ₂ e/ha	Areal mean CO ₂ emissions from fossil fuel combustion in the Project emissions	Calculation as discussed in Section 5.2.3
CO ₂ _ff _{bsl}	0.2655	t CO ₂ e/ha	Areal mean CO ₂ emissions from fossil fuel combustion in the baseline emissions	Calculation as discussed in Section 5.1.2
ΔCO ₂ _ff _t	-0.28	t CO ₂ e	CO ₂ emission reductions from fossil fuel combustion	Equation 41 (VM0042 v 2.0)

CO ₂ _lime _{wp}	0.335	t CO ₂ e/ha	Areal mean CO ₂ emissions from liming in the Project emissions	Calculation as discussed in Section 5.2.4
CO ₂ _lime _{bsl}	0.295	t CO ₂ e/ha	Areal mean CO ₂ emissions from liming in the baseline emissions	Calculation as discussed in Section 5.1.3
ΔCO ₂ _lime _t	-0.5544	t CO ₂ e	CO ₂ emission reductions from liming	Equation 44 (VM0042 v 2.0)

5.4.2 Nitrous Oxide Emission Reductions (ΔN₂O_t)

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

$$\Delta N_2O_{soil}_t = \sum_{i=1}^n (\overline{N_2O_{soil}_{bsl,i,t}} - \overline{N_2O_{soil}_{wp,i,t}}) \times A_i \quad (49)$$

Where:

$\overline{N_2O_{soil}_{bsl,i,t}}$ = Areal mean nitrous oxide emissions from nitrogen inputs to soils in the baseline scenario for sample unit i in year t (t CO₂e/ha)

$\overline{N_2O_{soil}_{wp,i,t}}$ = Areal mean nitrous oxide emissions from nitrogen inputs to soils in the project scenario for sample unit i in year t (t CO₂e/ha)

Nitrous oxide emission reductions from biomass burning are not included in the AgreeenaCarbon Project boundary.

Table 5-16. Data inputs and outputs for calculating nitrous oxide emission reductions in the PAI $i = 7627$

Parameter	Value	Unit	Description	Source
A _i	13.86	ha	PAI size in hectares	Farm attestation

N ₂ O _{soil} _{bsl}	1.26	t CO ₂ e/ha	Areal mean N ₂ O emissions from soil in the baseline emissions	Calculation as discussed in Section 5.1.4
N ₂ O _{soil} _{wp}	0.64	t CO ₂ e/ha	Areal mean N ₂ O emissions from soil in the project emissions	Calculation as discussed in Section 5.2.5
ΔN ₂ O _{soil} _t	8.59	t CO ₂ e	N ₂ O emission reductions from nitrification/denitrification in soil	Equation 49 (VM0042 v 2.0)

5.4.3 Methane Emission Reductions (ΔCH₄t)

Methane emissions are not included in the Project boundary.

5.4.4 Uncertainty

The AgreeaCarbon Project 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 sampling unit; 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 - subsequently detailed. Other model inputs (e.g. Project area, management data) are subject to QA/QC procedures detailed elsewhere in this document; 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 VMD0053, as well as model predictions for Project PAIs. Equation 51 in VM0042 v2.0 is used to compute model prediction errors.

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

Where:

$s_{model,\Delta}^2$	= Variance of modeled estimates of emission reductions in gas or pool • (t CO ₂ e/ha) ²
$\widehat{\Delta}_{bsl}$	= Modeled estimate of change in emissions reductions in gas or pool • in the baseline scenario (t CO ₂ e)
$\widehat{\Delta}_{pr}$	= Modeled estimate of change in emissions reductions in gas or pool • in the project scenario (t CO ₂ e)
$s_{model,\bullet}^2$	= 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 ₂ e/ha) ²

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

Then:

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

Where:

ρ	= Correlation of errors in project and baseline scenario pairs (estimated from side-by-side field trials of baseline and project scenarios)
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Scientific studies in our calibration and validation data make us of space-for-time substitutions which requires that, for a validation at $t = 1$ (or whenever remeasurement occurred) and initial SOC stock, y_0 , that measured baseline SOC stock $y_{1,bsl} = y_0$. Following the calibration process described in the Project's model validation report, we have $\widehat{y_{1,bsl}} = y_0$. Denote measured SOC stock in the project (non-baseline) arm at time $t = 1$ obtained from the studies in our CVD and denote it $y_{1,pr}$, likewise corresponding modelled estimate of SOC stock as $\widehat{y_{1,pr}}$.

The resulting estimate, when following bullet point 2) of Section 8.6.1.1 of VM0042v2.0, of the covariance is:

$$\text{cov}(\widehat{\Delta \bullet_{pr}}, \widehat{\Delta \bullet_{bsl}}) = \text{cov}((\widehat{y_{1,pr}} - y_{1,pr}), (\widehat{y_{1,bsl}} - y_{1,bsl})) = \text{cov}((\widehat{y_{1,pr}} - y_{1,pr}), 0) = 0$$

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.

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

Where:

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

and:

$s_{sampling, \Delta \bullet, t}^2$	= Variance of emission reductions in gas or pool • due to sampling error at time t across the entire project area (t CO ₂ e) ²
$s_{sampling, \Delta \bullet, h, t}^2$	= Variance of emission reductions in gas or pool • within stratum h due to sampling error at time t (t CO ₂ e) 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 ₂ e/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 ₂ e/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 $s_{\Delta \bullet, t}^2$ is computed for the mean emissions reductions/removals estimate as it relates to Equation 54 in VM0042 v2.0.

$$s_{\bar{\Delta},t}^2 = \frac{s_{sampling,\Delta,t}^2}{A^2} + s_{model}^2 \quad (54)$$

Where:

- $s_{\bar{\Delta},t}^2$ = Variance of the estimate of mean emission reductions from gas or pool • at time t (t CO₂e/ha)²
- s_{model}^2 = Variance of the estimate of emission reductions in gas or pool • due to model prediction error (t CO₂e/ha)²
- A = Total project area

Final uncertainty deduction

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

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

$$Uncertainty = \frac{\sqrt{s_{\bar{\Delta},t}^2}}{\bar{\Delta}_t} \times 100$$

Where:

- $UNC_{\bar{\Delta},t}$ = 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 (%)
- $\bar{\Delta}_t$ = Mean estimated emissions reduction for gas or pool • across the entire project area in year t (t CO₂e/ha)
- $s_{\bar{\Delta},t}^2$ = 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 $\alpha = 0.666$ (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 $\bar{\Delta}_t$, the precise uncertainty deduction is verification period specific.

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 ERRs calculations that are 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=X1.

Note that Section 8.6.4 of VM0042v2, in the definition of $UNC_{\Delta, t}$, states that there is one fixed uncertainty deduction for the verification period. This monitoring report, following this definition, computes one fixed uncertainty deduction for the verification period (15-09-2021 to 31-12-2023) and uses the same value across the 3 vintages in this verification period. The Project's average removal, for this verification period, and the corresponding uncertainty deduction are displayed in Table 5-17.

Table 5-17. Data inputs and outputs for calculating the uncertainty deduction

Parameter	Value	Unit	Source	Notes
$cov(\Delta \bullet_{pr}, \Delta \bullet_{bst})$	0	-	Conservative estimate	Implies $\rho=0$ in Equation 52 (VM0042 v 2.0)
$s_{model, \Delta \bullet}^2$	0.359713	$(t\ CO_2e/ha)^2$	Equation 51 (VM0042 v2.0) and the MVR following VMD0053 v2.0	
A_h	676,245.88	ha	Post QA/QC field boundaries	
A	1,692,286	ha	Post QA/QC field boundaries	
n_h	11,632	# fields	Post QA/QC field boundaries	
$\Delta \bullet_{h, ip, t}$	0.404	$t\ CO_2e/ha$	Model runs from soil sampling initial values, $ip = 1$	
$\Delta \bullet_{h, t}$	0.387	$t\ CO_2e/ha$	Mean of ip points within strata h	

$s_{sampling, \Delta \cdot h, t}^2$	1153858	$(t \text{ CO}_2e/ha)^2$	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)
$s_{sampling, \Delta \cdot t}^2$	87042144	$(t \text{ CO}_2e/ha)^2$	Equation 53 (VM0042 v2.0) – not yet normalised by total Project area	
$\frac{s}{\Delta \cdot t}$	0.363343	$(t \text{ CO}_2e/ha)^2$	Equation 54 (VM0042 v2.0)	
$\overline{\Delta \cdot t}$	1.20314	$t \text{ CO}_2e/ha$	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	
$UNC_{\overline{\Delta \cdot t}}$	21.77	%	Equation 65 (VM0042 v2.0)	Uncertainty deduction applied to SOC stock removals, used in Equation 38 (VM0042 v2.0)

5.4.5 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.

$$\begin{aligned}
 E_{red,t} = & \Delta CO2_{ff_t} + \Delta CO2_{lime_t} + \Delta CH4_{ent_t} + \Delta CH4_{md_t} + \Delta CH4_{bb_t} \\
 & + \left(\Delta CH4_{soil_t} \times (1 - UNC_{t,CH4_{soil}}) \right) \\
 & + \left(\Delta N2O_{soil_t} \times (1 - UNC_{t,N2O_{soil}}) \right) + \Delta N2O_{bb_t}
 \end{aligned} \tag{37}$$

Where:

$E_{red,t}$	= Estimated net GHG emissions reductions in year t (t CO ₂ e)
$\Delta CO2_{ff_t}$	= Total carbon dioxide emission reductions from fossil fuel combustion in year t (t CO ₂ e)
$\Delta CO2_{lime_t}$	= Total carbon dioxide emission reductions from liming in year t (t CO ₂ e)
$\Delta CH4_{ent_t}$	= Total methane emission reductions from livestock enteric fermentation in year t (t CO ₂ e)
$\Delta CH4_{md_t}$	= Total methane emission reductions from manure deposition in year t (t CO ₂ e)
$\Delta CH4_{bb_t}$	= Total methane emission reductions from avoided or reduced biomass burning in year t (t CO ₂ e)
$\Delta CH4_{soil_t}$	= Total methane emission reductions from increasing uptake into the SOC pool in year t (t CO ₂ e)
$UNC_{t,CH4_{soil}}$	= 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 ₂ e)
$UNC_{t,N2O_{soil}}$	= 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 ₂ e)

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

Where:

- $E_{rem,t}$ = Estimated net GHG emissions removals in year t (t CO₂e)
- $\Delta CO2_{soil,t}$ = Total carbon dioxide emission removals from increasing the SOC pool in year t (t CO₂e)
- $LE_{BR,t}$ = Leakage emissions from the diversion of manure or crop residues from baseline energy applications in year t (t CO₂e)
- $\Delta C_{TREE,t}$ = Total carbon dioxide emission removals from increasing tree biomass in year t (t CO₂e)
- $\Delta C_{SHRUB,t}$ = Total carbon dioxide emission removals from increasing shrub biomass in year t (t CO₂e)
- $UNC_{t,CO2}$ = 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 CO₂e)

Table 5-18. 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
$\Delta CO2_{ff,t}$	-0.28	t CO ₂ e	CO ₂ emission reductions from fossil fuel combustion	Calculation as discussed in Section 5.4.1
$\Delta CO2_{lime,t}$	-0.5544	t CO ₂ e	CO ₂ emission reductions from liming	Calculation as discussed in Section 5.4.1

$\Delta N_2O_{soil,t}$	8.59	t CO ₂ e	N ₂ O emission reductions from nitrification/ denitrification in soil	Calculation as discussed in Section 5.4.2
$\Delta CO_2_{soil,t}$	11.1	t CO ₂ e	CO ₂ emission removals from increasing the SOC pool in year t	Calculation as discussed in Section 5.4.1
$LE_{BR,t}$	3.99	t CO ₂ e	Leakage emissions	Leakage calculations as discussed in Section 5.3
UNC_{t, CO_2}	21.77	%	Uncertainty deduction in year t associated modeling SOC stock changes	Uncertainty calculations as discussed in Section 5.4.4
$E_{red, t}$	7.76	t CO ₂ e	Estimated net GHG emissions reductions	Equation 37 (VM0042 v 2.0)
$E_{rem, t}$	5.56	t CO ₂ e	Estimated net GHG emissions removals	Equation 38 (VM0042 v 2.0)
ERR_t	13.32	t CO ₂ e	Estimated net GHG emissions reductions and removals	Equation 39 (VM0042 v 2.0)

5.4.6 Calculation of Verified Carbon Units

Verified Carbon Units (VCUs) are calculated using Equation 66 from VM0042 v2.0, which integrates the values of E_{red} , E_{rem} , 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 CO₂e)
 $Buffer_t$ = Number of buffer credits to be contributed to the AFOLU pooled buffer account in year t (t CO₂e)

Table 5-19. Data inputs and outputs for calculating verified carbon units for the sample unit i = PAI ID 7627

Parameter	Value	Unit	Description	Source
$E_{red,t}$	7.76	t CO ₂ e	Estimated net GHG emissions reductions	Calculations as discussed in section 5.4.5
$E_{rem,t}$	5.56	t CO ₂ e	Estimated net GHG emissions removals	Calculations as discussed in section 5.4.5
$Buffer_t$	1.33	t CO ₂ e	Number of buffer credits to be contributed to the AFOLU pooled buffer account	The VCS AFOLU Non-Permanence Risk Tool
VCU_t	11.99	t CO ₂ e	Number of VCUs	Equation 66 (VM0042 v 2.0)

Table 5-20 Summary of the Project Non-Permanence Risk Assessment

State the non-permanence risk rating (%)	24%
Has the non-permanence risk report been attached as either an appendix or a separate document?	☒ Yes ☐ No
State, in tCO ₂ e, the expected total GHG benefit to date.	2,679,896.74
If a loss occurred (including a loss event or reversal), state the amount of tCO ₂ e lost:	N/A

Table 5-21 The Project crediting period and calculation allocations

Vintage period	Baseline emissions (tCO ₂ e)	Project emissions (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Buffer pool allocation (tCO ₂ e)	Reductions VCU (tCO ₂ e)	Removals VCU (tCO ₂ e)	Total VCU issuance (tCO ₂ e)
Year 1 (15 September 2021 – 31 December 2021)	24,316.95	-2,765.47	698.76	3,147.94	9,617.29	9,968.48	19,585.77
Year 2 (1 January 2022 – 31 December 2022)	591,010.01	-83,265.35	19,875.60	70,898.16	276,786.56	224,510.84	501,297.40
Year 3 (1 January 2023 – 31 December 2023)	2,031,385.22	-455,592.76	76,040.96	281,137.00	913,563.31	890,267.16	1,803,830.47
Total	2,646,712.18	-541,623.59	96,615.32	355,183.1	1,199,967.15	1,124,746.49	2,324,713.64

Table 5-22. Estimated ex-ante GHG emission reductions and carbon dioxide removals for the monitoring period. Includes the percentage difference and explanation of quantities of reductions and removals post buffer deductions

Vintage period	Ex-ante estimated reductions/removals	Achieved reductions/removals	Percent difference	Explanation for the difference
Year 1 (15 September 2021 – 31 December 2021)	21,231	22,734	+7%	Buffer pool allocation impacted slightly the difference following new AFOLU NPRR.
Year 2 (1 January 2022 – 31 December 2022)	547,456	572,196	+5 %	Buffer pool allocation impacted slightly the difference following new AFOLU NPRR.
Year 3 (1 January 2023 – 31 December 2023)	543,554	2,084,967	+284 %	Increase in the amount of hectares. ²⁵¹ Please see Section 3.3 for the justification of fields undergoing full eligibility check and QA/QC Process.
Total	1,112,241	2,679,896.74	+ 107 %	N/A

²⁵¹ Due to the nature of grouped projects and inclusion of new PAIs, different PAIs will implement different and improved practices and therefore lead to an increase in overall VCUs and ERRs. The rate of increase in VCUs is proportionate to the increase of hectares due to the addition of new PAIs in the grouped project. For more information please see Section 3.3 on Grouped Projects.

APPENDIX 1: COMMERCIALLY SENSITIVE INFORMATION

Commercially sensitive information, program sensitive information and sensitive information as defined in the VCS Standard 4.5 document, has been excluded from the public version of the Monitoring Report covering this first verification period. 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 4.5 (Section 3.5.4).

The materials including the VMD0053 report, the breakdown of clusters for stratification can be considered commercially sensitive as the materials, including the supplement as well as the model contain significant proprietary information that could jeopardize the business. The RothC model has been parameterized using data that Agreena has sourced and invested significant financial investment in external researchers. Public disclosure of the specific parameters, data sources, or model adaptations would directly reveal the results of this investment, allowing competitors to benefit without incurring similar costs. In addition, Agreena has developed a novel stratification approach in line with VM0042 version 2.0 including criteria, threshold and spatial analysis that would expose the intellectual property of Agreena including those whose entire business model relies on offering stratification services. In addition, immediate replication of the information provided could also reduce incentive to invest in research and development on both model development and stratification. The information that has been provided already and the public version of the MVR allow for a complete replication of our ERRs, which is in line with the requirements of commercially sensitive information.

Table A1-1 Description of commercially sensitive information included in the monitoring report to be excluded in the public version

Section / Document	Information	Justification
Appendix 2	Soil Sampling Protocol, the procedure used by AgreenaCarbon in accordance to methodology requirements.	Is not directly tied to the quantification or the setting of the baseline or additionality tests. All requirements laid out in VCS 4.7 will be answered in the body of the MR.
Appendix 3	QA/QC Table, exemplifying the flagging process	The figure is already presented in the body of the MR.
Appendix 4	Emissions Reduction and Removals	Is provided as a public attachment to the MR.
Appendix 6	Accounting for leakage from diversion of Biomass Residue used for energy	Is not directly tied to the quantification or the setting of the baseline or additionality

	applications in the Baseline Scenario, summary of how the analysis is done	tests. All requirements laid out in VCS 4.7 will be answered in the body of the MR. The values are traceable in the ERR spreadsheet.
<u>Appendix 7</u>	Productivity reporting for future assessment of Leakage due to biomass declines(Pwp,P)	Is not directly tied to the quantification or the setting of the baseline or additionality tests. All requirements laid out in VCS 4.7 will be answered in the body of the MR.
Supplementary Calculation Material	Calculation step-by-step supplementary material contains code from RothC and model-building information.	Per the definition of sensitive information such that it 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.”
VMD0053 Report and IME Report	Containing full validation and calibration of the RothC model built by Agreea. A public version of the MVR has been uploaded for this verification period.	Per the definition of sensitive information such that it 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.” A public version of the VMD0053 report has been made available and shared as an attachment to this monitoring report.
Supplement for Clustering of Strata	Breakdown of clusters for stratification approach.	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.”

ⁱ <https://www.fao.org/faostat/en/#data/ESB>