ORIZON CARBONCROP REWARDS PROGRAMME

Project title	Orizon CarbonCrop Rewards Programme
Project ID	3368
Monitoring period	01-Aug-2018 to 31-Jul-2022
Crediting period	01-Aug-2018 to 31-Jul-2043
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Version	3.6
VCS Standard Version	4.7
Prepared by	Orizon Agriculture (Pty) Ltd

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1 PROJECT DETAILS

1.1 Summary Description of the Project

Orizon's CarbonCrop Rewards Programme (OCRP) supports and incentivizes South African farmers in the transition towards more sustainable agricultural practices by paying out a majority share of the carbon credit revenues resulting from emission reductions and carbon sequestration. Together with our partners, we support our farmers by providing tailored financial and practical advice, building online tools to assist farmers in their transition, connecting farmers with each other and contributing to local research on sustainable agriculture.

Currently, the organic matter ("OM") levels in South African soils are lower than ever, with 65% of soils containing less than 0.5% carbon and only 4% of soils containing more than 2% OM (Du Preez, 2011). Although much of this is due to arid conditions, on average, cultivated soils have seen a 46% loss of organic carbon since cultivation began. Furthermore, South Africa's agricultural industry is the most carbon intensive in the world when measuring the tCO_2e per U$1 million export value (Montmasson-Clair, 2020).

The encouraged practices all focus on reducing Greenhouse Gas ("GHG") emissions and building Soil Organic Carbon ("SOC") by improving soil health. The following practice categories qualify for inclusion in the project: Improved fertilizer (organic or inorganic) and inputs management; reduced tillage/improved residue management and retention; improved crop planting and harvesting (e.g., crop rotations and cover crops); and/or improved grazing practices. These methods have been shown to sequester more carbon and reduce GHG emissions in comparison to conventional practices. Each participating farmer adopts at least one of these practice changes to be included, although most farmers adopt multiple of these project activities in various ways.

The program, with its project boundaries being the geographic boundaries of the Republic of South Africa, will be registered as a grouped project under VM0042 - Improved Agricultural Land Management. Each project activity is carried out and monitored according to this methodology and its supporting methodologies, standards, and tools. Using our online platform, we receive the necessary data from participating farmers to calculate / model the emission reductions and removals as required for the purpose of issuing Verified Carbon Units ("VCUs"). This is monitored by assessing supporting documents, farmer attestations, technological tools, and multiple site visits per year to each project participant to ensure a healthy relationship and validation of practices.

The crediting period is 25 years (starting 1 August 2018) with the project lifespan being 100 years. It is estimated that this project will reduce and remove an average of 74,939 tCO_2e/year for the first crediting period (after buffer allocation). The total GHG reductions and removals generated for the first monitoring period, from 1 August 2018 to 31 July 2022, are 200,377 tCO_2e, including a contribution of 40,218 to the buffer pool.

Our vision is to be a comprehensive partner for our current and future farmers in their regenerative journey, support further research and investment into Regenerative Agriculture ("RA") and to ultimately help drive a national shift to improve soil health and productivity to secure the long-term future of agriculture in South Africa and a greener tomorrow.

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
Validation	01-Aug-2018-31-Jul-2043	VCS	SCS Global Services	25 (Twenty-five)
Verification	01-Aug-2018 – 31-Jul-2022	VCS	SCS Global Service	4 (Four)
Monitoring	01-Aug-2018 – 31-Jul-2022	VCS	SCS Global Service	4 (Four)
Total	01-Aug-2018 – 31-Jul-2022			4 (Four)

1.3 Sectoral Scope and Project Type

This project falls in the VCS Sectoral Scope 14: Agriculture Forestry and Other Land Use ("AFOLU"). It is a grouped project and will follow the guidance of VM0042 – Methodology for Improved Agricultural Land Management, Version 2.0, 30 May 2023 as well as its supporting methodologies (see Section 3.1).

Sectoral scope	14
AFOLU project category[1]	Agricultural Land Management (ALM)
Project activity type	Improved Cropland Management (ICM) Cropland and Grassland Land-use Conversions (CGLC)

1.4 Project Eligibility

1.4.1 General eligibility

The project meets the eligibility criteria under the VCS Program, as:

1. The carbon sequestration and emission reductions resulting from this project would not have taken place in the business-as-usual case. Historical practices prior to implementation of improved Agricultural Land Management ("ALM") practices were based on advice of experts and knowledge at the time and represent the conventional and widely accepted / practiced agricultural practices within the project area.

2. This project does not feature on the list of projects that are explicitly excluded project activities under the terms of Verra (VCS Standard, v4.7, Table 1 on Section 2.1).

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[1] *See Appendix 1 of the* VCS Standard

3. The VCS Methodology VM0042 eligibility and additionality criteria are assessed for each project instance. Furthermore, this project and all its qualifying planned project activities meet the applicability conditions as set out in VCS Methodology VM0042 v2.0. These include the management practice, current and historic land use and land type, productivity / leakage, and biochar requirements. VM0042 v2.0 is an eligible methodology as per section 2.1.1. point 3 of the VCS Standard v4.7.

4. The scope of the VCS Program only includes GHGs listed in the Kyoto protocol list of GHGs, being CO_2, CH_4 and N_2O. This project removes and reduces emissions of these listed GHGs.

5. The baseline activities did not originally emit GHG's for the purpose of subsequently generating carbon credits as the project area only includes productive land and the baseline practices were generally practiced long before any carbon credit markets existed.

1.4.2 AFOLU project eligibility

Further AFOLU-Specific eligibility criteria are detailed in Section 3.2 in the VCS Standard v4.7 with the following table providing evidence to confirm that this project also meets these requirements.

Table 1.4.1: High-level AFOLU-Specific Matters Section 3.2.1 – 3.2.9 in v4.7 of the VCS Standard

High-level requirements in the VCS Standard for AFOLU projects		Project Applicability
1	There are currently six AFOLU project categories eligible under the VCS Program, as defined in *Appendix 1 Eligible AFOLU Project Categories* below: afforestation, reforestation, and revegetation (ARR), agricultural land management (ALM), improved forest management (IFM), reduced emissions from deforestation and degradation (REDD), avoided conversion of grasslands and shrublands (ACoGS), and wetland restoration and conservation (WRC). Further specifications with respect to eligible activities which may be included within methodologies approved under the VCS Program can be found in the *VCS Methodology Requirements.*	This project and all its project instances meet the eligibility for ALM activities mentioned in Appendix 1 of the VCS Standard v4.7. The eligible activities include: 1. Improved cropland management (ICM): The predominant practices of reduced tillage (No till or minimum tillage), cover cropping and the application of organic amendments all fall into this activity category. 2. Cropland and Grassland Land-use Conversions (CGLC): Several project instances have made some once-off conversions of degraded lands and have started reducing GHG emissions by improving carbon stocks.
2	Where projects are located within a jurisdiction covered by a jurisdictional REDD+ program, project proponents shall follow the requirements in this document and the requirements related to nested	This project is not located within a jurisdiction covered by any jurisdictional REDD+ program.

	projects set out in the *Jurisdictional and Nested REDD+ Requirements*.	
3	Where an implementation partner is acting in partnership with the project proponent, the implementation partner shall be identified in the project description. The implementation partner shall identify its roles and responsibilities with respect to the project, including but not limited to implementation, management, and monitoring of the project, over the project crediting period.	Orizon is the current implementation partner. The roles and responsibilities of Orizon's employees are outlined in Section 6.3 in the monitoring plan for this project.
4	The project proponent shall demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design. Where no new project activities have been implemented during a verification period, project proponents shall demonstrate that previously implemented project activities continued to be implemented during the verification period (e.g., forest patrols or improved agricultural practices of community members).	Implementation of the project activities is verified by Orizon's account managers per farmer included in the project.
5	For all IFM, Avoiding Planned Deforestation (APD) (except where the agent is unknown), Restoring Wetland Ecosystems (RWE), Avoiding Planned Wetland Degradation (APWD), Avoiding Planned Conversion (APC), and ALM project types, the project proponent shall, for the duration of the project, reassess the baseline every ten years. For all Avoiding Unplanned Deforestation and Degradation (AUDD), APD (where the agent is unknown), Avoiding Unplanned Conversion (AUC), and Avoiding Unplanned Wetland Degradation (AUWD) project types, the project proponent shall, for the duration of the project, reassess the baseline every six years.	The project will implement the following to meet this eligibility requirement: • Use the latest version of all VCS templates and the applied methodology at the time of baseline reassessment. • The baseline will be reassessed every 10 years in accordance with the timelines set out in point 5. • Orizon will reassess and capture changes in land use, hydrology and other relevant practices and incorporate these into the revised estimates of baseline emissions. • The original baseline's validity will also be reassessed. This will be done to determine if the original baseline can continue to be used or a new baseline scenario needs to be established.

		• No ex-ante baseline projections beyond the baseline reassessment period will be done. • Update the necessary sections of the project description as required by the VSC Standard at the time of the baseline reassessment. • Further to this the project will need to meet the criteria set out under section 3.2.7 where applicable.
6	Where ARR, ALM, IFM or REDD project activities occur on wetlands, the project shall adhere to both the respective project category requirements and the WRC requirements, unless the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is deemed below *de minimis* or can be conservatively excluded as set out in the *VCS Methodology Requirements*, in which case the project shall not be subject to the WRC requirements.	There are no project activities included on wetlands as per the methodology.

Section 1.5 Project Design provides further specific guidance and details regarding the eligibility criteria applied to this project.

1.4.3 Transfer project eligibility.

This section is not applicable to this project as this grouped project is neither seeking transfer nor is it a CPA registered under another GHG program.

1.5 Project Design

The project has been designed as a:

☒ Grouped project.

Grouped Project Design

The Orizon CarbonCrop Rewards Programme is designed as a grouped project that allows for the inclusion of multiple project activity instances. This project specifically focuses on incentivising, supporting, and rewarding farmers that implement qualifying practices that result in a transition from more conventional practices by the farmer to a more holistic and regenerative approach to agriculture. As per v4.7 of the VCS Standard, this project is designed to adhere to the rules pertaining to the classification of a project as a grouped project as well as meeting all the necessary eligibility criteria for grouped projects and the subsequent addition of new project instances. The design of this project allows for the addition of new instances post validation and will therefore be able to support more farmers transitioning away from conventional practices in the future.

The validation process for this project will initially include project instances in the following provinces of South Africa: Kwa-Zulu Natal, Gauteng, Mpumalanga, Free State and North West. Future instances from other provinces are planned to be added after validation and Orizon will ensure that each new instance is in line with the VCS Standard v4.7 requirements of eligibility and, where methodology-specific criteria is required, as outlined in VM0042 v2.0, the new project instances will also be compliant with this.

The diagram below provides a brief annotated summary of the process that Orizon follows for including new farmers and instances in this project:

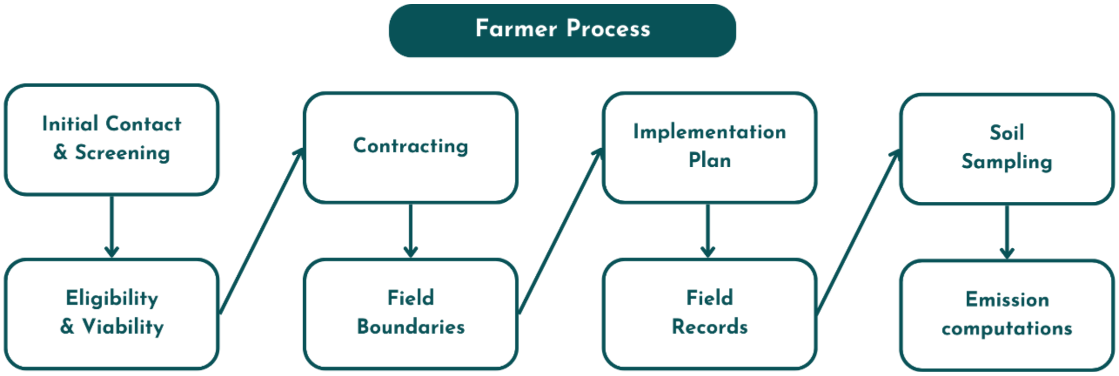

Figure 1.5.1: Outline of the process followed per project instance.

Eligibility Criteria

As per VCS Standard v4.7 this project's initial and future instances will comply with the following eligibility criteria and applicability conditions of VM0042 v2.0. This list of criteria and requirements applies to the entire area of the project.

As per section 3.6.16 in VCS Standard v4.7, grouped projects shall include one or more sets of eligibility criteria for the inclusion of new project instances. The eligibility criteria ensure that new project activity instances:

Table 1.5.1: New project instance eligibility criteria

Eligibility Criteria		Justification for each project Instance
1	Meet the applicability conditions as set out in VM0042 v2.0.	Refer to Section 3.2 for the full list of applicability conditions and the justifications for how this project meets the requirements for each applicability condition. Each project instance has introduced or is introducing at least one practice change considered compliant with the methodology requirements of what constitutes a practice change. The following practice changes are eligible for current and future project instances: • Improved fertilizer (organic or inorganic) and inputs management • Reduced tillage (No till or minimum tillage) and improved residue management • Improved crop planting and harvesting • Improved grazing practices Where the practice change is quantitative, the activity change qualifies for this applicability condition only when exceeding a 5% change, calculated as the difference between the average rate/quantity across the baseline historic look-back period used for the schedule of activities and the average rate/quantity across the project period. Projects need to be implemented on land that is either cropland or grassland at the project start date. The land must remain cropland or grassland throughout the project crediting period. Where land is converted from grasslands to croplands, the applicability conditions of Section 4.3 (a or b) of VM0042 v2.0 need to be met. Orizon assesses this in line with the approach detailed in Section 3.2. Negative applicability conditions/exclusions need to also be met, as detailed in Section 3.2, including the clearing of native ecosystems within 10 years prior to the project start date, a sustained drop in productivity greater than 5%, biochar applications on project lands and wetland presence on project fields.
2	Use the technologies or measures specified in the project description	Project instances have agreed to participate in the program as part of their transition to more sustainable practice and have begun implementing these practices as specified in this project description.

Eligibility Criteria		Justification for each project Instance
3	Apply the technologies or measures in the same manner as specified in the project description	The project instances have successfully started implementing activities that are building SOC and reducing emissions as specified in this Project Description Document (PDMR). This is evidenced by the results in Section 5 and 7, as well as the implementation status of the project activities outlined in section 4.1.
4	Are subject to the baseline scenario determined in the project description for the specified project activity and geographic area	All project instances included in the first monitoring period are subject to the baseline scenario described in Section 3.4. Although each field's data is used to develop its own baseline scenario based on the activities performed during the historical look-back period on that field, the project instances all follow the same general baseline trends as described in Section 3.4 and average values across all project instances were detailed there. Where degraded grassland to cropland converted fields were included, these need to pass the applicability conditions of Section 4.3 (a or b) of VM0042 v2.0, which Orizon assesses in line with the approach detailed in Section 3.2. The baseline practices for these converted fields are, of course, different to those listed in Table 3.4.1 as they were not managed as croplands before the project start date. However, as they meet the VM0042 applicability conditions and due to the low adoption rates of the ALM practices, it can be assumed that these would have followed the common baseline practices in the absence of the project. They would therefore be subject to the same baseline scenario as described in Section 3.4. Data was gathered for this period and is primarily based on historic management records. Where this was not available, historic management plans are used. Attestations from farmers were signed to support these practices. For instances where historical data is lacking for the look-back period, a regional baseline has been applied based on data for the common practice for the region. The principle of conservativeness was applied in all data collection procedures where there are variations in the data based on the data source. All future project instances will be subject to the same process of determining a baseline as was required for the initial project instances. This is explained further in Table 1.5.2

Eligibility Criteria		Justification for each project Instance
5	Have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area. For example, the new project activity instances have financial, technical and/or other parameters (such as the size/scale of the instances) consistent with the initial instances, or face the same investment, technological and/or other barriers as the initial instance).	Based on the common practice assessment the adoption rates are currently well below the allowed maximum of 20%, at 7.73%. This adoption rate will be revised for the latest information available at each verification event and for each instance added to the grouped project. Barriers will be re-assessed based on consultations with new project instances to ensure adherence to the eligibility requirements. Future project instances will follow the same additionality requirements as those applied in Section 3.5 to the initial instances. See Table 1.5.2 for further details. Additionality is described in detail in Section 3.5 in this PDMR.

Grouped projects provide for the inclusion of new project activity instances after the initial validation of the project. Provided they meet the eligibility criteria of 3.6.17 of the VCS Standard v4.7. New project activity instances shall:

Table 1.5.2: Eligibility criteria for project instances post initial validation.

VCS Standard v4.7 3.6.17: New project instance eligibility criteria		Description of how a new project activity instance is eligible for inclusion
1	Occur within one of the designated geographic areas specified in the project description.	All current and future project instances will be located within the geographical boundaries of the Republic of South Africa. Where project instances are located in a local region (within the project boundary), which has not yet been included under the additionality assessments, these new regions will be validated to ensure the same barriers and adoption characteristics apply to the new regions.
2	Conform with at least one complete set of eligibility criteria for the inclusion of new project activity instances. Partial conformance with multiple sets of eligibility criteria is insufficient.	All potential new project instances undergo an eligibility assessment based on the eligibility criteria in Table 1.5.1 and Section 1.4 of this PDMR. Each new project instance will have its baseline assessed as per the same requirements as the initial PAIs. This is done by developing a historical schedule of activities (using farm management records) which is an assessment of practices implemented during the period prior to the project start date (as per section 6 of v2.0 of VM0042) and to ensure that these

VCS Standard v4.7 3.6.17: New project instance eligibility criteria		Description of how a new project activity instance is eligible for inclusion
		baseline activities are broadly in line with those described in Section 3.4. For future project instances where historical data is lacking for the historical look-back period, a regional baseline will be applied based on data for the common practice for the region, if it can be evidenced that the general baseline activities of Section 3.4 still applied to such fields. This process will follow all the same requirements as applied to the initial set of project instances at project validation. The use of a regional baseline is also applied for fields where a grassland to cropland conversion has taken place as historical records are also unavailable in these specific cases. Refer to Section 3.2 of the PDMR for details specific to this applicability condition. Future project instances will follow the same additionality requirements as those applied to the initial instances. This requires 3 steps: 1. Demonstrate regulatory surplus 2. Identify and provide evidence of the same investment, technological and/or social/cultural barriers as the first project instances. 3. Demonstrate that the adoption of new project activities is not common practice Each new project instance will be required to undergo an assessment for common practice. The assessment will follow the requirements outlined in Appendix 3 of v2.0 of VM0042. • In cases where new activities are added or where combined activities are non-additional on their own in a given stratum, a new weighted average will be calculated as per Step 3 of Section 7 of v2.0 of VM0042. • Where new activities are added or where combined activities in a given stratum are below the 20% common practice threshold, a new weighted average is not required to be calculated.

VCS Standard v4.7 3.6.17: New project instance eligibility criteria		Description of how a new project activity instance is eligible for inclusion
3	Be included in the monitoring report with sufficient technical, financial, geographic, and other relevant information to demonstrate conformance with the applicable set of eligibility criteria and enable evidence gathering by the validation/verification body.	The data from the new Instances will be provided to the VVB for the relevant monitoring period. This data will be sufficient information as per the requirements of the VCS Standard. All required evidence for the new project instance will be collected and provided to the VVB at the next verification.
4	Have evidence of project ownership, in respect of each project activity instance, held by the project proponent from the respective start date of each project activity instance (i.e., the date upon which the project activity instance began reducing or removing GHG emissions).	Each project instance must sign a contract with Orizon giving Orizon sole rights to the credits issued. The farmer is the owner / lessee of the property and implements the project activities, but Orizon has ownership of the project. Where leased, the lease must be a stable, long-term lease and the landowner must agree to the project activities.
5	Have a start date that is the same as or later than the grouped project start date.	All project instances would have to start after 1 August 2018 to be eligible.
6	Only be eligible for crediting from the later of start date of the project activity instance or the start of the verification period in which they were added to the grouped project, through to the end of the total project crediting period.	Instances joining in the next monitoring period will only be eligible for credits from 1 August 2022 even if their project instance start date was earlier than that date but later than the overall grouped project start date of 1 August 2018.
7	Not be or have been enrolled in another VCS project	All project instances must provide a commitment (in the contract) and sign an attestation that they are only joining this VCS project.
8	Adhere to the clustering and capacity limit requirements for multiple project activity instances set out in 3.6.8 – 3.6.9.	This will be analyzed for each additional project instance.

1.6 Project Proponent

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1.7 Other Entities Involved in the Project

This section is not applicable as Orizon is the sole developer of the grouped project.

1.8 Ownership

The project proponent, Orizon, will have full ownership of the project and any/all resulting VCUs that are issued.

Most of the fields (more than 80% of the 15,547 hectares) are owned either directly by the farmer or a related company/trust of the farmer whilst some fields are leased to the farmer implementing the practices. In all cases the person implementing the practices has the right to implement these IALMs. Orizon ensures due diligence is done for all lease agreements. This due diligence includes several safeguards that are implemented to reduce the risk of non-permanence with respect to any leased fields. The first is to ensure that the current lease agreement between the farmer implementing the practices and the landowner is stable and long-term. Evidence that was sought to make a decision on this included, amongst others, evidence of the contractual agreement, attestation by the farmer and evidence of past years managing these fields. Other safeguards include limiting the hectares of leased land to <20% of the total project area. Further safeguards include Orizon's title deed assessment to confirm the stated lessor is the owner of the land. The agreement signed between the farmer implementing the practices and Orizon includes a clause that requires the project proponent to have a meeting with the landowner to ensure the practices continue should the lease agreement not be renewed.

The project proponent's ownership of the project is based on signed contractual agreements with all participating landowners/farmers. This signed contractual agreement referred to above, meets the requirement in the VCS Standard v4.7 section 3.7.1.6 as follows:

The improved ALM practices are implemented by each farmer and Orizon will have the rights to any VCUs that occur from the implementation of these practices in each instance. The majority share of resulting revenues generated (up to 75%) by the sale of the issued VCUs will be distributed to the landowners/farmers in line with the signed contractual agreements.

1.9 Project Start Date

Project start date	1 August 2018
Justification	See detailed description below

The Orizon CarbonCrop Rewards Programme grouped project start date is 1 August 2018, which is after Orizon representatives, and its partner organisations started promoting the project activities to the participating farmers. As per the VCS Standard, this grouped project start date corresponds to the date from which the initial activities included in the project have started to remove and reduce GHG emissions.

The timing within the year coincides with preparation of the fields for the main planting season in the summer rainfall regions of South Africa and would include the participating farmers who commenced sustainable practices from the 2018/19 planting season.

A grouped-field approach is taken whereby the project start date for each instance is set in relation to the date of commencement of / commitment to sustainable practices on a farm-wide level. A field-level approach was not followed as this could result in carbon leakage in cases where farmers shift improved ALM activities from excluded fields to included fields, without actual net improvements.

There are, however, cases where certain fields have project start dates which are different to other fields belonging to the same grower, such as when additional fields are purchased or leased later. The grouped field project start date is defined as the earliest formal adoption date for the grower, provided the date is not earlier than 1 August 2018 and provided that the field in question was under the farmer's management control from that season onwards. A farmer's instance may therefore include fields with different start dates if new fields were leased / purchased over time but generally have the same start date for all other fields to minimise the risk of leakage.

- The below list is of the three predominant activities present in the initial project instances and is not an exhaustive list of all IALM activities that occurred during the first monitoring period. Refer to section 1.12 for more information regarding the project activities. Tillage – A reduction in tillage e.g. Deep/heavy tillage to minimum tillage or a complete reduction to no till. This information was obtained in management records and where possible verified with satellite imagery. Further examples of evidence include invoices for the purchase of such equipment, inspection of such implements on the farm and observed residues remaining on the field subsequent to the typical spring tillage window.

- Planting of cover crops (either winter or summer) – Conventionally, farmers do not plant cover crops in South Africa as shown by the absence of data regarding the adoption rate of this practice (See Section 3.5). The planting of a significant portion of the field area by a farmer in a particular season was often used as the instance's project start date. This was substantiated by observation, NDVI assessment for those seasons, invoices for the purchase of the cover crops, the presence of suitable equipment to plant such cover crops and management records.

- Applications of organic inputs and reduction of synthetic fertilizer. Application rates of synthetic fertilizer and organic inputs were obtained through management records. The timing of the reduction in usage of synthetic fertilizer and/or increase in organic inputs was often used as the instance's project start date.

The very first project activities adopted on and shortly after 1 August 2018 include a reduction in tillage in preparation for the 2018 planting season, the preparation for planting a summer cover crop, the commissioning of a composting operation and the reduction of fertilizer and liming applications. In the spring of 2018 (August & September), tillage events reduced by 23.2%. Fields totalling 1,194 hectares which were heavily tilled in the previous season were not tilled in the 2018 planting season. Relative NDVI values over the early-spring months confirmed this shift in tillage activity towards no till practices. In the 2017 planting season, these tillage activities started on 1 August.

Each project instance's start date was based on factual evidence (farm records, invoices or satellite imagery) as well as trend analysis to ensure the adjustments are >5% where they are quantitative. One such activity, for example, was the purchase of 311.9 cubes of beef manure from a feedlot in Bergville by a participating farmer to initiate a composting operation. The invoice is dated 3 August 2018 although the deliveries of the manure and establishment of the composting facility took place in the 2 – 4 days before this, resulting in a start date of 1 August 2018. Other examples include the purchase of no-till equipment, purchase of summer cover crop seeds, etc.

The following table illustrates the hectares included over the current monitoring period. The hectares increase as project instances are added based on their individual project start dates, all on or after 1 August 2018.

Table 1.9.1 Cumulative project hectares during the first monitoring period 2018-2022

Year	2018	2019	2020	2021
Season	2018/19	2019/20	2020/21	2021/22
Cumulative Hectares	10,940	11,630	14,110	15,547

1.10 Project Crediting Period

Crediting period	25-year crediting period.
Start and end date of first or fixed crediting period	1 August 2018 – 31 July 2043 (25 years)

As per section 3.9.3 in the VCS Standard v4.7 requirement for AFOLU projects, the crediting period for this program should be a minimum of 20 years with a maximum of 4 renewals within the maximum 100-year crediting period.

Aligned with the most impactful carbon sequestration period, we have chosen a 25-year crediting period with 3 renewals. This period also aligns with the minimum generational period from which the subsequent generation would start taking over farming operations and the probability of changing practices is heightened.

The project start date as per Section 1.8 above is 1 August 2018. The first crediting period therefore will end on 30 July 2043. The project lifespan i.e., end date will be 30 July 2118.

1.11 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated annual GHG emission reductions/removals of the project are:

☒ < 300,000 tCO_2e/year (project)

Table 1.11.1: Estimated GHG emission reductions or removals for the first crediting period.

Calendar year of crediting period	Estimated GHG emission reductions or removals (tCO_2e)
1-August-2018 to 31-December-2018	9,061
1-January-2019 to 31-December-2019	28,784
1-January-2020 to 31-December-2020	41,100
1-January-2021 to 31-December-2021	48,998
1-January-2022 to 31-December-2022	58,013
1-January-2023 to 31-December-2023	63,705
1-January-2024 to 31-December-2024	73,389
1-January-2025 to 31-December-2025	83,431
1-January-2026 to 31-December-2026	83,431
1-January-2027 to 31-December-2027	83,431

1-January-2028 to 31-December-2028	83,431
1-January-2029 to 31-December-2029	83,431
1-January-2030 to 31-December-2030	83,431
1-January-2031 to 31-December-2031	83,431
1-January-2032 to 31-December-2032	83,431
1-January-2033 to 31-December-2033	83,431
1-January-2034 to 31-December-2034	83,431
1-January-2035 to 31-December-2035	83,431
1-January-2036 to 31-December-2036	83,431
1-January-2037 to 31-December-2037	83,431
1-January-2038 to 31-December-2038	83,431
1-January-2039 to 31-December-2039	83,431
1-January-2040 to 31-December-2040	83,431
1-January-2041 to 31-December-2041	83,431
1-January-2042 to 31-December-2042	83,431
1-January-2043 to 31-July-2043	48,668
Total estimated ERRs during the first or fixed crediting period	1,873,473
Total number of years	25
Average annual ERRs	74,939

1.12 Description of the Project Activity

The Orizon CarbonCrop Rewards Programme, through a focus on regenerative agriculture, seeks to incentivise and support improved practices such as those outlined in Section 1.1. The project is set up as a grouped project so that it can be expanded across South Africa over time. Importantly, as part of the requirements of the VCS, this project is not located within a jurisdiction covered by any jurisdictional REDD+ program.

Besides Orizon and the farmers, several different role players such as consultants, researchers, agricultural organisations, and legal experts are working together to support farmers to overcome the barriers of transitioning to more sustainable practices. Orizon's account managers (see Section 6.3 for more information) have developed strong relationships with our farmers through a hands-on approach by making several annual farm visits to each operation and guiding the initial farmers through the process from sign-up and implementation to data collection. This process will continue with further communication regarding registration of the project and subsequent issuance. These relationships and farm visits will continue as the project progresses.

Participating farmers will need to make one or more practice changes as per the methodology and in line with its requirements. These practice changes often come at big costs and risks, including the cost of new implements, increased investment in livestock and the risk of potential short-term drops in productivity. There are also other challenges, such as investing management time to understand these new practices, combatting soil compaction and acidity levels without tillage, and maintaining yields while reducing synthetic fertilizer to name a few. By directing carbon credit funds to such farmers and providing them with the necessary support and resources, these risks are mitigated, and costs are offset.

The incentivized project practices are outlined in the table below along with some resulting positive environmental impacts (some of which are in addition to those quantified for the issuance of VCUs as part of the project):

Table 1.12.1: Improved practice activities and the environmental impact of these changes

Improved Practice Activity		Environmental impact
1	Improved fertilizer (organic or inorganic) and inputs management	
Baseline Scenario	Project Scenario	Impact
Almost exclusive use of synthetic fertilizer at high rates. Although application rates vary widely amongst initial project activities, an average of 72.68 kg N/ha applied per season across the historic baseline years. Actual application rates are used for baseline establishment.	Optimizing fertilizer application rates (resulting in a >5% decrease from the baseline scenario). Although application rates vary widely amongst initial project activities, an average of 69.93 kg N/ha applied per season across the project	- Reduction in N_2O emissions from synthetic fertilizers - Increase in N_2O emissions from organic fertilizers - Reduced water pollution (reduced

Improved Practice Activity		Environmental impact
	years. Actual application rates are used for project activity establishment. While this aggregated effect is less than 5%, 15 of the 22 initial instances had synthetic fertilizer changes of greater than 5% (on a kg N basis). The aggregated effect is expected to exceed 5% within the upcoming monitoring periods based on a drive to further reduce synthetic fertilizer. Urea-based fertilizers, with a higher emissions factor than other Nitrogen fertilizers, increased by 7.33% from 58.92 kg/ha 63.24 kg/ha in the baseline and project periods respectively. Changes in synthetic fertilizer regimes typically go hand-in-hand with changes in organic inputs. Farmers applying organic inputs managed to reduce their total N applications from synthetic fertilizers by 9.20% from 35.57 kgN/ha to 32.30 kgN/ha. Reductions are achieved through the incorporation of organic inputs, cover cropping with legumes, the use of more efficient products (different form / inhibitor of synthetic fertilizers), etc.	N_2O emissions by reducing leaching and volatilization of synthetic fertilizers) - Reduced fertilizer manufacturing and transport emissions (reduced N_2O emissions) - Increased SOC due to C-containing organic inputs - Accelerated build-up of Soil Organic Matter ("SOM") by managing Carbon:Nitrogen ("C:N") ratios - Improved pH levels of soils (more suitable for long-term SOC build-up through sequestration) - Reduced diesel / fuel combustion emissions through the optimization of fertilizer application (fewer fertilizer events in a season where fuel is required) - Reduced CO_2 emissions from the applications of Calcitic and Dolomitic agricultural lime
No / immaterial organic inputs. Although application rates vary widely amongst initial project activities, an average of 39.80 kg/ha applied per season across the historic baseline years. Actual application rates are used for baseline establishment.	Introducing / increasing organic inputs (resulting in a >5% increase from the baseline scenario). Although application rates vary widely amongst initial project activities, an average of 478.23 kg/ha applied per season across the project years. Actual application rates	

Improved Practice Activity		Environmental impact
	are used for project activity establishment. This is achieved through composting operations or the direct application of readily available manure / chicken litter. The total kg N reduction from baseline to project for the combined synthetic and organic applications increased by 8.01% from 74.862 kgN/ha to 80.858 kgN/ha.	
Significant liming applications at conventional rates, often blanket applied. Although application rates vary widely amongst initial project activities, an average of 0.93 t/ha applied per season across the historic baseline years. Actual application rates are used for baseline establishment.	Reduction in liming in the project scenario (resulting in a >5% decrease from the baseline scenario). Although application rates vary widely amongst initial project activities, an average of 0.87 t/ha applied per season across the project years. Actual application rates are used for project activity establishment. This is achieved by managing soil acidity in other ways, such as improved biology and reducing acid-based fertilizers, as well as through precision applications and improved soil sampling campaigns.	
2	Reduced tillage and improved residue management / retention	
Baseline Scenario	Project Scenario	Impact
Regular deep and high disturbance / intensity tillage, resulting in soil inversion and exposure due to full / material incorporation of surface residues. This includes deep discing, high disturbance ripping, deep chisel, ploughing, etc. Although depths range widely (15 – 50cm), the average tillage depth in the baseline years across the initial project	Minimum- or no-till practices are introduced. Where tillage still takes place, these are either not as deep (e.g. 5cm high-speed disc) or do not invert the soil and maintain soil cover (e.g. vertical ripping). Although depths range widely (5 – 10cm, or deeper to	- Improve the SOC stock by improving the soil structure and reducing carbon losses from soil inversion / destruction. Tillage incorporates Oxygen into the soil which accelerates soil

Improved Practice Activity		Environmental impact
instances was 21.43cm and the occurrence was an average of 0.91 tillage passes per field per season. Actual tillage events per field were used to establish the baseline.	40cm for low disturbance vertical ripping), the average tillage depth in the project years across the initial project instances was 8.60cm and the occurrence was an average of 0.49 tillage passes per field per season. Actual tillage events per field were used to establish the project activities.	respiration, decomposition processes and therefore SOC losses. - Higher soil temperatures due to a lack of soil cover increases decomposition. - Improved soil structure and cover reduces erosion (South Africa loses significant amounts of topsoil each year in crop production by conventional methods (13t/ha/year) (Le Roux, 2014)(Le Roux, 2014). This assists in storing the carbon in the soil (as SOC) whereas higher erosion risk in the baseline results in a release in carbon from the soil. - Allows mycorrhizal to build soil aggregates which facilitate optimal root growth and carbon storage and build a network to transfer nutrients and water improving crop tolerance to droughts and nutrient density of produce. - Reduced diesel / fuel combustion emissions. tCO_2e reduced by using less diesel in the project due to less tillage or baling activities
Partial or full residue removal through baling or grazing most/all residues. Only 5.7% of grazing days were on living crops. Actual events based on farm records are used to establish each field's baseline.	Elimination or reduction (>5% at a minimum) of baling or residue grazing. Although livestock are encouraged in the project, it is favorable to incorporate them onto living cover crops rather than dead residues. A significant shift of livestock onto cover crops and away from residue grazing was seen in the project, where grazing events are now on living cover crops for 47.8% of the grazing days. Baling was almost completely eliminated. Actual events based on farm records are used to establish each field's project activities.	
3	Improved crop planting and harvesting	
Baseline Scenario	Project Scenario	Projected Impact

Improved Practice Activity		Environmental impact
No (or minimal) off-season cover cropping. Across the initial project instances in the baseline period, only 6.5% of hectares were cover cropped.	Start or expand (>5% increase at a minimum) the hectares being planted to off-season cover crops. Across the initial project instances in the project period, an average of 34.1% of hectares were planted to cover crops each season. The diversity of cover crops was also improved by planting multi-species mixes which typically include legumes as a natural means to fix Nitrogen. Cover crops planted & planned typically include black oats, white oats, rye grass, stooling rye, vetch, radish, turnips, clovers, peas, etc.	- Increased C-containing biomass production, through increased photosynthesis increases SOC - Reduction in synthetic fertilizer due to the incorporation of legumes and planting of summer cover crops which require less fertilization - Regulates soil heat to avoid extreme temperatures which are destructive to soil microbiology - Builds soil structure and reduces bare soil component which builds resilience to heavy rain and reduces soil loss / erosion from surface runoff or wind - Increases annual production capacity
No (or minimal) in-season cover cropping. Across the initial project instances in the baseline period, only 0.9% of hectares were cover cropped in the main cropping seasons of the respective regions.	Start or expand (>5% increase at a minimum) the hectares being planted to in-season cover crops. Across the initial project instances in the project period, an average of 3.9% of hectares were planted to cover crops each season. This is a practice that Orizon wishes to promote more aggressively in future. However, it was not a widely adopted practice as it requires the growers to “skip” a season of their primary crop production income on those fields. Therefore, the project participants were hesitant to adopt this practice widely in these first monitoring periods but have stated they wish to increase these in future. Although the increase across all project instances is not material (lower than 5%) for in-season cover cropping, there are individual project	

Improved Practice Activity		Environmental impact
	instances where the 5% minimum rule was exceeded. Cover crops planted & planned typically include sorghum, babala, sunflower, cowpeas, sunhemp, etc.	
Mono-cropping or crop rotations which are not suitable to growing SOC (e.g. fallow summer period to plant a winter cash crop). Summer cash crops typically include Yellow Maize, White Maize, Soybeans and Sunflowers. While a winter cash crop (where applicable) typically consists of Wheat or Peas.	Incorporate crop rotations and grow in-season crops more suitable to the environment, focusing on balancing high biomass crops for SOC-building and legumes for nutrient management. Typically ensure a rotation is followed between grasses (e.g. Maize) and legumes (e.g. Soybeans). Ensure legumes are not over-fertilized to ensure the rhizobium is actively fixing atmonspheric nitrogen.	
4	Improved grazing practices	
Baseline Scenario	Project Scenario	Impact
Primarily grazing of residues only, removing soil cover. In the initial project instances, across the baseline period the average % of grazing days which were on cover crops was only 5.7%.	Shift towards grazing of living cover crops, which allows most of the residues to be incorporated into the soil through biology and stimulates root growth. In the initial project instances, across the project period the average % of grazing days which were on cover crops was 47.8%.	- Maintains soil cover, improving biological activity, reducing erosion and increasing SOC - Increase the SOC stock by allowing grasses to reach and remain in a vegetative state for longer - Increases productivity of livestock - Increases production of Hydroxyl Radical which helps break down GHG's in the atmosphere, especially methane
Selective grazing, reducing resting times of already-grazed areas and reducing the trampling effect. In the initial project instances, across the baseline period the average effective grazing days / ha under high density grazing was only 24.63 days/ha.	High-density grazing, increasing resting times of already-grazed biomass and increasing the trampling effect to create an improved soil cover. In the initial project instances, across the baseline period the average effective grazing days / ha	

Improved Practice Activity		Environmental impact
	under high density grazing was 35.58 days/ha.	

Below are some data visualisations for project context (Note: each season includes the baseline and project practices of all the farmers. For example, if a project instance has a start date of 2020/21 and a 3-year look-back period of 2017/18 – 2019/20, then the 2019/20 period includes that farmer's baseline activities even though it is after the grouped project start date. This effectively dampens the practice activity effects on the below visuals):

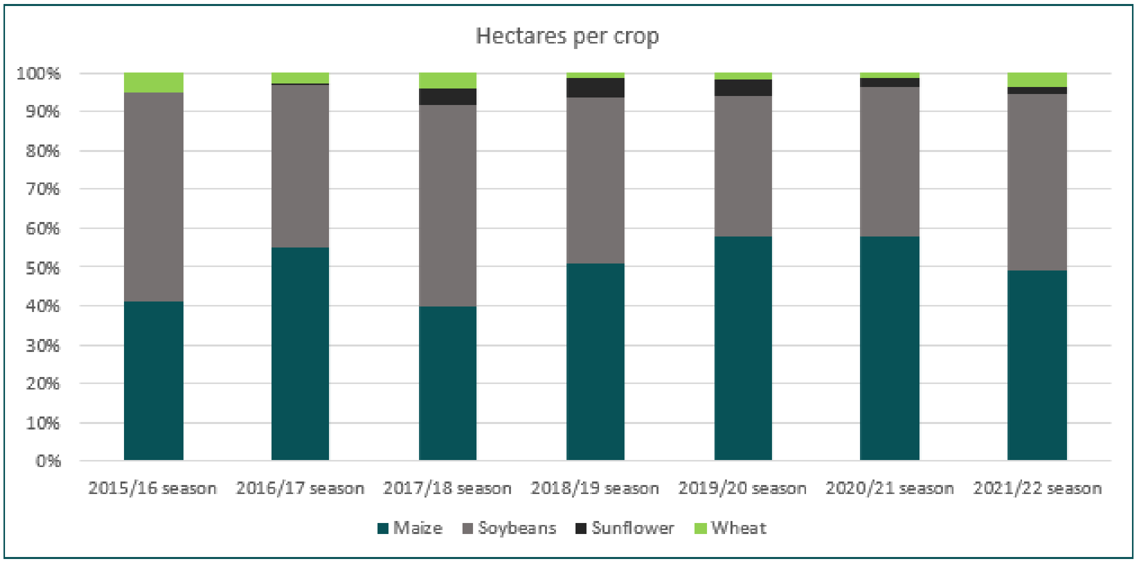

Figure 1.12.1: Hectares per crop

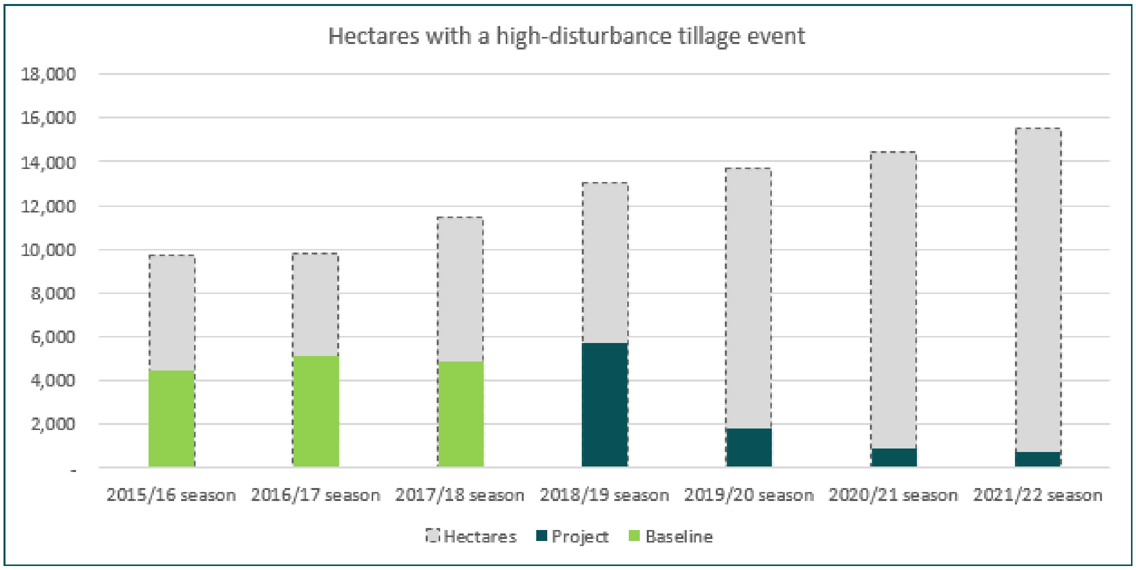

Figure 1.12.2: Hectares with a high-disturbance tillage event (including ploughing, deep discing, high disturbance ripping, etc.)

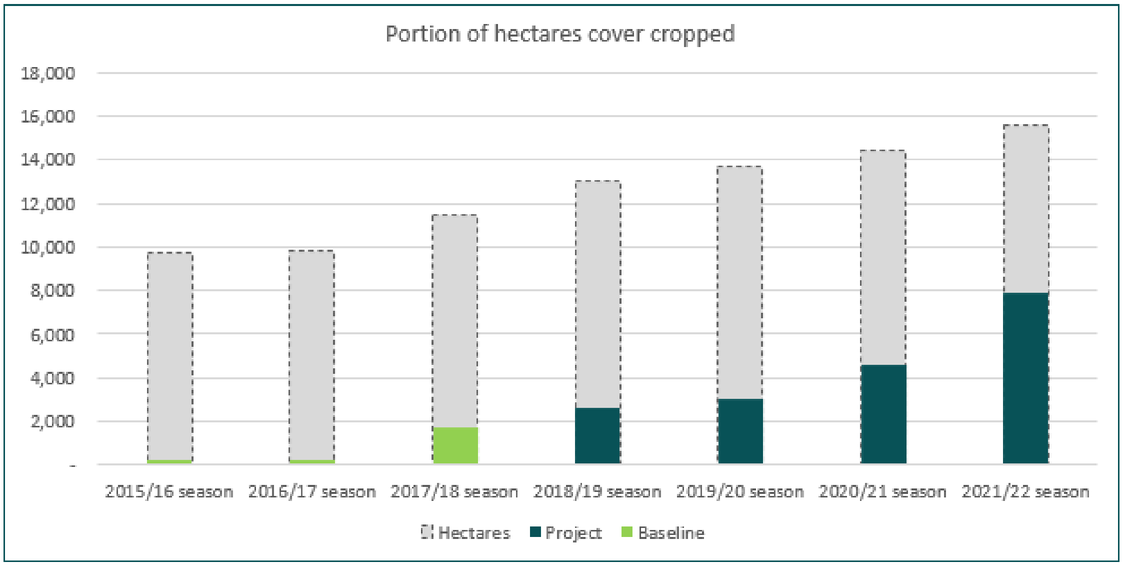

Figure 1.12.3: Hectares cover cropped in the off-season.

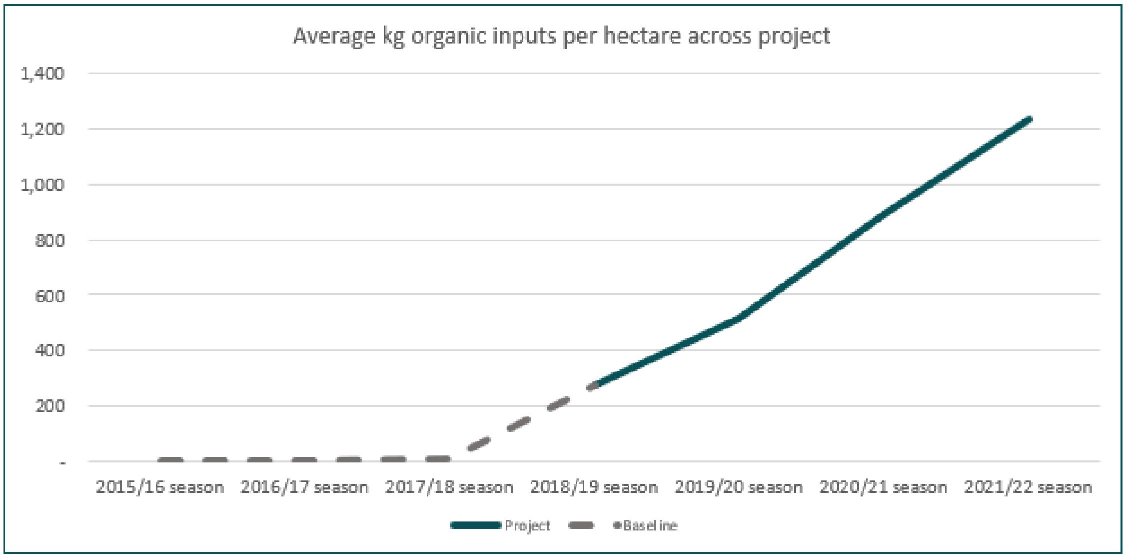

Figure 1.12.4: Average organic inputs per hectare across the project (kg/ha)

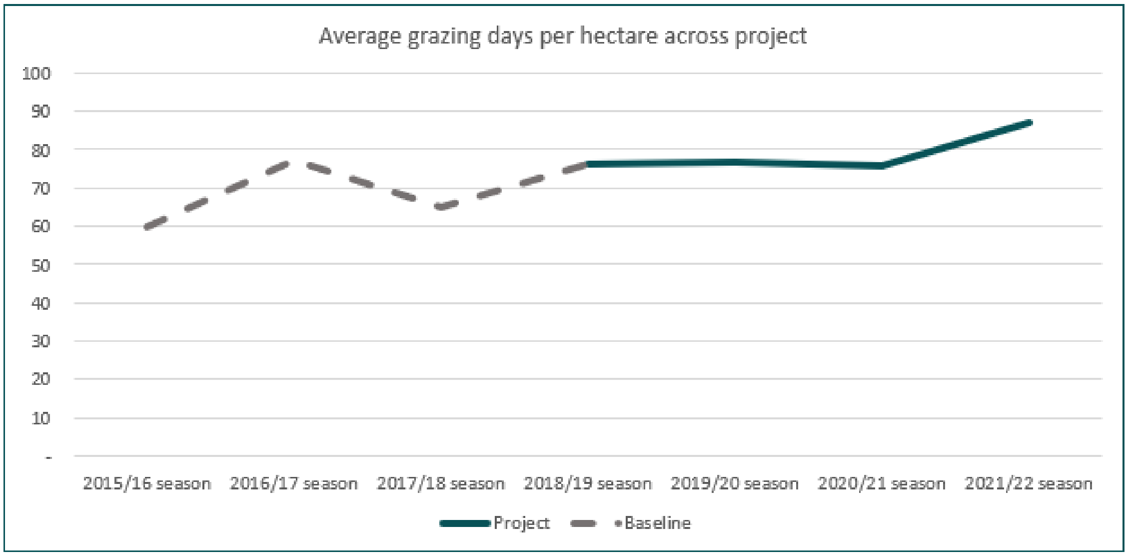

Figure 1.12.5: Average grazing days per hectare across the project (normalised to the equivalence of a medium-frame beef cow)

The project proponent receives the necessary data from the farmer to calculate and model the emission reductions and removals as required for the purpose of issuing VCUs. The GHG reductions and removals are quantified using the relevant equations and tools as per the methodology with Soil Carbon stocks being modelled using published calibrated parameters, validated using the published RothC methodology.

To ensure maximum continuity and permanence, the project has an extensive internal and external partner-support structure consisting of experts in the field, agricultural consultants, collaboration with research councils/bodies and provide a variety of materials to guide farmers in their regenerative journey. These materials include webinars, decision-making support, workshops, online tools, financial consults, and financial models, amongst others. We also link up farmers facing similar challenges in their regenerative journey with each other, to allow for a more streamlined network of information sharing amongst farmers that assists them to succeed with their RA practices in the long-term and with minimal risks.

1.13 Project Location

All project instances are located within the geographic borders of the Republic of South Africa. The location as well as the field boundaries and area of each project instance and sample unit (field) will be clearly defined and will be provided in Keyhole Markup Language (KML) format during the validation process. A KML file with the project boundary has been submitted. Figure 1.12.1 shows the geographical boundaries of the project with the provincial boundaries shown for provinces where current project instances are located.

Section 3.3 Project Boundary shows the locations of the initial project instances. There are 22 project instances, across five provinces combining a total of 15,547 eligible hectares that are included in the project. Orizon's contracted farmers own/lease and manage the fields that are included in the project.

Figure 1.13.1: Map of the project's boundary including provinces with instances currently.

1.14 Conditions Prior to Project Initiation

1.14.1 Ecosystem Types and vegetation: Figure 1.14.1 shows the different biomes in South Africa. Biomes are areas that have similar climatic and other abiotic (non-living) factors such as elevation, humidity, and soil type (*(Rutherford, 2006)*) which all contribute to the biological communities that thrive in such environments. Additionally, the variables described above all play a role in determining the carbon storage potential of the soils within a specific region. A biome is also considered a broad classification of ecosystem type of a region. Our project instances will be focused on the grassland and savanna biomes but also aim to expand to regenerate areas within other biomes. The project instances included in the first monitoring period all occur within the savanna and grassland biomes. Most of the annual rainfall (shown in Figure 1.14.2) falls in the summer months from October to March in these areas. For more detailed information regarding the conditions prior to the project initiation please refer to Section 3.4.

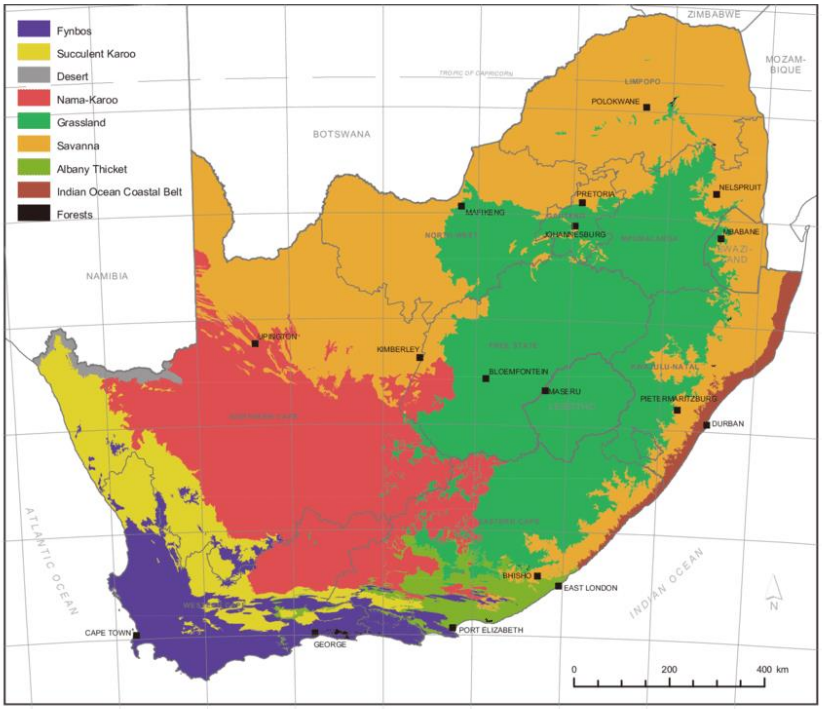

Figure 1.14.1: Biomes of South Africa Current and historical land use

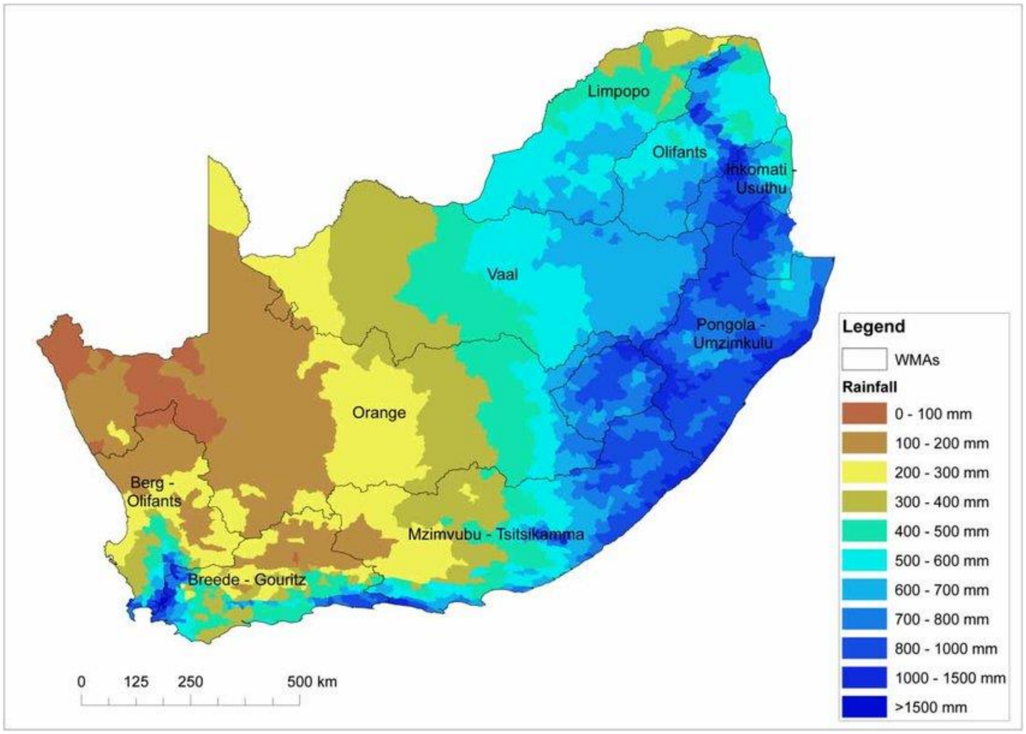

Figure 1.14.2: Map of annual rainfall across South Africa's Water Management areas (WMAs)
(Cole, 2017)

1.14.2 Agricultural Industry and land type: South Africa has a well-established commercial agriculture sector that covers c.46,4 million hectares, which represents 37,9% of the total surface area of South Africa (122,5 million hectares) *(SA, 2018)*. Commercial agricultural land comprised mainly grazing land (36,5 million hectares) and arable land (7,6 million hectares) *(SA, 2018)*. Grazing land is used mainly for livestock whilst arable land is planted with crops and pastures or established with orchards and vineyards. In the 2020/2021 planting season approximately 4.1 million hectares of crops were planted, with maize contributing 2.8 million hectares *(Esterhuizen, 2021)*. The second most planted crop, soybeans, has seen a sharp increase from c.134 000 hectares in the early 2000s to a record estimated 1.2 million hectares for the 2022/2023 season *(United States Department of Agriculture, (USFDA), 2023)*. Total agricultural land, including commercial, small-scale, subsistence and communal lands has decreased from a high of 101.3 million hectares in 1961 to 96.34 million hectares in 2020 *(Statista, 2023)*.

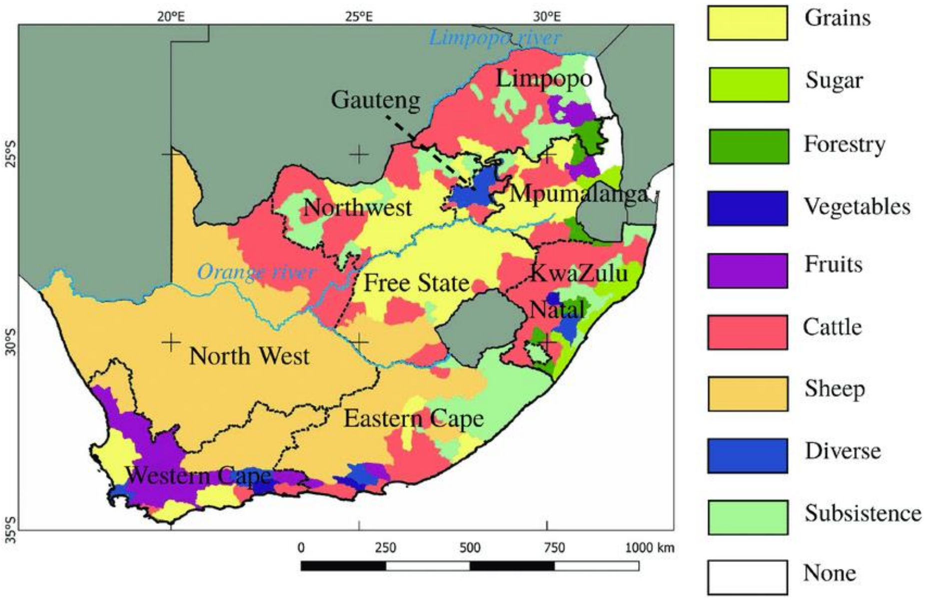

Figure 1.14.3: Agricultural regions of South Africa and provincial breakdown *(Waldner, 2017)*

1.14.3 Agricultural Practices: Conventional farming production practices have intensified in the commercial sector to make up for exponentially increasing input costs and the reduced area under commercial agriculture. The baseline scenario therefore comprises mostly of conventional forms of agriculture (see Section 3.4). The baseline activities did not originally emit GHG's for the purpose of subsequently generating carbon credits as the project area only includes productive land (i.e., it was economically viable to farm on it) and the baseline practices were generally practiced even before any carbon credit markets existed and were based on the advice of experts and the widely accepted best practices at the time.

1.14.4 Soil types: South Africa has a very wide range of soil types (see Figure 1.14.5 and Figure 1.14.6), mainly driven by the varying climates, topographies and historic natural events and formations. The maps below provide an indication of the national variation of soil types and textural classes. The soils generally found in agriculture are classified as Anthropic due to human disturbance. The dominant soil textural classes for our initial project instances are sandy clay loam, clay loam, clay, and sandy loam (illustrated below) with clay content ranges from 18.3% to 62.3% (see Figure 1.14.4).

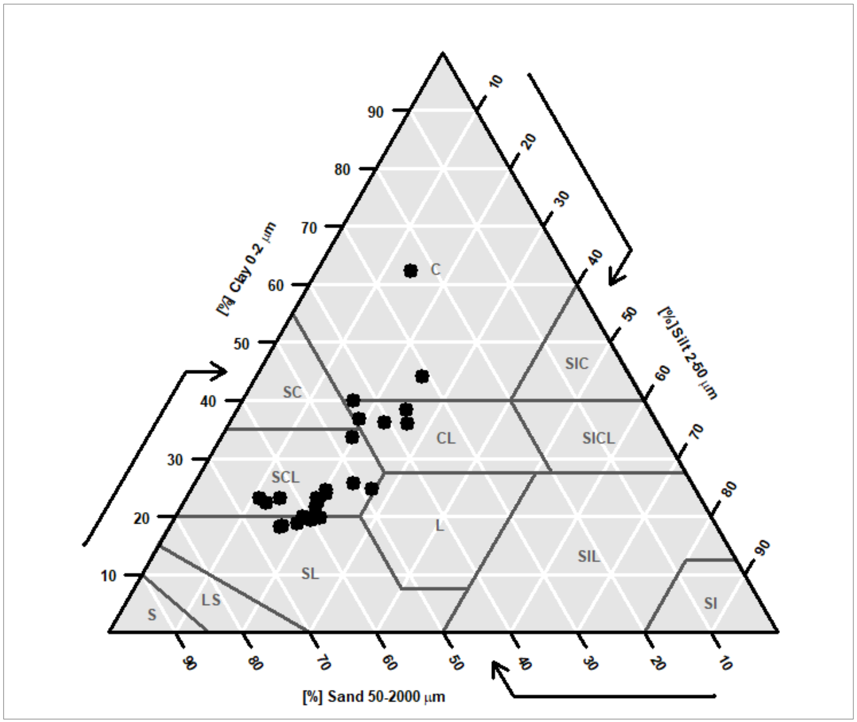

Figure 1.14.4: Soil texture diagram for the farms in the OCRP

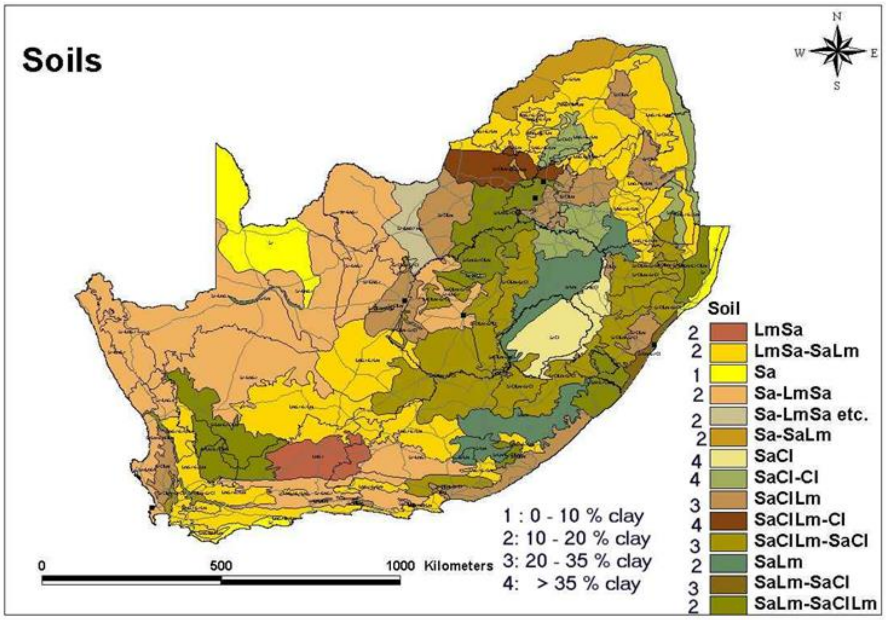

Figure 1.14.5: Map of soils classified based on clay content *(DWS, 2011)*

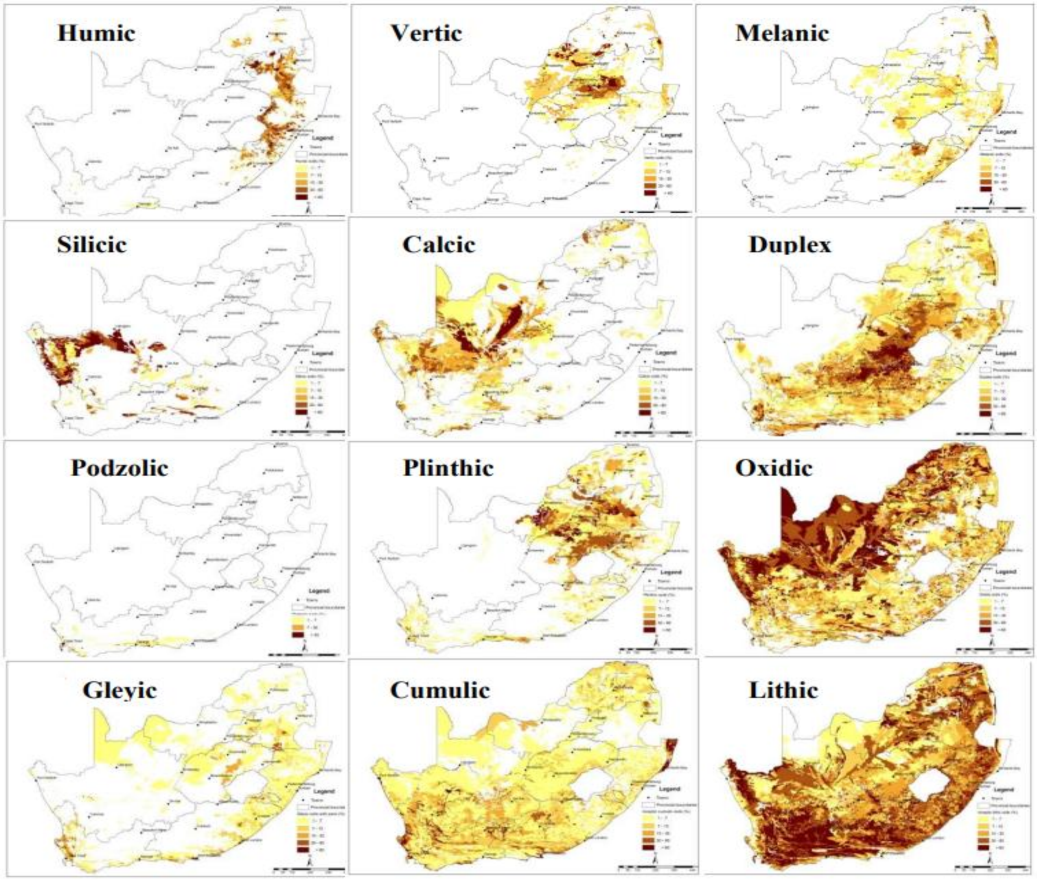

Figure 1.14.6: Distribution of the different soil groups across South Africa *(Fey, 2010)*

1.14.5 Soil Organic Carbon: Carbon levels, storage potential and the potential rate of sequestration is impacted by many factors, including climatic conditions, topography, soil type (primarily clay fraction), soil depth, land use and management practices. Our model takes these factors into account and will be validated for each area in which a field is included in the project. The current project instances are in areas where the SOC % ranges from 0.5 - 3% (based on Figure 1.14.7).

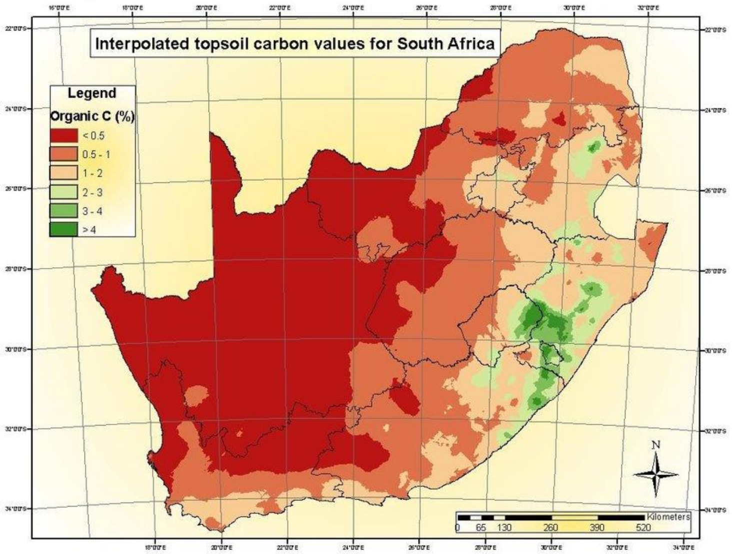

Figure 1.14.7: Distribution of soil organic carbon content (% by mass) across South Africa and Lesotho for the topsoil horizon only, based on 4 837 measured values *(Stronkhorst, 2008)*

1.13.5 Agricultural policy: The South African government and its agricultural extensions all strongly support the adoption of more sustainable agricultural practices. However, with limited resources, the need for private sector support and funding is clear. Currently, there are no regulations which prohibit a shift to regenerative agriculture, but neither are there any regulations, taxes or incentives which strongly encourage it.

The above all describes the broader / national conditions existing prior to project initiation. The conditions existing prior to project initiation on the specific participating fields were broadly aligned with the above-described conventional farming methods although some had already adopted some conservation practices which are now being expanded. Each sample unit will be individually assessed, and further details are included in Sections 3.2 and 3.4.

The initial project instances fall under the commercial agriculture sector. The aim of the project is to support both commercial and smallholder farmers in making the shift to improved land management practices. These practices would unlikely change without the commencement of this project due to financial, educational, and systemic barriers.

The baseline scenario is determined in line with VM0042, which assumes the continuation of historic practices as determined per individual project instance / field, based on actual field/farm records. Evidence is sourced in accordance with the Box 1 hierarchy within VM0042. Please see Section 3.4 for more information regarding the establishment of the baseline practice activities.

By using a combination of remote-sensing and satellite imagery such as Google Earth, Digital Earth Africa, Landsat, and the National Land Cover datasets will be used to confirm that the project activities are not taking place on fields that have been converted within 10 years of the project start date. For the currently include 22 project instances this assessment has been done and there are no fields where native ecosystems have been removed in the 10 years prior to project start date. For a detailed description of each project instance and the assessment please refer to the document Historical Land Use Assessment in the Appendices section.

A separate assessment report to determine the level of degradation and the likely impacts of implementing the project activities on these fields can be found in the Appendices with the title Land Conversion Assessment.

1.15 Compliance with Laws, Statutes and Other Regulatory Frameworks

This project, located within the geographical boundaries of the Republic of South Africa, is compliant with all relevant legislation and regulations. The project proponent has contracted the necessary legal expertise to provide oversight in this regard.

Orizon Agriculture's implementation plan with regards to compliance will include the following key components:

- Review the programme in accordance with applicable laws and regulations.
- Regularly update the list of laws and be aware of their requirements where applicable.
- Ensure clear communication with all staff regarding any changes in applicable laws and regulations directly related to the programme.
- Consistent communication with our legal partners who specialise in local environmental, climate, and carbon tax / market regulations.

Below is a non-exclusive list of identified RSA Regulations and legal frameworks that are adhered to as part of this project:

Table 1.15.1 List of relevant South African legislation and regulations.

Legislation/Regulation Name	Act Number & Year
Constitution of the Republic of South Africa	Act 108 of 1996
Companies Act	Act 71 of 2008
Carbon Tax Act	Act 15 of 2019
National Environmental Management Act (NEMA)	Act 107 of 1998
All amendments of NEMA up to and including 2014	Act 25 of 2014
National Water Act	Act 36 of 1998
All amendments of National Water Act up to and including 2014	Act 27 of 2014
National Heritage Resources Act	Act 25 of 1999

Legislation/Regulation Name	Act Number & Year
Constitution of the Republic of South Africa	Act 108 of 1996
Conservation of Agricultural Resources Act	Act 43 of 1983
The National Environmental Management: Biodiversity Act	Act 10 of 2004
National Environmental Management: Protected Areas Act	Act 57 of 2003
Agriculture Laws Extension Act	Act 87 of 1996
Fertilizers, Farm Feeds and Remedies Amendment Act	Act 4 of 1980
National Environment Management: Air Quality Act	Act 39 of 2004
Protection of Personal Information Act (POPIA)	Act 4 of 2013
Department of Forestry, Fisheries and Agriculture: Technical Guidelines for the validation and verification of GHG emissions	Government Gazette No. 45452, 12 November 2021
National Payment System Act	Act 78 of 1998
Financial Advisory and Intermediary Services Act	Act 37 of 2002
Basic Conditions of Employment Act	Act 75 of 1997
Labour Laws Amendment Act	Act 10 of 2018
Labour Relations Act	Act 66 of 1995

1.16 Double Counting and Participation under Other GHG Programs

1.16.1 No Double Issuance

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

☒ No

The project, or any of its project instances, has not received or is not seeking credit for reductions and removals from a project activity under any other GHG programs. Project instances joining over time will have to confirm this before entering into an agreement with Orizon and Orizon will perform high-level due diligence to validate this.

1.16.2 Registration in Other GHG Programs

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

☒ No

The project, or any of its project instances, has not been registered or is not seeking registration under any other GHG programs. Project instances joining over time will have to confirm this before entering into an agreement with Orizon and Orizon will perform high-level due diligence to validate this.

1.16.3 Projects Rejected by Other GHG Programs

Has the project been rejected by any other GHG programs?

☒ No

The project, or any of its project instances, has not been rejected by any other GHG programs. Project instances joining over time will have to confirm this before entering into an agreement with Orizon and Orizon will perform high-level due diligence to validate this.

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

1.17.1 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.

☒ No

This project does not reduce GHG emissions from activities included in an emissions trading programme or other mechanism for GHG allowance trading. All VCUs generated from this project will be sold only on the Voluntary Carbon Market (VCM).

1.17.2 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.

☒ No

The Orizon Carbon Crop Rewards Programme has neither sought nor received another form of GHG-related credit. The farmers included in the project have also confirmed, in their contract with Orizon, that they have also not sought or received another GHG-related environmental credit.

1.17.3 Supply Chain (Scope 3) Emissions

Do the project activities specified in Section 1.12 affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☒ No

This section is not applicable to this project for the following reason:

In the VCS Program Definitions v4.5 the “Supply Chain” is defined as ‘a network of organizations (e.g., manufacturers, wholesalers, distributors, and retailers) involved in the production, delivery, and sale of a product or service to the consumer. Supply chain entities include organizations upstream and downstream of the products whose GHG emission footprints are impacted by project activities.’

This project is not involved in the production, delivery, or sale of any products directly to the consumers. The produce is bulked together with other producers and sold as a commodity, rather than an individualised product.

As a result, the product’s emission footprint is not quantified and does not change throughout the value chain.

1.18 Sustainable Development Contributions

1.18.1 Sustainable Development Contributions Activity Description

The 2030 Agenda for Sustainable Development was adopted by all the United Nations member states in 2015, of which South Africa is a signatory. South Africa had also developed the National Development Plan (NDP): Vision 2030 “Our future – make it work” that was published in 2012. This together with the SDGs of the UN are an important aspect of any project striving to promote a more sustainable way of life and working to secure the long-term future of agriculture in countries such as South Africa.

The above-mentioned SDGs comprise of 17 goals that are being continually developed as a global partnership. The concept behind these goals is the recognition that ending poverty and other deprivations must go together with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans, forests, and other ecosystems. The sub-dividing of these 17 goals into targets and indicators provides a means to monitor and measure these goals.

This project strives to report and measure the benefits that are non-GHG related as well as ensuring that this project is not harmful to align with the SDGs. Besides the core mission of Orizon’s CarbonCrop Programme, being to accelerate the adoption of regenerative agricultural practices, Orizon also strives to benefit local ecosystems and society through these SDG contributions.

The implemented project activities contribute towards six SDGs:

The implemented project activities of no till, minimum tillage, cover crops and organic inputs contribute to the six SDGs as follows:

- By increasing the area under productive and sustainable agriculture the activities contribute to SDG 2.4. This will help with long-term food security in South Africa.
- The implemented project activities contribute to SDG 6.4.1 change in water-use efficiency over time by reducing runoff, improving water retention, and increasing the soil's ability to absorb / infiltrate water.
- By reducing the amount of CO_2 per unit value added, these project activities contribute to SDG 9.4.1 through emission reductions whilst maintaining productivity levels of the farming system.
- Reduction in fossil fuel usage and liming applications contribute to 12.2.2 domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP.
- The implemented project activities help improve soil health by building SOC which contributes to SDG 13.2, Tons of greenhouse gas emissions avoided or removed. SOC increase sequesters (removes) CO_2 from the atmosphere and the improved project activities contribute to emission reductions. And
- The conversion of degraded land to productive croplands contributes to SDG 15.3, namely the proportion of land that is degraded over total land area, by reducing the area of land that is considered degraded or degrading.

At the heart of this project and Regenerative Agriculture is ensuring increased awareness around sustainability and providing our farmers with the best information to achieve this to secure the future of agriculture for the next generations in South Africa. The SDGs are an integral part of this process and another important consideration for long-term decision-making in this project.

Other SDGs which are expected to be included in the future include ones relating to a reduction in poverty through increased employment, reduction of hunger, increased biodiversity, and others. These are not formally assessed currently but should be monitored in the future as improvements are expected as our farmer survey shows intentions to increase employment due to sustainable practices and implement some charitable and conservation projects on their farms with time and through the carbon credit revenues being generated.

1.18.2 Sustainable Development Contributions Activity Monitoring

The below table provides a detailed breakdown of the SDG Indicators to which this project contributed/s during this monitoring period. These indicators are representative of the first monitoring period of this project and it is likely that with this project's future expansion that there will be contributions to other SDGs not named here. As this is the first monitoring period, only contributions for this period are included.

Table 1.18.1: Sustainable Development Contributions

Row number	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 area under productive and sustainable agriculture	The inclusion of 22 project instances implementing sustainable agricultural practices has contributed an additional 15,547 ha of area under productive and sustainable agriculture	Contributed 15,547 ha of area under productive and sustainable agriculture.
2)	6.4	6.4.1 Change in water-use efficiency over time	Implemented activities to increase water-use efficiency over time	Planting of 18,165 ha of cover crops improve water retention of the soil and reduce surface runoff of water. Overall increase in level of SOC across the project by a net average of 1.05 t SOC/ha per season further improve water retention, reduce surface runoff, and improve soil's ability to hold water from precipitation and therefore improve the water efficiency of the entire system. (Blignaut. J, 2015)	Contributed 18,165 cumulative hectares of cover crops and an increase in the net average of t SOC/ha of 1.05 per season. Overall, there has also been a significant increase in the application of organic inputs from 39.80kg/ha on average across the baseline to 478.23kg/ha on average across the project – across all fields.
3)	9.4	9.4.1 CO_2 emission per unit of value added	Implemented activities to decrease the CO_2 emission per unit of value added	22 Project instances started implementing more sustainable practices during the monitoring period. This contributes to a reduction in CO_2 emissions per unit of value added as productivity remained stable whilst GHG emissions decreased by 200,377 tCO_2e.	CO_2 emission per unit value has decreased in the project lifetime as productivity has remained stable whilst emissions have been reduced by 200,377 tCO_2e.

4)	12.2	12.2.2 Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP	Implemented activities to increase sustainable management and efficient use of natural resources.	Across the current 22 project instances the activities that have contributed to this SDG include a reduction in fossil fuel usage and reduction of liming applications. For fossil fuel this equated to a reduction of 1,000.2 tCO_2e and a reduction of 1,911.7 tCO_2e for liming during the first monitoring period.	The project has positively contributed to increasing sustainable management and efficient use of natural resources by reducing fossil fuel usage by 1,000.2 tCO_2e and reducing liming applications by 1,911.7 tCO_2e over the project lifetime.
5)	13.2	Tons of greenhouse gas emissions avoided or removed	Implemented activities to decrease emissions i.e. increase emissions reductions	By implementing project activities such as reduced tillage (No till or minimum tillage), improving water management, improving fertilizer management, improving crop planting and harvesting; or improving grazing practices across 22 project instances has achieved and overall reduction and removal of 200,377 tCO_2e during this first monitoring period.	Total ERRs achieved for the project lifetime are 200,377 tCO_2e.
6)	15.3	Proportion of land that is degraded over total land area	Implemented activities to decrease	The conversion of degraded land to cropland in 12 project instances contributed positively to the reduction in area of degraded land during the first monitoring period. This area totaled 941.13 ha in total of converted land.	Over the project lifetime so far 941.13 ha of degraded land has been converted to cropland.

1.19 Additional Information Relevant to the Project

Leakage Management

Improved ALM projects may result in leakage through new application of organic amendments from outside the project area (i.e., organic amendments applied in the project from outside of the project area, that were not previously applied in the historical look back period) productivity declines displacement of livestock outside of the project boundary and/or diversion of biomass residues that were used for bioenergy applications in the baseline scenario. Guidance on how to account for each type of leakage is provided below.

As per the methodology VM0042 v2.0 there are three specific types of leakage that need to be monitored, and the relevant data provided. These are as follows:

1. Leakage from new application of organic amendments from outside the project area
2. Leakage from livestock displacement
3. Leakage from productivity declines; and
4. Leakage from the diversion of biomass used for energy applications.

The above-mentioned avenues for leakage are assessed by Orizon across the project in the following ways, and farmers will be informed of the possible instances where leakage may take place and the potential impact on overall credit issuance:

New applications of organic inputs:

Several farmers have started applying or have increased their organic input applications in the project period. These are all from sources which have an over-supply of such organic inputs, and therefore, no diversion of organic inputs from non-project lands took place.

This has been documented in an Organic Inputs Leakage Report submitted as part of the audit pack.

A materiality assessment has been performed and the maximum possible leakage deduction for the initial monitoring period would be 895.1 tCO_2e across the project. However, this is not considered as these applications are not diverted from soil applications on non-project lands.

Livestock displacement:

Although some individual instances experienced declines in the total effective grazing days per hectare (either through decreases in animal numbers, or through a reduction of the days spent on project fields), the aggregated project instances increased net grazing days / ha by 16.25 days.

Net emissions from livestock increased by 1,469 tCO_2e from the baseline to the project period indicating that no leakage deduction is necessary.

Productivity declines:

Although productivity assessments are only required to be completed every 10 years, we continuously track average yields to ensure that any potential areas of concern are identified and addressed.

Our analysis shows a marginal increase in yields for Maize, Soybeans and Sunflowers in the project period, while winter wheat experienced a decline. Winter wheat is not a commonly planted crop in our project (1.9% of hectares) and is therefore not a concern as the marginal decrease is negated by the increases in the primary crops.

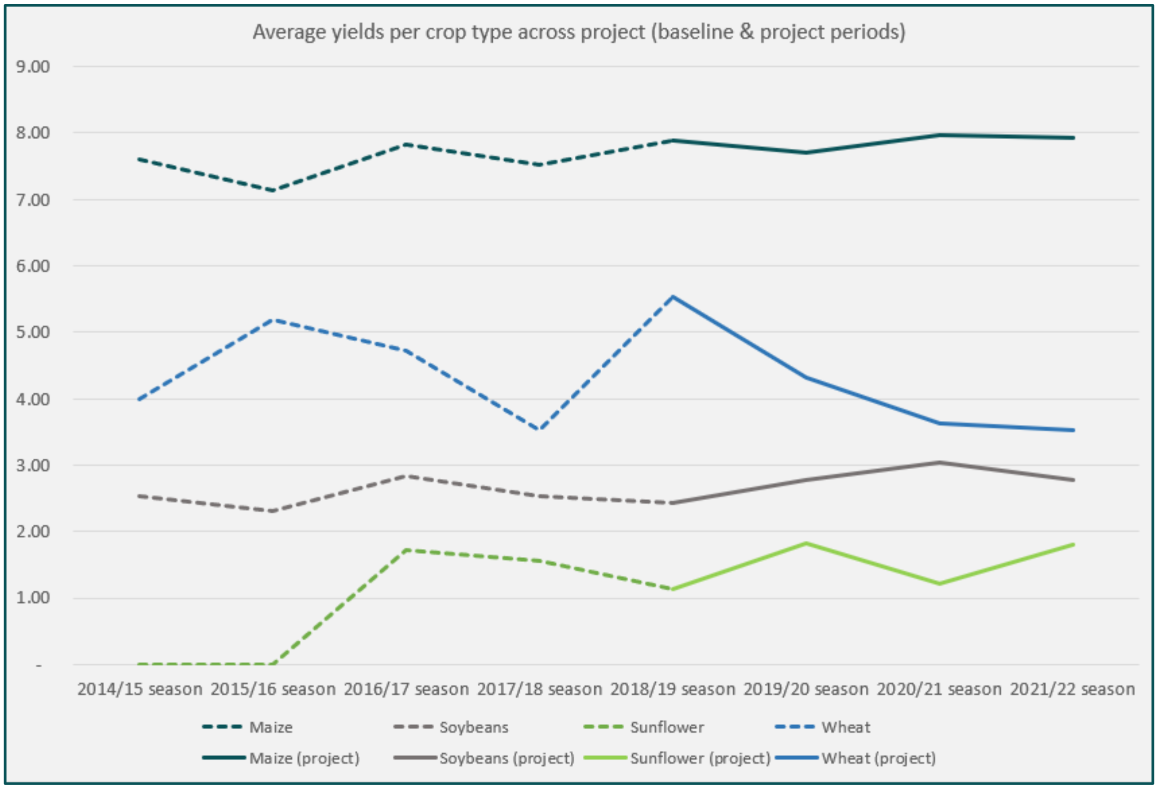

Figure 1.19.1: Average yield assessment across all instances

Our detailed assessment of the impact of our project activities shows a weighted average increase in crop yields of 9.9% when comparing the average yields throughout the project period to the average yields of the baseline period.

However, the GrainSA data also showed a slight increase in productivity across these periods, indicating that this increase is partially due to seasonality. After netting off the effect of seasonality and weather patterns, it appears that the true effect of the project activities on crop yields (weighted by the hectares planted to each) is an increase of 3.5%.

Livestock grazing days increased by 16.78% from an average of 96.87 days/ha in the baseline periods to an average of 113.12 days/ha in the project periods, indicating a gain in productivity.

<u>Biomass used for energy applications:</u>

Currently, no biomass is diverted from any energy production facilities. This is monitored through consultations with farmers and through a review of the data and sources of organic materials being purchased.

Any future leakage would need to be accounted for in the overall calculations of credits issued for this project. The leakage calculations can be found in the data package provided to the VVB. Leakage results in a reduction of credits issued. Total leakage and uncertainty are deducted from the gross GHG emissions pool.

This project does not expect significant leakage and through careful monitoring, strict initial farmer screenings and increasing awareness amongst our farmers, strives to minimise any chance of significant leakage taking place.

Commercially Sensitive Information

Commercially sensitive information, as defined under ‘Sensitive Information’ in the VCS Program Definitions v4.5 (16 April 2024) document, has been excluded from the public version of the project description. Whilst Orizon provides the location of the project instances, information relating to management practices of these instances as well as the soil samples taken as part of the sampling strategy (amongst other information required by Verra) and any information that may identify any of the individual farmers is not included in the project description. The latter includes any information specific to the contractual agreements between Orizon and all farmers, partners, agricultural consultants, and any other parties that have signed a contract / agreement with Orizon specifically for this project. Any farmer data or information that may identify the farmers has been redacted to ensure the protection of farmer privacy.

The following are reasons why the above-mentioned information meets the criteria of ‘Sensitive Information’ as per the document VCS Program Definitions v4.5 (16 April 2024):

1. The soil sampling campaign is a material cost in the project development. Making all this information publicly available allows other entities to use this data freely and effectively build their own soil carbon models based on our costs. While we are sharing much of this information with universities with the goal of improving scientific understanding of such practices and their effects on soil carbon, making this data available publicly will negatively impact the project and its participants. A redacted version could still contain a great amount of detail, while limiting the use of such data by competitors for purposes which compromise the position of our farmers as part of our project.
2. Management practices are also all available and have been audited by the VVB. However, we do not want to allow for others to correlate the locations and practices to soil sampling results and therefore build their projects on our (and our farmer’s) costs.

3. Many of the practices our farmers are implementing are trials together with corporates and it would not be in their best interests for this information to be publicly available in such detail that it can be replicated by their competitors.

Importantly, none of the information required to successfully complete the reviews was withheld from the VVB and Verra during the review processes and the information withheld due to commercial sensitivity only applies to the documents & workbooks available to the public. Redacted versions of these documents are provided.

Further Information

There is no further information included here. The PDMR in its current form provides all the relevant and required information in the other sections. Should there be the need to amend and include further information for any future instances added to this grouped project then the PDMR will be amended and updated accordingly to reflect any relevant information that applies to this section of the document.

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

Improved ALM and its associated practices create benefits not only in the agricultural sector but also benefits on an economic, social, and environmental level. Section 1.18 as well as this section expand on some of these other benefits, environmental safeguards, and the stakeholder component of this project.

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

The below table describes the stakeholder identification process for the initial instances included in the first monitoring period. Justification for any non-applicable items is also provided as required.

Stakeholder Identification	The identification of stakeholders was done through consultations, conversations and farm visits to each of the 22 project instances. Orizon ensured that training of our staff included the ability to recognize stakeholders based on Verra's requirements and understanding of the VCS Standard when doing farm visits and during conversations with farmers, farm managers and farm workers. Other industry role players such as consultants, farmer co-

operations and agronomists, as well as other carbon project developers, were also contacted to identify groups of people who might impact or be impacted by the project activities.

For each project instance the stakeholder identification was done by determining whether any stakeholders were present as per the definition of a stakeholder set out in the Programs Definition document v4.5. Broadly defined, this meant determining which groups of people could potentially affect or be affected by the implementation of the project activities.

Currently identified stakeholders in the project:

- Farm owners / Farm managers
- Permanently employed farm workers

The 22 initial project instances are commercial farms with private property rights. There are no communal lands present in the included project instances. The identified stakeholders are the farmers (who are the implementation partners of the project activities) and the permanent employed workers / managers who receive payment as labor on the farms. Currently, only permanent farm workers who are reliant on the farming operations for year-round employment are included as stakeholders in this project.

Contractors and seasonal workers are not included as stakeholders as they are not involved with the project activities. Based on consultations with the farmers and permanent farm workers, Orizon determined, as per section 3.18.1 of VCS Standard v4.7, that the contractors and seasonal workers are intermittent user groups. Although they are involved with the wider farm operation (e.g. financial consultants, contracting for fencing, seasonal harvest of a seasonal crop not included in the project, etc.), they do not impact or are not impacted by project activities and therefore need not be defined as stakeholders.

Through the consultations with farmers, farm managers and permanent farm workers it was clear that the impact of the project activities is viewed as positive. The consensus was that the improved soil health and climate resilience is beneficial to all stakeholder groups as it reduces the financial risks of the operation. It was also established that these farming methods are more enjoyable as they are more aligned with nature and generally improve work conditions due to reductions in chemicals.

It is noteworthy that there are no stakeholders who are directly reliant on the actual project activities (e.g. cover cropping, no till, composting, etc.) but rather, these identified stakeholders are reliant on the income from employment of the wider farming operation. Further to this, due to project safeguards in place, it is highly unlikely that project activities will result in the loss of employment or worsened employment conditions.

These safeguards include the following:

- Productivity may not decline by >5%, meaning that project activities cannot lead to a material decrease in primary revenues.
- Project activities mostly result in diversified revenues streams (e.g. livestock on cover crops, or multiple crop types) and therefore a lower business risk profile.
- The project activities often result in additional labour opportunities (e.g. tending to rotational livestock, planting cover crops, and managing a composting operation). This is undoubtedly a benefit to the community due to the high unemployment rates in South Africa. This has been confirmed through a survey performed with the 22 growers, where 90.9% of growers confirmed that labour opportunities will either increase or remain consistent.
- Labour in South Africa is well-regulated resulting in satisfactory employment conditions. Out of the 560 permanent employees & managers, the farmers that have been audited in the past 5 years represent 78.6% of these employees while even more have been audited in the past, but beyond 5 years ago. These labour department audits are intended to ensure compliance with labour laws, fair pay and satisfactory conditions for all employees.

	• All 22 farmers are registered for Unemployment Insurance Fund (UIF) and as such, laborers are protected in cases where employment opportunities are lost. UIF registration numbers were collected during monitoring. • The carbon credit revenues are an additional and diversified income stream which lowers business risk.
Legal or customary tenure/access rights	Not applicable. All fields currently included in the project are located on private property and are either directly owned by the farmers or a related party; or, for a subset of project fields, leased from the property owner. The details of ownership at a field level are available in the Appendices & Audit Pack: • Farm Ownership Assessment workbook [data of research of title ownership of all project farms & fields] • Ownership Title Deeds
Stakeholder diversity and changes over time	We predict that over time there will be minimal change in the diversity of the stakeholders that have been identified in the initial project instances during the first monitoring period. The current farming model of farmers (implementation partners) and the workers on the farms is consistent across the country and is likely to remain. In line with global trends, mechanization has and may further reduce the number of farm workers marginally. This is not due to project activities, but due to technological advancements and economies of scale of growing farm sizes in the farming sector. Overall, this will have a minimal impact at the project level as many project farmers adopt practices which offer some additional labor opportunities (such as tending to rotational livestock, planting cover crops, managing a composting operation).
Expected changes in well-being	The well-being of the farmers, farm managers and farmworkers is expected to improve over time through the successful implementation of the project activities. The project activities should build a more resilient farming system through regenerative practices that are expected to

	increase and sustain profitability of the system over time. The successful implementation of the project activities will also assist in further securing the stable financial state of each project instance which in turn provides better job security in the long term for the workers. A financially stable farm also reduces the risk of a farmer selling the land or reducing the workforce numbers. The implementation of regenerative practices by the project will improve the soil health of the project area, which in turn benefits the stakeholders by providing long-term stability in yields. The requirements of VM0042 to not clear native vegetation and to not allow any inclusion of fields on wetlands should preserve the hydrology of the project area. By protecting the wetlands in the project area there are several ecosystem services such as improved water quality in the project area that will indirectly benefit the stakeholders over time.
Location of stakeholders	There are no Indigenous People (IPs), local communities (LCs) or customary rights holders predicted to be impacted by the project as none of the project instances contain any communal lands or land with customary rights to lands, territories, and resources as per the definition (Program Definitions v 4.5). Section 1.13 of this PDMR shows the locations of each project instance and the associated implementation partner (farmer) implementing the project activities. The farmers, farm managers and farm workers are located on the farms included in the project.
Location of resources	Not applicable. As there are no stakeholders that own or have customary access to the properties.

2.1.2 Stakeholder Consultation and Ongoing Communication

Each included project instance involved on-farm consultation with the farmer or farm manager(s) prior to them joining the project. Orizon's Account Managers visit each project instance regularly and provide communication regarding the progress of the project directly to the farmers. Informal on-the-job discussions have been conducted with farm workers who are directly involved with project fields and potentially can affect or be affected by the project activities.

Date of stakeholder consultation	Various dates. The stakeholders were consulted at varying stages prior to joining the project. Orizon's initial consultations with farmers, farm workers and other industry role players were held from 2017 onwards around regenerative agriculture and the barriers of a wide-spread adoption of such practices. These were mostly conducted by the Orizon founders and its partner organizations who have been supporting these pioneering farmers. These partner organizations include, but are not limited to, UPL SA, Standard Bank SA, Barenbrug, Agricol, Agrisol and RegenZ. These organizations have all been supporting our growers in the adoption of these practices and a formal/informal partnership exists between Orizon and these partners.[2] These initial consultations showed a great need for carbon credits or a similar incentive / mechanism, especially in the absence of any significant premium markets for regenerative / organic produce and the lack of support or incentives from government for such practices. Ongoing, regular communication with the farmers is important and the consultations, during and after this monitoring period, involved at least 3-5 farm visits per project instance and additional online meetings, WhatsApp communication, emails, phone calls, etc., took place across this period.
Stakeholder engagement process	Potential farmers and farm managers were approached through already established relationships with Orizon agronomists or partner organisations, at farmers days or through other farmers. This method is very successful and proved a good starting point for building trustworthy relationships with each of the farmers. Any engagement regarding potential project activities to be implemented

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[2] These organizations are not involved in the development of the project but rather provide ad hoc assistance to these farmers where needed.

	was based on a willing and eager attitude toward Regenerative Agriculture shown by each farmer. Orizon does not dictate to farmers 'how to farm' but rather provides knowledgeable advice to assist in the transition from conventional farming methods to a more sustainable system, along with the potential for carbon incentives for implementing and expanding on these practices (of which a majority share of the revenues are paid directly to these farmers). Farm visits were conducted before the contract was signed and afterwards, with regular meetings & updates all based on a good relationship with each of our participating farmers.
Consultation outcome	Through a thorough engagement process that included multiple physical visits to each potential project instance. The stakeholders who agreed to join the project then signed a contract with Orizon. This was done after the project implementation, risks, costs etc., were discussed with the farmers and farm managers. The approach and process are detailed further as follows: An Information booklet was provided containing all relevant information regarding the project process. The concept of carbon credits, potential revenues, project costs, profit sharing and other contractual arrangements, data collection, ethics surrounding carbon credits, risks of the market, non-permanence risks, buffer credits, etc. were discussed with the farmers and farm managers prior to them formally joining the programme. An Eligibility & Viability study was performed to ensure that the project instance is eligible and that the eventual potential revenues are worthwhile for the farmer. This process is done on the Orizon online data collection platform where each farmer creates their own account. Once the E&V stage is passed, contract is signed digitally after allowing time for the growers to review the contract in detail and in their own time, and a one-page summary of the contract is provided to the signee to ensure a thorough understanding of contractual terms.

The next step is an implementation plan (on the Orizon data collection platform), which contains information on the data collection, the carbon credit market, important VM0042 and VCS aspects, the modelling, baseline scenarios, project activities to be implemented, etc.

Through multiple farm visits we gather information on barriers to entry, costs, and other important information from the farmers and farm workers.

The site visits also provide an important opportunity to provide all stakeholders with updates regarding the progress of the project development. It is here where expected timelines to issuance and other aspects are discussed. We have emphasised the fact that these projects take time to be successful and that it is a very thorough and long process before any carbon payouts are realised. Informal discussions with farm workers also take place and it is with these site visits that the stakeholders are also informed of the progress of the audit where applicable.

Additional consultations were executed in the form of surveys, in which details around employment conditions, management team experience and compliance with employment regulations was collected. Refer to the Orizon CarbonCrop Programme – Stakeholder Safeguards report for more information on this survey and other consultation outcomes & safeguard considerations.

Stakeholder consultation and communication is regular and ongoing. Project instances already included will also continue to be visited and receive regular consulting advice and communication with regards to the project.

The grievance process is described to all stakeholder groups.

Through Orizon’s consultations with the farmers / farm managers and farm workers and those between Orizon’s implementation partners and the farm workers, 100% of stakeholders have been reached.

Ongoing communication	Each farmer (and farm manager where applicable) has an assigned Account Manager from Orizon who serves as a direct contact point for any project-related matters. Apart from regular site visits, communication is via email, telephone calls and WhatsApp mostly. Orizon has built up good relationships with our farmers through regular communication directly with each farmer. Regular visits to each farm are carried out to maintain these strong and personal relationships as well as to ensure monitoring of the implemented project activities. These visits also have provided the platform to interact with some of the farm workers and to provide them with any relevant information around the project.
Stakeholder input	Stakeholder input was considered in the following ways during the process: • During in-person interviews with farmers and farm managers, with relevant information recorded on the Orizon software and data collection platform. • Some adjustments in the process were made after such interviews. In some instances, this was due to the requirement of more evidence in the stakeholder process or where initial understanding of the process by the stakeholders was limited. • Examples of adjustments included the collection of further information/data around farm workers and their rights, where a lack of evidence may have been present. • A further adjustment in the process included a more in-depth explanation of certain concepts of carbon credits such as buffer credits, permanence, and additionality. This ensured a better understanding amongst stakeholders overall of these and other specific concepts where initial understanding may have been insufficient.

2.1.3 Free Prior and Informed Consent

Importantly the process outlined below refers to the farmers and farm managers that have signed contractual agreements with Orizon only. As they are the landowners, Orizon requires their consent to implement the project activities.

Obtaining consent	Farmers were approached prior to them joining the project. Their signing of a contractual agreement with Orizon is completely voluntary after all information is made available to them, including risks, info around alternative carbon project options, potential revenues, etc. Although signing of the contract is voluntary and is done online via DocuSign in their own time without an Orizon representative being present, the contractual agreement is still necessary before any further project steps are pursued. Currently all 22 project instances are on private commercial farmland properties with no overlap with any communal lands or other groups. There are no ongoing or unresolved conflicts related to land tenure currently. Farmers are encouraged to voluntarily report any conflicts and/or any grievances they may have. The grievance policy document is publicly available on Orizon's website.
Outcome of FPIC	Farmers sign a contractual agreement with Orizon once they have provided consent and agreed to joining the project. The farmers are the implementation partner of the project as they directly carry out the project activities on their fields. The project fields during the first monitoring period are all existing fields for cultivation and no encroachment, displacement or relocation of any people has taken place, nor are there any risks of such. This is supported by the ownership evidence provided in the Ownership Assessment workbook and summary.

2.1.4 Grievance Redress Procedure

Orizon's relationship with the project stakeholders is one built on trust and transparency, and we consider the opportunity for the stakeholders to be able to address grievances as a critical component of a successful relationship. This is an essential component of a successful long-term project. This process is outlined in more detail in the table below:

Development process	The development of the grievance redress procedure was done in such a way that grievances can be easily submitted regarding the project. As this is a recent addition to the VCS Standard this process has been developed quite recently by Orizon and will be amended and improved upon based on the nature of any future complaints received.

	The development of the process was discussed internally at Orizon. The submission/hearing of grievances was suggested to the stakeholders in terms of how these should be carried out. Input from stakeholders in this process was also taken into consideration during the process. As part of the development of the grievance redress process, the option is also provided to submit grievances to Verra through a link our process document. Detailed information regarding the grievance redress process at Verra is also available on the Orizon website. Stakeholders have been informed regarding this process and further information is consistently communicated in this regard. Should there be any amendments or changes to the policy, this will first be discussed with the affected stakeholders before being implemented.
Grievance redress procedure	For any grievances that stakeholders have they can send an email to info@orizonagriculture.com. The grievance can be submitted without a name attached. This however can impact the resolution of the grievance should the complainant be difficult to contact subsequently. This process has been explained to the stakeholders. Grievances made will receive a response by email, within 72 hours (3 business days), confirming receipt of the grievance. This response provides a short explanation of the process and likely timeframe of further communication. Each grievance or complaint is reviewed by a senior staff member at Orizon. Once reviewed, the complainant will be provided with an update via email. This response will be supplemented with either a text message or phone call depending on the severity of the complaint. From there, the complainant receives direct communication by a staff member at Orizon. For most grievances an email or telephonic response is sent through with the potential resolution for the affected parties. However, if the grievance is considered of such a nature that an in-person discussion with all affected parties is necessary, then the opportunity for an in-person discussion is arranged to start resolving the grievance. The

	ideal timeframe for a resolution will be determined on a case-by-case basis as there are various factors to consider such as the severity of the grievance and how busy the different affected parties may be. The procedure for addressing grievances will be adjusted and improved with time and experience. As there were no grievances during the first monitoring period, we have been unable to test the process in terms of its efficiency and helpfulness to address the grievance effectively and successfully for all parties involved.

Grievances received	Resolution and outcome
There were no grievances raised by the stakeholders during the first monitoring period from 1 August 2018 – 31 July 2022	Not applicable. The grievance process is easily accessible for any affected party. A link on the website is available that provides an outline of the grievance redress process.

2.1.5 Public Comments

Comments received	Actions taken
The project received no public comments during the public commentary period from 4 August 2022 to its completion on 4 September 2022. Orizon shared the document widely on social media, some agricultural consultants and non-participating farmers and there was no negative feedback received or any public comments made regarding this project during this public commentary period.	Not applicable as there were no public comments received during the public comment period for this project.

2.2 Risks to Stakeholders and the Environment

The table below provides an overview of the identified risks in the project with respect to stakeholders and the environment during the first monitoring period. Any relevant mitigation or prevention measures are also outlined for each identified risk where applicable. The risk assessment process will be undertaken for each future project instance to be added to this grouped project. Where a risk category is not applicable to this project, we provide reasons for this to support this claim. Generally, as there are no identified stakeholder groups, the risks associated with the project are relevant to the farmers only and of course the environment. Where relevant we have substituted the term stakeholder with farmer.

	Risks identified	Mitigation or preventative measure taken
Risks to stakeholder participation	Carbon credit price	Mitigate this risk by ensuring highest possible integrity of the carbon credits produced by the project. Secondly, selling generated credits in batches to get a price-average across time.
	Resistance to transitioning to more sustainable practices	Provide evidence of farmers successfully implementing project activities
Working conditions	Working with heavy machinery when implementing the project activities	Commercial farmers provide as safe as possible working conditions. Farmers use only the most experienced and qualified workers to use the heavy machinery such as tractors and this significantly reduces the risk of injuries happening.
	Hot, dry, or unclean facilities for farm workers	Generally, conditions are set up in such a way which optimizes productivity. Ensuring cool-down periods on hot days, sufficient water and food and other clean conditions assist in productivity and working conditions. Labor Department audits also help ensure good conditions while Orizon farm visits also provide an opportunity for the identification of any unsafe or sub-optimal working conditions. Refer to the Orizon CarbonCrop Programme – Stakeholder Safeguards report for more information.

Safety of women and girls	Implementation of project activities e.g. seed planting or spraying of crops by hand	There are safety measures in place when implementing project activities as described in the previous section 'Working conditions.' No men or women under the age of 18 are employed by the farmer. This ensures that no child labor takes place. This is mitigated by requiring proof of identification of the workers. The Department of Labor also requires information from the farmers regarding who they employ to work on the farm. This is another aspect that aims to ensure that no child labor takes place on the farms. Women are often employed on farms but are generally given work that is not as physically intense to ensure their safety and job satisfaction.
Safety of minority and marginalized groups, including children	No applicable risks identified	N/A
Pollutants (air, noise, discharges to water, generation of waste, release of hazardous materials)	Fertilizer leaching into groundwater that may be used for drinking water	Reduction of area of bare soil on fields by planting cover crops and allowing crop residues to remain on the fields during winter reduces the risk of surface runoff. A further mitigation is the transition away from synthetic fertilizers to different animal manure which greatly reduces the risk of water pollution through leaching. Other risks such as air quality of the surrounding area cannot be directly mitigated by the farmers as the

		main contributor to this specific issue is that of mining in the areas near to project instances as well as the coal-driven power stations that dominate South Africa's electricity generation sector.

2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

Discrimination and sexual harassment	Discrimination and sexual harassment cases have not occurred in the project instances during the first monitoring period. Orizon is communicating the importance of the grievance process to all the stakeholders and the need for any grievances to be made known to ensure that any discrimination and sexual harassment ideally is prevented from happening. Orizon is building up relationships with all stakeholders that seeks to ensure that communication is honest and open so that a strong trust is built between all stakeholders and the project can then ensure that there will be no issues of discrimination and sexual harassment.
Management experience	The farmers included in the project all have significant experience in successfully managing and implementing agricultural practices on the fields in the project. They also have extensive experience with the correct employment and labor practices in accordance with the relevant acts, laws, and regulations of the Republic of South Africa. The project instance start dates range from August 2018 to August 2021 but these fields were previously under cultivation as well for many years further supporting the claim that the farmers have substantial experience in implementing similar project activities. Whilst there are changes in the transition from conventional to regenerative agriculture, many aspects of the farming operation such as planting, and harvest timeframes have remained similar for many years, along with labor management best practices. As all these project instances employ people to work on the farm, there is also substantial experience amongst the farmers in navigating this sector. South Africa has very well-

	defined legislation with regards to labor. Farmers adhere to this legislation providing a safe work environment to the employees. Formal employment in the agricultural sector of South Africa is a critical component of the economy with close to 1 million people employed in primary agriculture in South Africa at the end of Q3 in 2023 (Stats SA, November 2023). Any form of employment in South Africa is highly sought after with the current unemployment level at just over 30% nationwide highlighting the importance of jobs. A survey performed on our initial 22 project instances showed the following: • Cumulative farming experience of 478 years (average of 21.7) • 18 out of the 22 farmers have a relevant agricultural / engineering degree or diploma. For more information, please refer to the Orizon CarbonCrop Programme – Stakeholder Safeguards report.
Gender equity in labor and work	For 2022-2023 the trend is clear that there is an increase in employment of women in the agricultural sector overall in South Africa with an almost 20% increase in women from 2022 to 2023 (Stats SA, November 2023). This is likely to continue to improve as government seeks significant improvement in gender equity when it comes to employment especially in the agricultural sector.
Human trafficking, forced labor, and child labor	Human trafficking is strictly prohibited by law in South Africa. All project instances adhere to all legislation related to employment. Forced labor and the use of children as part of the labor force is not allowed in South Africa with significant penalties for those that break these laws. This project seeks to ensure that all project instances conform with the applicable laws and regulations. Regular farm visits and informal interactions with the workers on the farms aims to further ensure that any issues can be identified relating to the farm workers.

2.3.2 Human Rights

Currently the included project instances do not include any IPs, LCs, or customary rights holders as per section 2.1.1. However, Orizon recognizes the importance of the recognition of the rights of these groups, and should they be included in future instances then the following will be incorporated into the assessment of each project instance to ensure the recognition, respect, and protection of the human rights of these groups. The below principles are also applied to the current farmers with whom Orizon currently has working relationships with.

The process applied will be as follows:

1. Conduct an impact assessment regarding human rights.
    - Begin the project with a thorough assessment of the potential impacts on human rights, with a focus on the rights of IPs, LCs, and customary rights holders.
    - Identify potential risks and benefits for these communities throughout the project's lifecycle.
2. Ensure that meaningful consultation is undertaken.
    - Ensure the active and informed participation of IPs, LCs, and customary rights holders in the decision-making processes related to the project.
    - Establish clear and transparent communication channels and engage in ongoing dialogues to address concerns and incorporate community input.
3. Ensure the process complies with ILO Convention 169 and aligns with the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP).
4. Establishment of grievance mechanisms such as those detailed in section 2.1.4.
5. Regular monitoring and reporting.
6. Continuous improvement of the project through feedback from Ips, LCs and customary rights holders as well as the adaptation of project strategies to address challenges and to ensure the project continues to align with international human rights laws.

Through the above steps, this project demonstrates a commitment to human rights and is in accordance with the applicable laws and regulations in this regard.

2.3.3 Indigenous Peoples and Cultural Heritage

This section is not applicable to the current project instances in the first monitoring period. This is because the project area does not currently include any land belonging to IPs. The project fields are all currently only on cultivated lands that are private property either owned directly by the farmers of fields leased from other farmers and private individuals. In future, should any communal lands be included in this grouped project, Orizon will ensure that any sites of cultural significance are preserved, and that no cultivation takes place on sites with graves etc. Furthermore, communal lands will likely have a component of significant numbers of IPs who are directly reliant on the communal land for food etc. and this will require a thorough survey and consultation process with these households to make sure the project is understood and does not infringe on any cultural heritage. A significant component of this work will be to request local communities to identify any culturally significant sites in the communal lands.

2.3.4 Property Rights

Rights to territories and resources	Not applicable. There are no territories or resources of IPs, LCs, and customary rights holders in the current project area. The project fields are all currently only on cultivated lands that private property either owned directly by the farmers of fields leased from other farmers and private individuals.
Respect for property rights	Not applicable as there are no properties belonging to IPs, LCs, and customary rights holders in the current project area.

2.3.5 Benefit Sharing

As per the VCS Standard v 4.7 section 3.19.22: Where the project activity impacts property rights, usage, or resources, the project shall include a benefit-sharing agreement between affected stakeholder groups and the project proponent.

As shown by the previous section 2.3.4, this project does not impact on IPs, LCs, or customary right holders in the project area. There is therefore no impact on property rights, usage or resources for IPs, LCs or customary right holders.

However, due to the implementation of improved ALMs on the project fields, it can be argued that there is an adjustment to land usage that does have an impact in the project area for a specific stakeholder group, the farmers. The contractual agreement entered into between the farmer(s) and Orizon is set up in such a way that the farmer directly benefits more from the issued carbon credits than Orizon.

Farmers, as the implementation partner of the project activities, receive most of the revenues (65 – 75%) from the sale of the carbon credits by Orizon. The exact % payable to the farmer is dependent on the extent of sustainable/regenerative practices adopted, based on the number of qualifying practices adopted per field. A qualifying practice is any improved ALM practice which generates carbon credits through the reduction or removal of GHG's. The following categories apply:

- 1 qualifying practice: 65%
- 2-3 qualifying practices: 70%
- >3 qualifying practices: 75%

The objective of this sliding scale mechanism is to incentivize the full adoption of the suite of sustainable practices.

There are also no costs involved for the farmers to join the project. These factors assist in minimizing risks to the stakeholders in the project. By reducing risks and costs to the landowner, the benefit received from the sale of carbon credits is maximized for the farmers through this benefit sharing agreement mechanism.

2.4 Ecosystem Health

This project has identified risks present that apply to ecosystem health. These risks have mitigation and prevention measures in place as detailed in the table below. It is important to stress that these risks will be monitored, and risk assessment carried out for each new project instance added in subsequent monitoring periods.

	Risks identified	Mitigation or preventative measure taken
Impacts on biodiversity and ecosystems	Wetland and grassland areas occurring near to or adjacent to project fields	No fields on wetlands were included / permitted. Once-off conversions from cropland to grassland are only allowed on degraded land. No clearing of native ecosystems in the previous 10-year period prior to the project start date was permitted. This will be continually monitored as new project instances are added.
Soil degradation and soil erosion	Project fields are susceptible to wind and soil erosion if left bare. Heavy tillage and use of chemical fertilizers also contribute to soil degradation.	Planting of cover crops and/or leaving crop residues on project fields to reduce bare soil and therefore reducing soil erosion risk. By increasing SOC over time (through no till and other practices such as replacing synthetic fertilizers with organic fertilizers) the project also mitigates against solid degradation over time.
Water consumption and stress	Irrigation can place stress on water resources in the area.	Precision irrigation systems and scheduling are to be advised. Use of cover crops and improving soil health allows for improved water retention ability of the soil and can reduce reliance on excessive irrigation in the future.
Usage of fertilizers	Leaching into nearby water sources and the	Gradual reduction in reliance on synthetic fertilizers and by reducing

	degradation of the soil quality over time.	time that project fields are bare will overall reduce the leaching risk.

2.4.1 Rare, Threatened, and Endangered species

Is the project located in or adjacent to habitats for rare, threatened, or endangered species?

☒ Yes

Orizon has researched the potential occurrence of rare, threatened, and endangered species of birds and mammals likely to occur in natural habitat located in or adjacent to the project area (project fields). These species occur on wetland, grassland areas and in indigenous forest found within the boundaries of the farms in which the current project fields are located.

According to methodology VM0042 v 2.0, no field occurring on a wetland may be included and there may be no removal of natural ecosystems. Naturally, for this project to meet these criteria, a thorough desktop assessment of the wetlands was conducted as well as an assessment at the field-level to confirm no removal of natural ecosystems has taken place in the preceding 10 years prior to the start date of each project instance. Monitoring of these requirements will continue to ensure that no natural ecosystems are negatively impacted by the project.

Furthermore, in future, the project will advise farmers regarding potential opportunities for wetland rehabilitation, particularly in the Mpumalanga Highveld regions where wetland systems are commonly exploited and drained on non-project areas primarily through mining activities. For the first monitoring period, each farmer has been provided with a Biodiversity and Wetland assessment that outlines the possible Red Data species of mammal and bird that occur as well as the threatened wetland types present on the property. The tables below provide a list of the threatened species of birds and mammals likely to occur in the current project area.

Site visits have confirmed the presence of several threatened bird species. Species such as Black-winged Pratincole, Amur Falcon and Blue Korhaan were seen in good numbers. Other important Red Data species such as African Grass Owl, Blue Crane and Grey Crowned Crane have been confirmed by farmers as being present on their properties. Orizon is supporting and growing a culture of conservation and passion for the environment amongst the farmers involved in the project. The biodiversity and wetland reports provided to each farmer form an integral part of this process.

Table of threatened bird species likely to occur in the project area.

Species	Regional Status	Global Status
Bush Blackcap	Vulnerable	Vulnerable
Denham’s Bustard	Vulnerable	Near Threatened

Species	Regional Status	Global Status
White-bellied Bustard	Vulnerable	Least Concern
Forest Buzzard (Endemic)	Least Concern	Near Threatened
Blue Crane	Near Threatened	Vulnerable
Grey Crowned Crane***	**Endangered**	**Endangered**
Wattled Crane***	**Critically Endangered**	Vulnerable
Maccoa Duck	Near Threatened	**Endangered**
Crowned Eagle	Vulnerable	Near Threatened
Martial Eagle	**Endangered**	**Endangered**
Tawny Eagle	**Endangered**	Vulnerable
Verreaux's Eagle	**Not assessed (Likely Endangered)**	Vulnerable
Lanner Falcon	Vulnerable	Least Concern
Red-footed Falcon	Near Threatened	Near Threatened
Greater Flamingo	Near Threatened	Least Concern
Lesser Flamingo	Near Threatened	Near Threatened
African Marsh Harrier***	**Endangered**	Least Concern
Black Harrier (Endemic)	**Endangered**	**Endangered**
Pallid Harrier	Near Threatened	Near Threatened
Southern Bald Ibis	Vulnerable	Vulnerable
Half-collared Kingfisher	Near Threatened	Least Concern
Blue Korhaan	Least Concern	Near Threatened
African Grass Owl***	Vulnerable	Least Concern
Black-winged Pratincole	Near Threatened	Near Threatened
Secretarybird	Vulnerable	Vulnerable
Abdim's Stork	Near Threatened	Least Concern
Black Stork	Vulnerable	Least Concern

Species	Regional Status	Global Status
Marabou Stork	Near Threatened	Least Concern
Yellow-billed Stork	**Endangered**	Least Concern
Sentinel Rock Thrush	Least Concern	Near Threatened
Cape Vulture	**Endangered**	Vulnerable
Ground Woodpecker	Least Concern	Near Threatened

**** Species reliant on good wetland habitat for breeding.*

Table of threatened mammal species likely to occur in the project area.

Species	Regional Status	Global Status
Swinny’s Horseshoe Bat	Vulnerable	Least Concern
Black-footed Cat	Vulnerable	Vulnerable
South African Hedgehog	Near Threatened	Near Threatened
Brown Hyaena	Near Threatened	Near Threatened
Leopard	Vulnerable	Vulnerable
Highveld Golden Mole	Near Threatened	Near Threatened
Rough-haired Golden Mole	Vulnerable	Vulnerable
Oribi	**Endangered**	Least Concern
Cape Clawless Otter	Near Threatened	Near Threatened
Spotted-necked Otter	Vulnerable	Near Threatened
African Marsh Rat	Near Threatened	Least Concern
Vlei Rat (Grassland Type)	Near Threatened	Not evaluated
Laminate Vlei Rat	Near Threatened	Near Threatened
White-tailed Rat	Vulnerable	Vulnerable
Mountain Reedbuck	**Endangered**	**Endangered**
Grey Rhebok (Endemic)	Near Threatened	Near Threatened
Serval	Near Threatened	Least Concern
African Striped Weasel	Near Threatened	Least Concern

2.4.2 Introduction of species

No species are being introduced in this project. However, the planting of non-native cash crops and cover crops is prevalent on the project fields during the first monitoring period. As these are planted and not native species, our understanding is that this section is required. The tables below provide details on the species planted and whether any of these are classified as potentially invasive species or currently invasive in the project area. The below table includes the primary cash crops planted by participating farmers and combines the cover crops into a single category as the classification, justification for use and any adverse effects/mitigation can be applied to all cover crops regardless of species.

Species introduced	Classification	Justification for use	Adverse effects and mitigation
Maize	Cash crop	Food production for humans and livestock and as silage for livestock	None
Soybeans	Cash crop & Nitrogen-fixing	Food production for humans and livestock	None
Wheat	Cash crop	Food production for humans and livestock	None
Sunflower	Cash crop	Food production for humans and livestock	None
Sorghum	Cash crop	Food production for humans and as silage for livestock	None
Cover crops	Cover crop as soil cover and nitrogen-fixing	Soil cover, livestock feed and nitrogen-fixing	None

Existing invasive species	Mitigation measures to prevent spread or continued existence of invasive species
Although there are non-native species planted on the project fields, all are harvested/terminated and not considered invasive species as they do not naturally spread into the surrounding areas of native habitat.	Not applicable. All planted crops, whether a cash crop or planted as a cover crop, are either harvested or terminated chemically and there is no risk of spread outside of the project fields.

2.4.3 Ecosystem conversion

As per Section 3.2 of this report, one of the applicability conditions is as follows: The project area has not been cleared of native ecosystems within the 10-year period immediately prior to the project start date. In summary, the number of project instances included in this assessment for the monitoring period starting 1 August 2018 and ending 31 July 2022 is 22. Overall, 1089 fields were assessed for historical land use. All current project instances have passed the assessment based on satellite imagery and other land use databases showing that the fields currently in the project were all part of agricultural production pre-1 August 2008. For more specific details please refer to Section 3.2 of this report and the Historic Land Use specialist report in the Appendices section for a detailed description of this analysis for every field currently included in the project area.

A once-off conversion from grassland to cropland or vice versa is allowed if the project proponent can prove that the land that was converted is degraded. The assessment confirmed that all the converted fields located in these project instances can be included in the project based on their degradation index being confirmed as degraded or degrading. This conclusion was further supported by evidence and analysis, based on mostly peer-reviewed literature, detailing the potential impacts of the project activities on these fields. This has the potential to be a significant step towards incentivizing the restoration of degraded farm fields and grasslands with the support of carbon finance.

Orizon will provide detailed progress reports regarding the results of the claimed benefits to these converted fields in subsequent monitoring periods as this collection of data could be of assistance to other similar projects, farmers and other landowners looking to reverse the degradation trends that are pervasive through much of the drier areas of the country. It is hoped that by allowing this once-off conversion of fields we will see an increase in productivity of degraded agricultural land in South Africa and assist in securing the long-term food security in the region in the face of a rapidly changing climate. For more specific details please refer to Section 3.2 and the Land Conversion specialist report in the Appendices section for the results of this assessment and the methodology followed to determine the level of degradation for all converted fields considered for this project.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version
Methodology	VM0042	Methodology for improved agricultural land management	2.0
Module	VMD0053	Model Calibration, Validation, and Uncertainty Guidance for the Methodology for Improved Agricultural Land Management	2.0
Tool	Not applicable	AFOLU Non-permanence Risk Tool	4.2

3.2 Applicability of Methodology

All project instances must meet the requirements in section 4 of VM0042 under applicability conditions. The methodology specifically states that it applies to a broad range of project activities that increase SOC storage and/or decrease net emissions of CO_2, CH_4 and N_2O from ALM operations compared to the baseline scenario. The methodology is globally applicable.

Justification for this project's applicability is demonstrated in Table 3.2.1 based on the project instances included in the first monitoring period. All fields in the project instances that did not meet the eligibility criteria for inclusion have been excluded from the current project area.

Table 3.2.1: Applicability conditions and justification for project applicability

Number	Applicability Condition	Justification for Project Applicability
1	Projects must introduce or implement one or more new changes to pre-existing agricultural management practices as per the below: ● Reducing fertilizer (organic or inorganic) application. ● Improving water management/irrigation. ● Reducing tillage intensity/improving residue management. ● Improve crop planting and harvesting (e.g., crop rotations, cover crops etc.). ● Improving grazing practices. Appendix 1 of VM0042 v2.0 provides a non-exhaustive list of eligible ALM practices. A change in practice constitutes adoption of a new practice, cessation of a pre-existing practice or adjustment to a pre-existing practice that results in GHG emissions reduction or removal	• Only activities within this list of categories will be included in the project and are included in the eligibility criteria. • Any other activities will not be considered for registration under this project. • Only activities listed will be included for quantification of emissions reductions and/or removals. • Of the four project activities, the adoption rates of the three most predominant ones can be seen in Table 3.5.2 in Section 3.5.
2	Projects that introduce or implement quantitative adjustments (e.g., decrease in fertilizer application rate) must exceed five percent of the pre-	• Practice changes included reduced tillage (No till or minimum tillage), improved fertilizer application through organic inputs, improved grazing management and improved cropping

Number	Applicability Condition	Justification for Project Applicability
	existing value, calculated as the average value over the historical look-back period, developed for the baseline schedule of activities (see Section 6 of VM0042). Appendix 1 provides additional details and guidance on practices and on determining practice change.	through planting of cover crops. All these activity changes qualify for this applicability condition when exceeding 5% change. • The following practice changes have been quantified by comparing the average values of the historical look-back period against the average values of the project period: o Changes in fertilizer applications are assessed in aggregate, combining synthetic and organic inputs as these practice changes go hand-in-hand. The combined increase in nitrogen applied from both sources is 8.01% from 74.862 kgN/ha in the baseline to 80.858 kgN/ha in the project period. ▪ While synthetic fertilizer applications decreased by only 3.77% from an average of 72.68 kg N/ha (across all project hectares) in the baseline scenario to 69.93 kg N/ha (across all project hectares) in the project scenario, 15 out of the 22 initial instances changed their synthetic fertilizer applications by more than 5%, some up to 47-53% ▪ Urea-based fertilizers increased by 7.33% from 58.92 kg/ha to 63.24 kg/ha in the baseline and project periods respectively. ▪ Organic input applications increased by 1,101.66% from an average of 39.80 kg/ha (across all project hectares) in the baseline scenario to 478.23 kg/ha (across all project hectares). ▪ Farmers applying organic inputs managed to reduce their synthetic fertilizer

Number	Applicability Condition	Justification for Project Applicability
		applications by 9.20% from 35.57 kgN/ha in the baseline to 32.30 kgN/ha in the project period. ○ Liming applications decreased by 5.78% from an average of 0.93 t/ha (across all project hectares) in the baseline scenario to 0.87 t/ha (across all project hectares) ○ Winter cover crop area planted increased by 425.74% from an average of 6.5% of project fields (across all project hectares) in the baseline scenario to 34.1% of project fields (across all project hectares) ○ Effective grazing days per hectare increased by 16.78% from 96.87 grazing days/ha in the baseline scenario to 113.12 grazing days/ha in the project scenario of which an increasing portion is managed under improved high-density grazing and involves the significant shift of the grazing of dead residues towards living cover crops. ○ Tillage events per field per season decreased by 46.8% from an average of 0.91 tillage passes/field (across all project hectares) in the baseline scenario to 0.49 tillage passes/field (across all project hectares) in the project scenario. ○ Similarly, the tillage intensity also decreased with average tillage depth decreasing by 59,9% from 21.43 cm in the baseline scenario to 8.60 cm in the project scenario. • The above practice changes are further supported by the average % change in GHG emissions for the practice changes

Number	Applicability Condition	Justification for Project Applicability
		in the monitoring period 1 August 2018 – 31 July 2022 which were as follows: ○ Fossil fuel combustion -14.83% reduction ○ Fertilizer (Organic & Synthetic) emissions +14.82% (Increase in emissions despite reduction in synthetic fertilizer is due to increase in organic inputs) ○ Liming Emissions -10.15% reduction ○ Livestock Emissions (N_2O & CH_4 combined) +8.34% increase ○ Nitrogen-fixing emissions +9.40% increase
3	Project activities must be implemented on land that is either cropland or grassland at the project start date and remains cropland or grassland throughout the project crediting period. However, land use change (i.e., conversion from cropland to grassland or vice versa) may be allowed under the following scenarios: • Introduction of temporary grassland into cropland is allowed where it can be credibly demonstrated prior to project validation that the integration of perennial crops (e.g., grasses, legumes) into annual crops is planned as part of a long-term agricultural management system (e.g., Integrated Crop-Livestock System) • Conversion from grassland to cropland or vice versa where it can be credibly demonstrated prior to project validation that project lands in the baseline scenario are degraded and the	• For this grouped project the inclusion of all new instances will adhere to the requirement of the activity taking place on grassland or cropland throughout the project lifespan except where the state of the soil allows conversion for its long-term productivity. • During this first monitoring period there were a total of 49 field portions out of a project wide total 905 fields that have undergone a one-time conversion to cropland from grassland and qualified to be included. This is a total 941.13 hectares. These included many fields which used to be cultivated under annual grain production systems many years ago but were converted to grasslands. These fields struggle to reach a viable productivity level and are often converted back to croplands. Following Orizon's assessment, many previously converted fields were excluded as they did not meet the criteria for degradation • Satellite imagery was used as a complimentary tool as well as confirming the status of degraded land that was converted to grassland/cropland as per Appendix II of v2.0 of VM0042. • The necessary documentation will be provided for any land use change that meets the eligibility criteria as set out

Number	Applicability Condition	Justification for Project Applicability
	introduction of improved practices involving land use change would lead to significant improvements in soil health and associated socioenvironmental benefits. In this case, projects must provide documentation demonstrating that lands are degraded at the start of the project and degradation will continue in the baseline scenario due to the presence of degradation drivers or pressures in the baseline scenario. See Appendix 2 for procedures on how to propose this type of land use change.	for this specific item in the methodology. • The project seeks to incentivize farmers seeking to restore degraded crop and/or grasslands. • All necessary information was provided to demonstrate land degradation to meet this applicability condition in the methodology as follows: 1. Demonstration of land degradation. The project proponent shall use the CDM Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities to demonstrate both that the land is degraded at the start of the project and that the land will continue to degrade in the baseline scenario. The Tool uses a two-stage process that involves: A. Identification of project lands classified as degraded under any verifiable local, regional, national, or international land classification system or credible study produced within the last ten years; This assessment was done using (Lindeque 2015) to determine the level of degradation of the region (at local municipal level) that each field was located in. The assessment was further evidenced by using the Land Degradation Assessment Index (LADA) of the Natural Agricultural Resources Atlas of South Africa as further evidence of the level of degradation for each field and the Conservation Index from the same resource to assess the likelihood of continued degradation. The identified indicators of land degradation include mining, unsustainable land management, alien invasive species, overgrazing and indirect drivers such as land tenure (more relevant in the communal areas). or B. In the absence of such study, through direct evidence based on indicators of degradation or through comparative studies. Exact procedures are outlined

Number	Applicability Condition	Justification for Project Applicability
		in the Tool. As we had a study available this step was unnecessary for determination of degradation. However, during the monitoring period, Orizon staff performed multiple site visits to converted fields both before and after conversion and observed degradation indicators including significant soil erosion, low productivity, alien invasive species and low/no diversity. 2. Demonstration of expected improvements resulting from project implementation. The project proponent shall provide an analysis of how the proposed project activities will lead to restoration of project lands. Such analysis shall be based on the degradation indicators identified in Step 1 and shall at minimum include expected impacts on soil health, plant (i.e., crops, forage) productivity, biodiversity, local ecosystems, and livelihoods. Evidence types may include relevant local, regional, national, or international studies and local expert analysis. Any experts consulted as part of the analysis should have at least 10 years of relevant experience in the project region and professional credentials (e.g., research scientist, certified agronomist) Examples of expected improvements include: ○ Improved soil health, building up of carbon in the soils, residues/cover crops reduce the risk of wind and soil erosion (Kooper 2020). ○ Higher Yields and Improved Crop Quality: Over time, the gradual cumulative impact of improved soil health, better water retention, and enhanced nutrient availability leads to increased crop yields (Kooper 2020). ○ Reduced risk of soil erosion by maintaining residues and or cover crops on the fields when

Number	Applicability Condition	Justification for Project Applicability
		not planted with cash crops will ensure that the hydrology of the area does not deteriorate further (Knott 2015). ○ By planting previously degraded fields, this may allow for jobs when land is improved from a degraded state. Degraded fields being non-productive do not offer the same job opportunities as fields being converted to annual cropland. Please refer to the Land Conversion specialist report in the Appendices section for a detailed description of the research, process and results of the land conversion assessments of all converted fields during this monitoring period.
4	Empirical or process-based models used to estimate stock change/emissions via Quantification Approach 1 must be:	• Please see Table 3.2.2 for the full description of model-specific applicability conditions and justifications for this project.
Methodology VM0042 is not applicable under the following conditions:		
5	The project area has been cleared of native ecosystems within the 10-year period immediately prior to the project start date.	• The main source for this data is satellite imagery from Google Earth, Landsat and Digital Earth Africa to determine that no native ecosystems have been removed in the 10-year period prior to the project start date. • Data from the National Land Cover database of 2000 (where available and relevant) served as supplemental evidence confirming that this applicability condition was met. • Where satellite imagery was insufficient or unavailable, alternative sources were used to ensure this applicability condition is met. Please refer to the historic land use assessment report in the Appendices section Specialist reports for a detailed description of this analysis for every field in the project area.
6	The project activity is expected to cause a sustained reduction in productivity of greater than 5	• The project is not expected to have a sustained production reduction over

Number	Applicability Condition	Justification for Project Applicability
	percent, as demonstrated by peer-reviewed and/or published studies on the activity in the region or a comparable region.	time and therefore there is little risk of a reduction in productivity. Cash crop yields will be compared with regional data at a provincial level for the preceding 10 years. The full productivity analysis is required every 10 years and will be done for the period 1 August 2018 – 31 July 2028. See section 5.3 and 7.4 of the PDMR for the current productivity analysis. • Several studies focusing on improved agricultural land management practices support the above statement as soil health improves (World Bank, 2006), (Branca, 2013)The referenced published paper specifically mentions the potential yield increase that sustainable agriculture practices offer in areas of low and variable rainfall. Large areas of South Africa have such rainfall conditions. • RA has the potential to increase average yields of existing produce as well as including diversification products (e.g., more cattle, chicken, pigs, cover crops as livestock feed, agroforestry, etc.) which further increase gross farm production. • Food security is also supported as fields become more drought and disease tolerant through RA practices as the water holding capacity and infiltration increases and nutrient cycling is restored. • Whilst there may be risks for initial production losses incurred when transitioning from conventional to regenerative agriculture, these losses usually occur where errors are made during the transition. Orizon mitigates the risk by providing farmers with a network of support from farmers already successfully implementing RA as well as directly assisting our farmers in their transition to RA. • While the full productivity analysis is only due after a 10-year period, interim results showed an increase of 9.9% in the weighted average yields (weighted by planted are per crop type). This was,

Number	Applicability Condition	Justification for Project Applicability
		however, partially due to seasonality as the regional average yields also showed a small increase in this period. After removing such effect, the average increase in yields is c. 3.5% from the baseline to project period, after the implementation of project activities.
7	The project activity is biochar application. Biochar may be applied as a soil amendment in the project area provided that the total organic carbon content of the biochar applied is subtracted from the estimated SOC stock change in the project scenario at each verification event.	• Any new project instances will adhere to this condition. • Farmers will confirm that they have not added any biochar unless it was done in such a way as permitted by the methodology • Instances where biochar is applied in future will be required to provide detailed records of such activities which can be used to offset against (subtracted from) the calculated tSOC increases.
8	The project activities occur on a wetland this condition does not exclude crops subject to artificial flooding where it is demonstrated that crop cultivation does not impact the hydrology of any nearby wetlands.	• Any new project instances will adhere to this condition. • Satellite imagery will be used in conjunction with the national wetland database shapefiles and GPS data regarding the field locations to ensure that no new sample units/fields or any of the initial project activities take place on a wetland.

Additional conditions where models are applied:

Methodology VM0042 does not provide instruction of the use of a specific model. The module VMD0053 applies where empirical or process-based models used to estimate stock change/emissions meet specific conditions. According to the module VMD0053 the applicability conditions for models are as follows:

Table 3.2.2: Applicability conditions for when an empirical or process-based model is applied.

Number	Applicability Condition	Project Applicability Justification
1	Publicly available; though not necessarily free of charge, from a reputable and recognized source (e.g., the model developer's website, IPCC, or government agency).	This project will utilize the publicly available Roth C model that has a proven track record for this specific type of project globally (examples include (Coleman K, 1997),

Number	Applicability Condition	Project Applicability Justification
	Sufficient conceptual documentation of inputs, outputs, and information on how the model functionally represents SOC dynamics must be accessible to the public. Providing the source code or an API for independent replication of calculations is not required.	(Francaviglia, 2012), (Nieto, 2010), (Zimmermann, 2007)
2	Shown in peer-reviewed scientific studies to successfully simulate changes in soil organic carbon and trace gas emissions resulting from changes in agricultural management included in the project description;	The model appears in several peer-reviewed studies that specifically look at the quantification of Carbon stock (Coleman K, 1997), (Morais, 2019), (Jebari A, 2021) and therefore support the relevance and applicability of this model for the purposes of this project
3	Able to support repetition of the project model simulations. This includes clear versioning of the model use in the project and stable software support, as well as fully reported sources and values for all parameters used with the project version of the model. Where multiple sets of parameter values are used in the project, clearly identify the sources of varying parameter sets and how they were applied to estimate stock change/emissions in the project. Acceptable sources include peer-reviewed literature and statements from appropriate expert groups that demonstrate evidence of expertise with the model via authorship of peer-reviewed model publications or authorship of reports for entities supporting climate-smart agriculture. These sources must describe the datasets and statistical processes used to set parameter values.	The Roth C model supports repetition of the project model simulations. This will be shown by the project proponent providing a detailed Model Validation Report. The sources for all parameters will be provided. The report will provide the following: • Details of the sources for all parameter datasets and calibration / validation datasets • Evidence of the independence of the calibration data to the validation data • A description of how the model was applied to determine estimates for stock changes/emissions. • A description of our calibration and validation procedures The model will be calibrated using published parameters for CA and CT systems and validated for each practice category / crop functional group combination included in the project instances. The validation data will include published datasets from each climatic and

Number	Applicability Condition	Project Applicability Justification
		designated soil type occurring in the project, or a justifiably similar region if data limitations are evident.
4	Validated per datasets and procedures detailed in Section 5.2 of VMD0053 Model Calibration and Validation Guidance for the Methodology for Improved Agricultural Land Management. Model prediction error must be calculated using datasets as described in Section 5.2.5 of VMD0053and must use the same parameters or sets of parameters applied to estimate stock change/emissions in the project.	The Model Validation Report will detail our compliance with the guidance of VMD0053 and will include all calculations and statistical analysis of the data to show model prediction error. The same model used for validation will be used to estimate stock change/emissions in the project.
5	Using the same model version in the baseline and project scenarios. Further, the same parameters/parameter sets must be used in the baseline and project scenarios. Model input data must be derived following guidance in Table 6 and Table 8. Model uncertainty must be quantified following guidance in Section 8.6. Models may be recalibrated or revised based on new data, or a new model may be applied, provided the above requirements are met	The Report provided will outline how the same model versions and parameters have been used for the baseline and with project scenarios. This will be made available for testing for the validation and verification body ("VVB") along with all other required information and datasets.

3.3 Project Boundary

As per Methodology VM0042, the project boundary is defined as follows: "The spatial extent of the project boundary is all lands planning to implement the proposed improved ALM practice(s). All project instances take place on grassland or cropland as per the eligibility criteria. The geographic boundary of this project and its associated practices is that of the borders of the Republic of South Africa.

Table 3.3.1 below outlines the selected carbon pools for both the baseline and project scenarios. Table 3.3.2 refers specifically to the GHG emissions sources, those included and those excluded, as part of the project for both the baseline and project scenarios.

Table 3.3.1: Selected Carbon Pools for the Baseline and Project Scenario

Pool	Included/Excluded	Justification for Inclusion/Exclusion
Aboveground woody biomass	Included	For the project scenario where new or existing agroforestry practices occur, those eligible for the project, will be included. Aboveground woody biomass will be calculated using the CDM A/R Tools Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities and Simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities implemented on lands other than wetlands. The project instances included in the first monitoring period do not include these practices. Therefore, aboveground woody biomass is excluded in the first monitoring period.
Aboveground non-woody biomass	Excluded	As per the VCS rules this Carbon pool does not have to be included because it is not subject to significant changes, or potential changes are transient in nature. Accordingly, as per methodology VM0042, this pool is excluded.
Belowground woody biomass	Included	This is an optional pool. For the project scenario where new or existing agroforestry practices occur, those eligible for the project, will be included. Belowground woody biomass is calculated as per the guidelines for aboveground woody biomass. The project instances included in the first monitoring period do not include these practices. Therefore, aboveground woody biomass is excluded in the first monitoring period.
Belowground non-woody biomass	Excluded	As per the VCS rules this Carbon pool does not have to be included because it is not subject to significant changes, or potential changes are transient in nature. Accordingly, as per methodology VM0042, this pool is excluded.

Pool	Included/Excluded	Justification for Inclusion/Exclusion
Dead wood	Excluded	As per the VCS rules this Carbon pool does not have to be included because it is not subject to significant changes, or potential changes are transient in nature. Accordingly, as per methodology VM0042, this pool is excluded.
Litter	Excluded	As per the VCS rules this Carbon pool does not have to be included because it is not subject to significant changes, or potential changes are transient in nature. Accordingly, as per methodology VM0042, this pool is excluded.
Soil Organic Carbon	Included	Soil Organic Carbon is the main carbon pool affected by the project activity. The implementation of new practices and regenerative agriculture has an impact on SOC. It is expected to increase in the project scenario.
Wood products	Excluded	Carbon pool is optional for ALM project methodologies and may be excluded from the project boundary as per the VCS rules. For this project this pool is excluded.

Table 3.3.2: GHG sources included In or Excluded from the Project Boundary in the Baseline and Project Scenario

Source	Gas	Included/Excluded	Justification for Inclusion/Exclusion
Soil Organic Carbon	CO_2	Included	SOC is a major GHG source. It is quantified as stock change in the pool, rather than an emission source (see Table 3.3.1).
Fossil Fuel	CO_2	Included	The source of fossil fuel emissions are vehicles and mechanical equipment as required by the ALM activity. The project will reduce the use of these sources or minimize where possible.
Liming	CO_2	Included	Application of limestone or dolomite as soil amelioration may represent a significant source of CO_2.
Soil Methanogenesis	CH_4	Excluded	Excluded from both the baseline and project scenarios. It is beyond the scope of the model being utilized for this

Source	Gas	Included/Excluded	Justification for Inclusion/Exclusion
			project. Furthermore, this project is not expected to increase CH_4 emissions.
Enteric Fermentation	CH_4	Included	These emissions must be included in the project boundary as some of the farms have livestock.
Manure Deposition	CH_4 & N_2O	Included	As per previous point. For all eligible project activities, the CH_4 and N_2O emissions from manure deposition and management must be included in the project boundary.
Use of nitrogen Fertilizers	N_2O	Included	Where, in the baseline scenario, the project area would have been subject to nitrogen fertilization or where nitrogen fertilization is greater in the with-project scenario relative to the baseline scenario, N_2O emissions from nitrogen fertilizers must be included in the project boundary. In the project scenario farmers will often reduce fertilizer use. This will be done in conjunction with the utilization of soil testing and a more regulated use of fertilizer and fertilizer substitutes.
Use of nitrogen-fixing Species	N_2O	Included	Nitrogen fixing species are planted in the project, either as cash crops, cover crops or as intercrops, N_2O emissions from nitrogen fixing species must therefore be included in the project boundary. This is for the project scenario compared to the baseline scenario.
Biomass Burning	CO_2	Excluded	CO_2 emissions under burning are assumed as zero and therefore not included. Any change in soil carbon stocks however will be calculated as per VM0042 guidelines.

Source	Gas	Included/Excluded	Justification for Inclusion/Exclusion
	N_2O & CH_4	Included	For eligible sample units changing from a regime of burning to options with less burning. This is likely to apply primarily to croplands in the Northern Cape, Western Free State and Swartland areas of the Western cape where burning is a common practice. Burning of sugarcane, forestry and grazing areas may fall under the scope of VM0042 but will not be included in this grouped project. Any change in Carbon stocks will be calculated as per VM0042 guidelines. Must be included where the project activity may significantly increase emissions compared to the baseline scenario and may be included where the project activity may reduce emissions compared to the baseline scenario. Included as the project scenario is expected to decrease emissions compared to the baseline as a reduction in burning will be incentivized in the project scenario. There are no biomass burning events in the first monitoring period for this emission category.
Woody Biomass	CO_2	Included	It is quantified as stock change in the pool, rather than an emissions source (see Table 3.3.1). It will be calculated using the CDM A/R Tools Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities and Simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities

Source	Gas	Included/Excluded	Justification for Inclusion/Exclusion
			implemented on lands other than wetlands.

The project instances included during the first monitoring period occur in several provinces, namely Kwa-Zulu Natal, Free State, Gauteng, Mpumalanga and the North West Province. Future instances will include other provinces, with the Northern Cape, Limpopo, Eastern Cape, and Western Cape being likely provinces which will host future project instances. The exact locations and specific details of each instance will be provided in the documentation for validation in the required formats. The below figure 3.3.1 provides an overview of the current project instances included in the project:

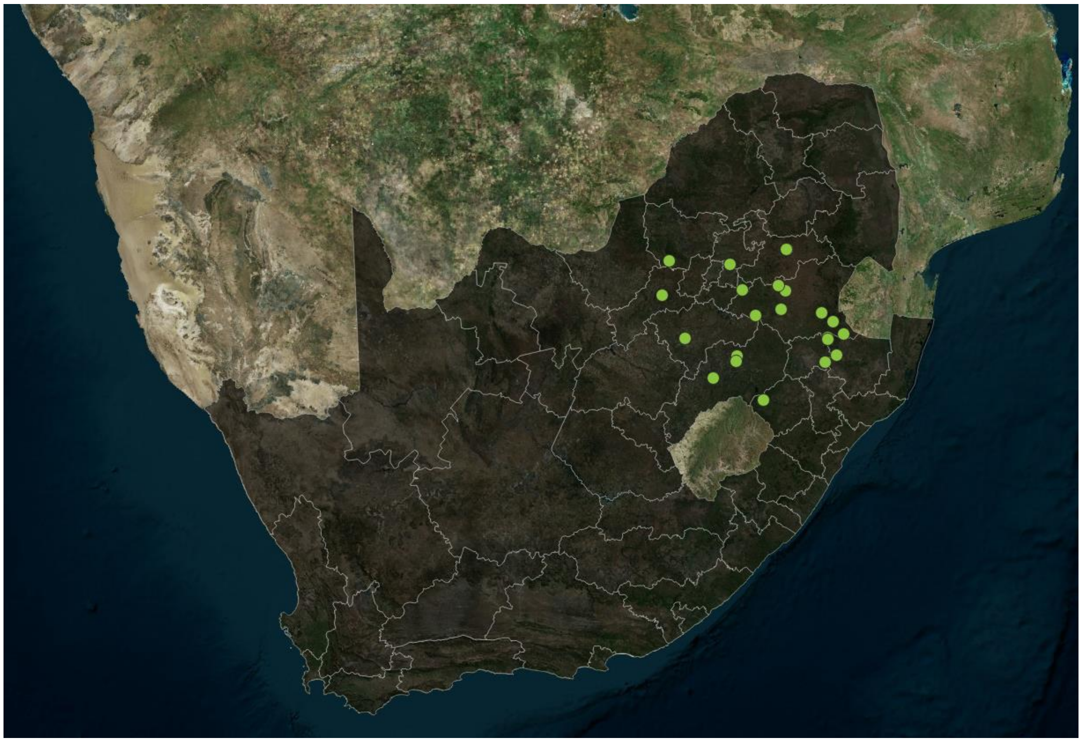


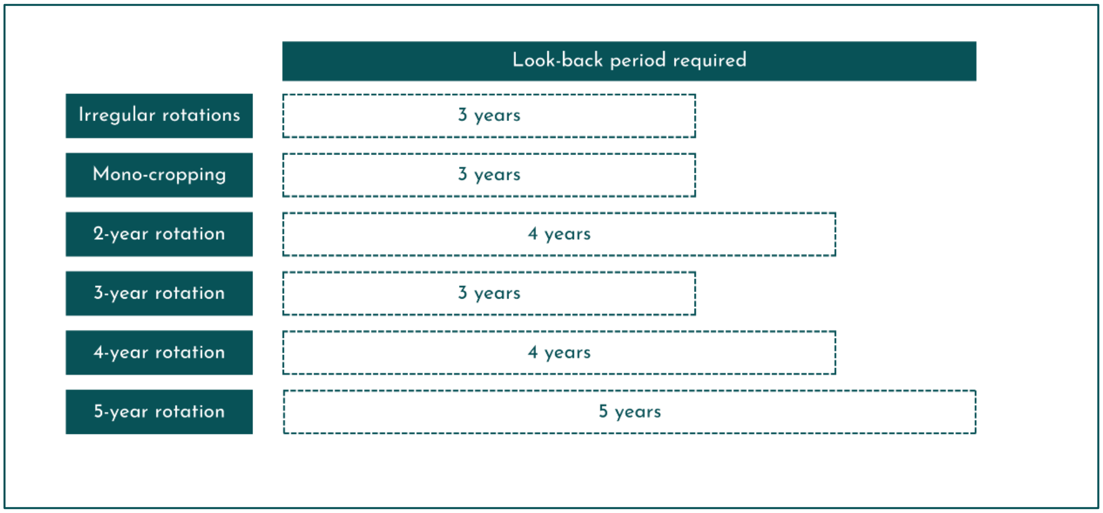
Figure 3.3.1: Locations of current project instances (20 instances clearly visible, with the remaining 2 being neighboring farms appearing as one location)

3.4 Baseline Scenario

As per the Methodology, the most likely baseline scenario is the continuation of pre-project agricultural management practices. Of importance is that each sample unit (project field) requires the project proponent to determine a baseline scenario for that sample unit. In other words, Orizon has determined a baseline scenario for each of the 905 included project fields for this first monitoring period as per section 6 of v2.0 of VM0042. These baselines may be modified in future in line with Verra's baseline re-assessment requirements.

For each of the 905 project fields, practices applied in the baseline scenario are determined applying a historic look-back period to produce an annual schedule of activities to be repeated over the first crediting period. As per the methodology, the look-back period should be a minimum of 3 years and include at least one crop rotation. As the grouped project start date is 1 August 2018 the historical look-back period for project instances with the start date of 1 August 2018 was at least 3 years prior i.e. 1 August 2015, unless the crop rotation required a longer look-back period as per the methodology requirements.

The look-back period years (e.g. 1 August 2015 – 31 July 2018) were based on the crop rotations immediately preceding the project start date. To determine the crop rotations, Orizon collected and received detailed information at the field level through farmer's management records that were subsequently uploaded to the Orizon platform. To determine the required look-back period the following rules applied:



	Look-back period required
Irregular rotations	3 years
Mono-cropping	3 years
2-year rotation	4 years
3-year rotation	3 years
4-year rotation	4 years
5-year rotation	5 years

Figure 3.4.1: Rules for the determination of the look-back period in different rotations

For each project instance there is an extensive excel workbook that includes details of each event on each field during this look-back period. The farmer data came in a variety of formats from excel workbooks, John Deere Operations software to handwritten records filed manually by the farmer. The collection of this data required numerous visits to each of the 22 project instances and further consultation via email or telephone with the farmers. Almost each field event is supported by historic management records. Where such records were not available, management plans / recommendations were used. Where these were also not available in rare circumstances reliance was placed on attestations and regional averages based on data for each province. The hierarchy of Box 1 in VM0042 was followed as guidance for the quality of evidence required for the establishment of the baseline schedule of activities. The events recorded on Orizon's platform over the various baseline periods for the initial project instances include 2,517 planting and harvesting events; 3,802 fertilizer applications (3752 synthetic and 50 organic); 1,022 liming applications; 10,635 spraying operations; 160 cover crop planting events; 2,641 livestock grazing events and 3,047 tillage events amongst other records collected and documented. This data forms the historic schedule of activities for each unique sample unit.

Baseline emissions/stock change are then modelled (for SOC stock change only), directly measured or calculated using accepted conservative benchmark calculations. The crops and practices assumed in the baseline scenario are re-evaluated as required by the VCS Standard and revised, if necessary, to reflect current agricultural production in the region.

Data for the determination of the annual schedule of activities aligns with the specific locations in the project. This data was, as mentioned above, received directly from the farmers for each field and was based on their actual implemented management activities on participating fields prior to the implementation of improved ALM practices. This data was further supported and evidenced by satellite data and other sources and studies performed on the practices of farmers within a certain area but is primarily based on management records. Where management records or plans were unavailable, we sourced the information elsewhere to determine the annual schedule of activities through accepted means as per the methodology Box 1 (see more information in the section below table 3.4.1). The below table provides an overview of the determination of the schedule of activities in the historical look-back period where historical data is available for each field included in the project.

Considerations in respect of grassland to cropland conversions:

For the few fields that were converted from grassland to cropland, the data for the historic schedule of activities was considered inappropriate and not conservative to use. This is as these degraded fields were being managed in a way which is not conducive to good SOC levels (e.g. low biomass growth, selective grazing, low diversity, baling/burning of grasses, etc.). Based on our assessment, it was deemed more conservative to base the baseline on regional practices for croplands, rather than the actual practices of those fields. These practices were often also not available in sufficient detail to accurately model SOC stock changes. Effectively, the grasslands were converted to croplands and then project activities commenced subsequent to this, and therefore, it is more appropriate and conservative to model cropland scenarios in both the baseline and project for these fields.

The below table includes the specifications and measures for ALM practices in the baseline scenario for cropland fields, which are the practices that would be implemented in the absence of the project regardless of the history of the field (i.e. whether the field was previously cropland or degraded grassland).

NB: Please note that due to the fact that each field has numerous field events per year that the below table merely provides examples and summarised values as it would be impractical to attempt to include all field event data here (e.g. baseline fertilizer applications included 3,752 separate application events with 64 difference products represented each with their own NPK ratios (i.e. N-content) and applied at various rates across the different fields).

Table 3.4.1: Specifications and measures for ALM practices in the baseline scenario.

ALM Practice	Qualitative measures	Quantitative measures	Source of Evidence
Reduced tillage / improved residue management and retention			
Regular / conventional tillage	Tillage presence and implement being used (typically high disturbance implements such as discing / ripping, which invert the soil). Average tillage runs per field in the baseline was 0.91 per season. Tillage events are assessed per individual field/portion.	Depth of tillage (typically >15cm, ranging between 15 – 50cm). Average depth in baseline years was 21.43cm. Dates of event.	Management records, supported by observations/inspections of the implements (e.g. disc / deep ripper) and lack of residues on the soil. Where historic management records are not available, management plans are used. Attestations are used where no documentation is available. Regardless of the source of evidence, it is supported by satellite imagery & NDVI analysis. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm.
Partial / full residue removal - baling	Residue baling activity presence. Whether bales were removed from the field. Events are assessed per individual field/portion.	T dm/ha residues removed (by multiplying dry matter weight per bale x number of bales / ha). Dates of event.	Management records, supported by observations/inspections of the implements (e.g. mower, rake & baler), lack of residues on the soil and bales collected. Where historic management records are not available, management plans are used. Attestations are used where no documentation is available. Regardless of the source of evidence, it is supported by satellite imagery & NDVI analysis. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm.

ALM Practice	Qualitative measures	Quantitative measures	Source of Evidence
Improved fertilizer (organic or inorganic) and inputs management			
Synthetic fertilizer	Fertilizer presence with planting. Pre-plant fertilizer applications presence. Top-dress fertilizer applications presence. Product & implement used per application. Events are assessed per individual field/portion.	NPK ratio of product (e.g. 2:2:1 (34); or 13.6% N). Application rate varies widely, with an average of 72.68 kg N/ha applied per season across the historic baseline years. Dates of event.	Management records (typically machine records, prescription maps, fertilizer invoices, excel records, etc.). Where historic management records are not available, management plans are used (typically agronomist recommendations, quotes for order, excel plans per field, etc.). Attestations are used where no documentation is available. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm.
Organic inputs	Presence of an organic fertilizer application (typically none in baseline). Type of organic input. Events are assessed per individual field/portion.	Application rate varies widely, with an average of 39.80 kg/ha applied per season across the historic baseline years. Dates of event.	Management records (typically machine records, prescription maps, invoices, delivery notes, excel records, etc.) and observation of composting operations or evidence of manure/compost applied on field. Where historic management records are not available, management plans are used (typically quotes for order, excel plans per field, etc.). Attestations are used where no documentation is available. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm.

ALM Practice	Qualitative measures	Quantitative measures	Source of Evidence
Liming	Presence of a liming event on a field. Product (e.g. Mafikeng Calcite or Calmasil Dolomite, etc.) Events are assessed per individual field/portion.	Application rate varies widely, with an average of 0.93 kg/ha applied per season across the historic baseline years. Dates of event.	Management records (typically machine records, prescription maps, liming invoices / financial statement records, excel records, etc.). Where historic management records are not available, management plans are used (typically agronomist recommendations, quotes for order, excel plans per field, etc.). Attestations are used where no documentation is available. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm.
Improved crop planting and harvesting			
Off-season cover cropping	Cover crop presence in the off-season (typically none planted in baseline – only 6.5% of hectares had been planted during the baseline). Species of cover crop (list if multi-species cover crop). Events are assessed per individual field/portion.	% biomass attributable to each species within mix. tDM biomass at termination varies based on biomass model and biomass sampling. Dates of event (planting and termination).	Management records, supported by observations of cover crop presence during site visits and soil sampling campaigns. Where historic management records are not available, management plans are used. Attestations are used where no documentation is available. Regardless of the source of evidence, it is supported by satellite imagery & NDVI analysis. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm.

ALM Practice	Qualitative measures	Quantitative measures	Source of Evidence
In-season cover cropping	Cover crop presence in the in-season (typically none planted in baseline – only 0.9% of hectares had been planted during the baseline). Species of cover crop (list if multi-species cover crop). Events are assessed per individual field/portion.	% biomass attributable to each species within mix. tDM biomass at termination varies based on biomass model and biomass sampling. Dates of event (planting and termination).	Management records, supported by observations of cover crop presence during site visits and soil sampling campaigns. Where historic management records are not available, management plans are used. Attestations are used where no documentation is available. Regardless of the source of evidence, it is supported by satellite imagery (e.g. observations of grazing of the crop as opposed to harvesting). Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm.
Crop rotation	Crop species planted per season within baseline. Most farmers already followed a crop rotation of some sorts in the baseline. Events are assessed per individual field/portion.	t/ha average yield for the field. Dates of event (planting and harvesting).	Management records (typically machine records, excel records, insurance documents, etc.). Where historic management records are not available, management plans are used (typically excel plans per field, or colour coded maps, etc.). Attestations are used where no documentation is available. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm. Regardless of the source of evidence, it is supported by satellite imagery analysis.

ALM Practice	Qualitative measures	Quantitative measures	Source of Evidence
Improved grazing practices			
Materials being grazed	Materials being grazed (typically dead residues post-harvest in the baseline). Type of livestock.	Number of mature & young animals (separately). Frame size. Grazing start & end dates.	Management records (typically excel records, insurance documents, VET bills, stock count sheets, etc.). Where historic management records are not available, management plans seldom used as they are mostly not suitable as one cannot plan for livestock (e.g. cannot plan the mortality or birth rate). Attestations are used where no documentation is available. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm. For livestock-related data, farmers often do not have field-specific values as field-groups are typically grazed. The average values per field are derived mathematically from the field-group data based on each field's relative size.
Grazing Density	Whether the residues / cover crops were grazed selectively or with higher densities & on a rotational basis.	Number of moves per day. Stocking density (calculated based on field size, number of animals, and moves per day).	Management records (typically excel records, insurance documents, VET bills, stock count sheets, etc.). Where historic management records are not available, management plans seldom used as they are mostly not suitable as one cannot plan for livestock (e.g. cannot plan the mortality or birth rate).

ALM Practice	Qualitative measures	Quantitative measures	Source of Evidence
			Attestations are used where no documentation is available. Regional data (by province & field type) is used only where there are valid reasons for no data being available, such as the purchase of a new farm. For livestock-related data, farmers often do not have field-specific values as field-groups are typically grazed. The average values per field are derived mathematically from the field-group data based on each field's relative size.

The determination of the baseline scenario for each of the project fields is compliant with any relevant law as set out in Section 1.15 for example, the Protection of Personal Information Act (POPIA) Act 4 of 2013. This law relates to all personal information from the farmers being kept confidential and that this information has only been obtained with the consent of the farmers involved in the project. There are no specific government regulations pertaining to the determination of the baseline scenario but should this change in future then Orizon will ensure that this is taken into account and adjustments made to ensure compliance with these regulations. As a developing nation, South Africa has no government policies or legal requirements which obligate or even encourage any specific cropping practices including those under consideration in the baseline or project scenarios.

Regional Baseline Development (For fields lacking historical data):

For the few fields where no historic data for baseline establishment is available (such as where the field is newly purchased and the previous owner is not willing to share information with Orizon), a regional baseline is applied based on the common practices prevalent in the region, in line with the source data hierarchy in Box 1 within VM0042. This assessment was carried out at the provincial level. As an example, if a farmer in Gauteng province did not have historical management records for a specific cropland field, then Orizon applied the Gauteng regional baseline activities information of croplands to that field. This is further detailed below.

For such fields where historical management practices were not directly available, the regional values were based on data available per region (i.e. province), as well as consultations and a signed attestation by a qualified independent local expert. A regional baseline was developed for each province for croplands in which initial project instances were present which did not have their own baseline data. A separate baseline was established for irrigated and dryland fields within each province to distinguish between these.

The baseline data was based primarily on information from Grain SA, the Agricultural Research Council, FERTASA (Fertilizer Association of South Africa) and government census data, amongst other supplemental evidence. Full source data and processes can be found in the “Regional Baseline Development” report and the “Regional Baseline Development” workbook.

The regional baseline data was summarised and sent to multiple qualified independent local experts for their review and signing of an attestation form to confirm the reasonability of the practices. A qualified independent local expert could only sign off on the reasonability of the practices in provinces where he/she had the required experience and knowledge.

Where fields did not have historic data, the regional baseline data was only applied after reviewing satellite imagery and NDVI data on the fields to ensure the actual historic practices of the previous owners were aligned with the assumptions of the regional baseline data for the province for the main practice assumptions (crop rotation, tillage practices and cover cropping).

The application rates (and therefore the emissions) are conservative in that they under-estimate what the most likely application rates would be, resulting in lower-than-likely emissions in the baseline.

Most fields had baseline data available backed by actual historical management records and plans, and the above approach was only followed for a minority of fields (ca. 15.4% of total hectares on a weighted-by-year basis).

Summary of field records collection and baseline establishment:

To summarise, the following hierarchy of data sources was used as guidance for the monitoring teams, based on Box 1 of VM0042 (in order of preference):

1. The following data sources are equal in quality, and therefore the most readily available records were used. Often, more than one of these sources were used and checked for consistency (e.g. even when farmers had cover crop records, an NDVI assessment was still performed to ensure the accuracy of the data. Or when tillage records show no till practices were adopted, the monitoring teams would ensure that soil residue cover and appropriate implements were observed:
    a. Farm / management records; typically in the form of machine data (e.g. John Deere Operations Centre, AgFinity, SMS, etc.), excel records, diary entries, prescription maps for applications which were followed, invoices, financial statements, livestock stock count sheets, etc.
    b. Satellite analysis: using NDVI analysis, we performed an assessment for cover crop presence and tillage activity where possible.

c. Observation; through 3-4 annual visits to each operation and through questionnaires on our soil sampling data collection forms (i.e. data collected by the soil sampling teams, such as crop planted, residue visibility, residue type, tillage activity, organic inputs observations, cover crop presence, etc.).

2. Recommendations or management plans, which typically included detailed excel plans, recommendations by agronomists (e.g. chemical programme), etc.
3. Only where no data was available (e.g. for a newly purchased land), provincial data was used to fill any gaps. This was further supported by attestations by the farmer and satellite analysis of the general practices on those fields.

All of these records were further supported by attestations from the growers confirming the accuracy of all provided data. Other supporting evidence included time- and location-stamped photos / videos and consultations with the grower's agronomists / neighbours in many cases, who confirm the general practices of the farmer.

Where inconsistent values were apparent, the most conservative values were used. There were very limited data points which had conflicting information.

Data gap filling procedures are described in detail in the "Orizon CarbonCrop Programme - Farmer Process & Field Records" report listed in the Appendices and provided to the VVB.

The following data points are collected per type of field event:

- Planting
  - Crop type / species
  - Planting method (e.g. no till planter vs conventional planter vs fine seed planter)
  - Planting date
- Harvesting
  - The crop harvested
  - Harvesting method (e.g. dry vs silage)
  - Harvesting Date
  - Average Yield for the field
- Tillage
  - Implement type used
  - Tillage date
  - Depth of tillage (cm)
- Fertilizer (including organic inputs)
  - Type of fertilizer
  - Application method (e.g. with planter vs spreader vs fertigation, etc.)
  - Application date
  - Application rate (kg/ha)
  - Nutrient breakdown of product (i.e. NPK ratios)
  - Whether sourced externally or produced on-farm
- Liming
  - Product type (e.g. Hiqua Witbank Dolomite vs Calmasil Dolomite vs Gypsum)
  - Application date
  - Implement used for application
  - Application rate (kg/ha)
- Cover Cropping

  - Cover crop type (e.g. Winter CC vs Summer CC vs Intercropping, etc.)
  - List of species
  - % of biomass attributed to each species on average
  - Planting method (e.g. drone vs fine seed no till planter, etc.)
  - Planting date
  - Termination method (e.g. herbicide spray vs roller-crimper, etc.)
  - Termination date
- Chemicals / Biological
  - Product type (e.g. Herbicide vs Fungicide vs Compost Tea, etc.)
  - Application date
  - Implement used for application
  - Application rate (l/ha)
- Livestock (Note: often given for a group of fields when livestock have access to multiple fields at a time)
  - Animal type (e.g. Beef Cattle vs Sheep vs Dairy Cattle)
  - Relative Frame Size (range in kg per animal)
  - Number of adult animals & young animals
  - Grazing start date & end date on field
  - Portion of day on project fields
  - Supplemental feed (type of feed and kg/animal/day)
- Irrigation (Note: often based on modelling by an agricultural irrigation engineer when data was not available)
  - Method (e.g. pivot vs water canon)
  - Mm irrigated per month (separately for each month)
- Other
  - Other data collected includes details on baling events, fire, crop damage, etc.
  - For all events listed above, the % portion of the field is also a required input (e.g. where only half of a field is tilled)

<u>Overview of emission reduction calculations:</u>

The GHG reduction calculations are set out in VM0042 for both the project and baseline scenarios. Essentially these are quantified by comparing the project scenario to the performance of the "repeating" baseline scenario. The below figure illustrates the repeating baseline periods against the project periods, which is unique per individual field based on actual historic records in the look-back period:

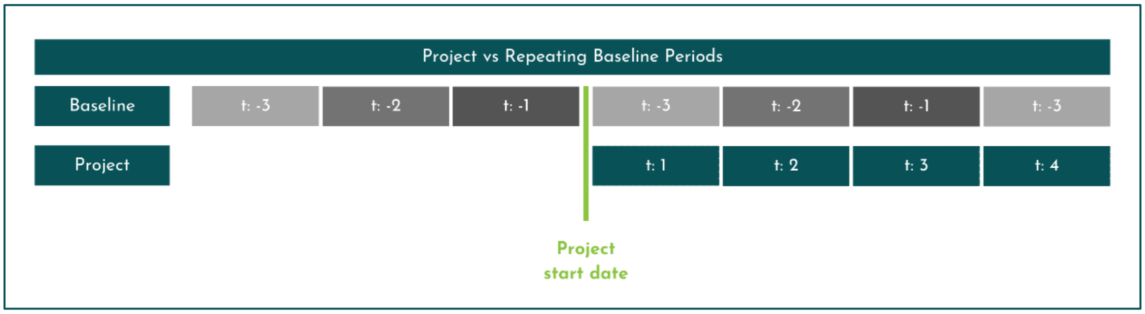


Figure 3.4.2: Repeated baseline illustration for a 3-year look-back period

Quantification Approach 1, measure and model is used to quantify Soil Organic Carbon (SOC) stocks in sample units, using a calibrated and validated model and considering the climatic conditions, soil texture, bulk density, yield data and other aspects of the farmland. The model chosen for this project is the RothC (Rothamsted C) model. The value at t=0 initiates the model for each project instance. The model's performance was assessed against an array of validation studies (with details provided in the Model Validation Report) and will be further corroborated by comparing future SOC measurements to the estimations of the model. This will be done following a standardised procedure by taking soil samples from the same location around the same date in intervals as prescribed by the requirements for 'true-up'/re-calibration of the model. Initial direct measurements or samples will be taken at project start date or within 5 years thereafter and then back-modelled. The guidance in Section 8.6.1.3 of VM0042 v2.0 is followed for the remeasurement, model true-up and cumulative crediting. Once the model true-up process is completed the model is rerun for both the baseline and project scenario from t_0 to present day. Uncertainty deductions are recalculated to be applied to future credit vintages.

The methodology also provides a set of equations and default values that will be applied under Quantification Approach 3 to quantify the baseline emissions relating to non-SOC emissions. In the long-term, these baseline emissions are reduced in the project scenario due to the application of the new project activities i.e., any applied improved land management practices as part of RA.

Where aboveground and belowground woody biomass is included, these will be calculated by using the CDM A/R Tools Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities and simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities implemented on lands other than wetlands. There is currently no project instance where this is applicable, but this will be done for future instances where this is required.

The quantification approaches followed in quantifying the baseline scenario for the project area are outlined in the table below. Please note all GHG Sources and Pools as per Section 3.3 that are included in the project boundary are shown here. However, 'not applicable' has been assigned for sources that do not contribute to the emissions in the current project instances.

Table 3.4.2: GHG sources included in the boundary in the baseline and project scenarios.

GHG	Source	QA 1: Measure and Model	QA 3: Default Values
CO_2	SOC	x	
	Fossil fuel		X
	Liming		X

	Woody biomass		Not applicable
CH_4	Enteric fermentation		X
	Manure deposition		X
	Biomass burning		Not applicable
N_2O	Use of nitrogen fertilizers		x
	Manure deposition		x
	Use of nitrogen-fixing species		x
	Biomass burning		Not applicable

3.5 Additionality

3.5.1 Regulatory Surplus

Is the project registered or seeking registration in an UNFCCC Annex 1 or Non-Annex 1 country?

☐ Annex 1 country ☒ Non-Annex 1 country

South Africa is listed as an Annex 1 country as per the UNCC website: Parties | UNFCCC

Are the project activities mandated by any law, statute, or other regulatory framework?

☐ Yes ☒ No

3.5.2 Additionality Methods

Regulatory surplus is detailed in section 3.5.1 above. Additionality is shown in accordance with the requirements of the methodology as well as through the following steps:

Step 1: The project and implementation of the project activities (Section 1.12) is not mandated by any law, statute, or other regulatory framework in South Africa. These activities all represent improved agricultural land management practices that exceed the legal responsibilities of landowners or land users. Participation in this project is a voluntary coordinated action by the PPs.

The South African agricultural sector is dominated by mostly conventional methods *(Findlater, 2019)*These methods generally do not include the practices considered as part of the improved land management practices as set out in VM0042, although some sustainable practices have already been extensively adopted (such as marginally improved residue management and some livestock integration)

The South African government acknowledges the need for more sustainable practices as mentioned in the National Development Plan for 2030 *(NDP, 2012)*. However, there are currently no formal regulatory frameworks prescribing or incentivising sustainable practices.

Step 2: Identify barriers that would prevent the implementation of a change in pre-existing agricultural management practices.

Any change in an agricultural system faces barriers that would make such a change unlikely without an incentive. This project provides enough incentive and other mechanisms of support for barriers to be overcome in the transition from conventional to sustainable agriculture including RA. This transition would not happen without this project and its interventions as the practices are expensive and require financial intervention, especially for cover crops, organic inputs and no till equipment. The barriers have existed for many decades and are the reason why these practices have not yet been widely adopted. These low adoption rates are testament to the challenges that come with the project activities. The identified barriers pertinent to this project were identified through discussions with several important role players in the agricultural sector including consultations with all of our participating farmers. Some of the identified barriers that this project is allowing farmers to overcome include the following:

Table 3.5.1 Barriers with and without project intervention

Barrier description	Orizon intervention	Scenario without intervention
	Financial & Operational Risk Barriers	
Large capital investment is required for no till practices and planting of cover crops (Direct consultation with farmers, farmers days and through stakeholder engagement in the agricultural sector).	Carbon revenues aid in the effective return on investment (ROI) on these implements, labour, livestock and seed costs, making it financially attractive. By paying out up to 75% of revenues, the farmers receive the largest benefit of this project. Orizon is also partnering with local banks who are	There are no other incentives or premium markets which exist in South Africa to assist farmers in recovering the costs of such investments. Reliance for a positive ROI is placed solely on the practice itself. These practices often do not have a direct benefit (e.g. no till and cover crops aid in long-

Barrier description	Orizon intervention	Scenario without intervention
Large capital investment for livestock (e.g., increasing stocking rate under rotational grazing management, requiring more livestock and fencing, piping and other investments) (*(Kooper, 2020)*and direct consultation with farmers).	starting to incorporate carbon financing into their own lending decisions and aim to better match the investment cash outflows with carbon cash inflows.	term health and climate resilience but do not necessarily result in short-term gain or measurable ROI). Based on consultations with farmers and agronomists, livestock dynamics are currently such that the beef prices are too low and seed costs too high to profitably farm livestock on cover crops. Intervention is required to make it feasible.
Concern over potential drops in yields in the initial years of adopting regenerative practices *(Jat R. W., 2012)*, *(Jat R. S., 2014)*, *(Kooper, 2020)*	Orizon shows local data and studies to demonstrate that this is not necessarily the case. Orizon communicates the reasons why there could be yield drops in early years and through consultations with Orizon and its partner organisations, this risk is minimised through effective planning and soil preparation. This strategy has proven effective, as demonstrated by the increased productivity after adoption of the project activities (Refer to Section 5.3.3).	The concern about yield drops remains amongst farmers. Many non-participating farmers we consult with list this as one of their primary barriers to adopt RA practices as they believe there is a trade-off between stewardship and profitability.
Decreased availability of finance for such investments as the	Carbon revenues serve as an additional income	Without carbon revenues, more financing is

Barrier description	Orizon intervention	Scenario without intervention
Agricultural Land and Development Bank is in financial difficulties and commercial banks are not yet able to cover that capacity *(Sihlobo, 2020)*).	source which will reduce the need for financing.	required. The availability of this funding is limited.
Comparatively high interest rates (7.5% in South Africa versus 4.5% in the USA and 2.9% in the EU) which make debt financing of capital investments expensive *(Trading Economics, 2025)*	Orizon is in discussions with leading local banks to reduce interest rates in "Green Bonds" or sustainability financing to meet their own sustainability goals and to fit the risk profile of sustainable farming vs conventional farming, where sustainable farming has a lower risk profile. Orizon has partnered with a bank to perform such assessments and enable this.	Financing for sustainability projects would carry a similar perceived risk profile as conventional agriculture and therefore, the same high interest rates would be applicable.
No subsidies, tax deductions or any other incentives to motivate the adoption of RA practices. Government has largely moved away from subsidizing any commercial farmers, which was a prevalent policy up until the late 1990s *(Ministry for Agriculture and Land Affairs, 1998)*	The carbon project would be the first incentive of any kind that is received by farmers in South Africa for their good stewardship and the consequent GHG reductions/removals.	There are no plans by government for any subsidies, tax incentives or other structures to encourage the adoption of sustainable practices. South Africa is not in a financial position to support its farmers in such a way. Similarly, there are no local premium markets in the pipeline to offtake regeneratively produced products at scale.

Barrier description	Orizon intervention	Scenario without intervention
Record high national farm debt levels mean there is limited capacity for many farmers to absorb additional financing *(Sihlobo, 2020)*	The additional income stream from carbon revenues will aid in de-risking the farm's financial profile.	Current trends of increased debt would continue.
Decreased historic profitability means farmers are hesitant to make big changes which can threaten their short-term profitability and entire operations (Direct consultation with farmers and GrainSA representatives). In a research paper on local trials the author notes "changes in SOC and other soil properties due to management practices simply occurred too slowly to reflect in yields or profitability in the short- or medium-term" *(Swanepoel, 2018)*.	The incentive of carbon revenues allows farmers, who have narrow profitability margins, to invest in soil-building as they now receive short- to medium-term returns on this investment as opposed to the long-term & indirect benefits of improved soil health.	Farmers with a narrow profitability margin cannot afford to invest in soil health for its long-term benefits as they need to focus on their short-term performance.
Perception & Educational Barriers		
Little awareness / education around the issue of climate change and the positive impact that RA has as well as some of the misconceptions associated with the term RA that provide farmers with incorrect information and therefore a resistance to RA in general *(Kooper, 2020)*	Orizon is building awareness towards RA practices and its positive climate impact through farm visits, talking on farmer days / events and social media.	Limited programmes are actively reaching out to farmers around the benefits of RA practices. Awareness gaps would continue to exist.
Perception that sustainable practices are only suitable to very specific areas (e.g., cover crops are not feasible in drier areas or no-till systems are impossible in sandy soils) *(Knott, 2015.)*	Orizon is partnering in on-farm trials in different areas in order to prove that these practices are adaptable to any context.	The perception has not changed in the last decades and will likely not change as there is limited connection of farmers to share success

Barrier description	Orizon intervention	Scenario without intervention
	Orizon is sharing these results with other farmers. Orizon has established WhatsApp groups and other channels to connect farmers from different areas to share their success stories or lessons learnt.	stories in areas where these practices are more challenging.
There is limited technical capacity, such as extensively available sustainability-minded technical expertise / consultants to assist with the shift to RA *(Kooper, 2020)*	Orizon is employing regeneratively minded agronomists to assist farmers in their transition, including assisting them with technical challenges. Orizon also incentivises independent agronomists to encourage their farmers to transition towards regenerative practices as they are paid a reward when helping farmers in this transition.	Agronomists / consultants are not incentivised to promote regenerative practices as this limits the products they can sell to the farmers. For example, the fertilizer consultant would not promote regenerative practices which reduce the need for chemical fertilizers. This structure is ineffective towards sustainability.
Social / Cultural Barriers		
RA is not the social norm for South Africa and farmers making changes run the risk of being ostracized from the farming community as this different method of farming may not be seen as agreeable with the community due to, amongst other factors, that these lead or pioneer farmers are often viewed as having unreliable information to share *(Mnkeni PNS, 2019)*.	Orizon has introduced / connected farmers to each other within similar areas with a similar context, so that they can share experiences. Orizon runs campaigns to promote regenerative practices and to connect farmers.	Through farmer consultations it has become clear that limited communication exists between farmers and pioneering farmers, although willing to share their story, are not being approached by other farmers. They are often labelled as “the crazy farmer” or similar when

Barrier description	Orizon intervention	Scenario without intervention
Surveys conducted by the relevant government departments in South Africa showed a reluctance amongst farmers of approaching the 'pioneer' or 'lead' farmers which has a direct impact on the adoption rate of regenerative agriculture practices *(Mnkeni PNS, 2019)*.	Orizon has established WhatsApp groups where farmers can connect with pioneering/leading farmers. Orizon has brought together farmers from similar areas through farmer days and regenerative trial demonstrations, to show that the information on the benefits of RA is not unreliable.	they go against the status quo.
A high level of respect in South African farmers for their fathers and grandparents (and the way in which they farmed) often limits adaptation to a changing climatic and financial environment. In general, older farmers are more reluctant to make changes, whilst the younger generation in general is risk-seeking and often less reluctant to change farming practices *(Jat R. W., 2012)*.	Orizon connects young and old farmers and aims to promote regenerative practices based on evidenced benefits, and not as it's a buzz word. Orizon has regeneratively-minded partners who are retired farmers. These are often approached to communicate with older-generation farmers who are not willing to adapt their practices to the changing context. This has shown great success.	Many farms continue to resist adaptation to a changing climate and financial context. Based on consultations with participating and non-participating farmer, older generations continue to play a role in this resistance.
A social barrier to the successful implementation of CA/RA practices is how familiar the farmer is with these same CA/RA practices *(Mnkeni PNS, 2019)*	Orizon connects aspiring CA/RA farmers with those with more experience as well as informing them of farmer days, regenerative conferences and networks that they would otherwise	Unfamiliarity with CA/RA practices would remain and result in negative results and farmers no longer pursuing the transition from conventional agriculture

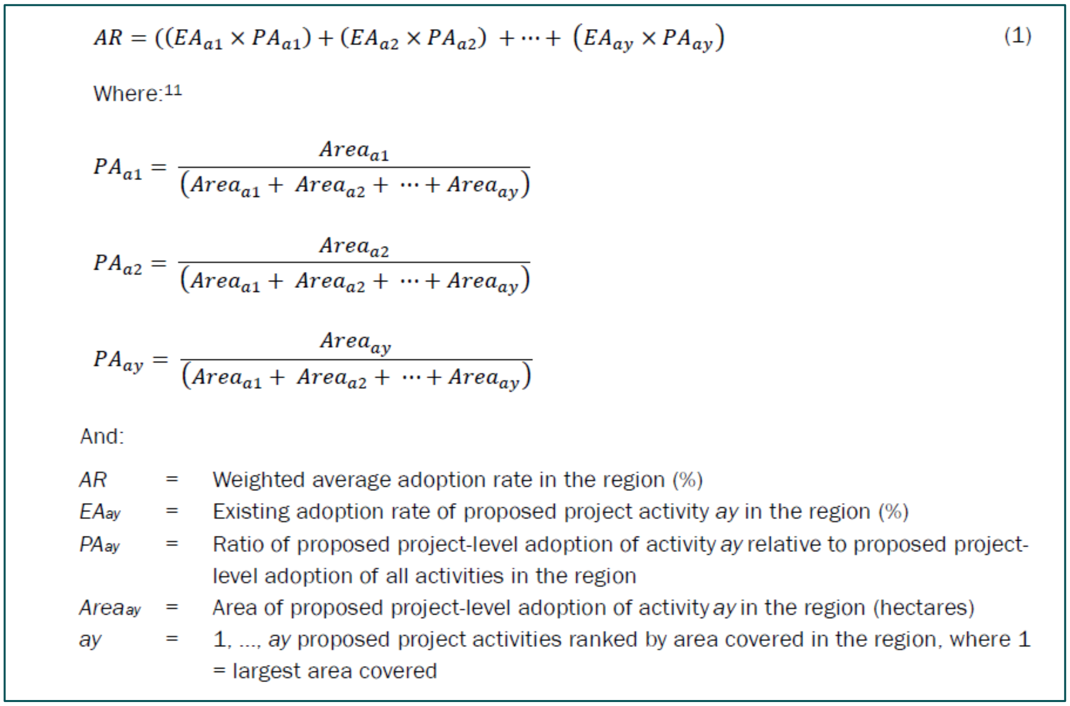
Barrier description	Orizon intervention	Scenario without intervention
	not be aware of without Orizon's input.	to more sustainable methods.

From our consultations with the farmers, it is clear that they require the support of such a carbon project to adopt project activities, continue with the improved practices and to scale them even more. Many farmers we consult with have indicated that they will only plant their first cover crop once these carbon credits materialise for other farmers.

In a local study, the author concludes that, depending on the soil type, "an additional payment scheme would be required to reward farmers in southern Africa for C-sequestration to make CA profitable and achieve increased C-mitigation through soil sequestration" *(Swanepoel, 2018)*.

Without carbon finance, these farmers would not be incentivised to adopt the project activities as there is no/limited short- to medium-term financial benefit. They would also not receive sufficient support and technical knowledge without Orizon and its partner organisation's interventions. Effectively, the project would not exist and these project activities would not be scalable in South Africa without the carbon financing.

Step 3: Demonstrate that the adoption of the suite of proposed project activities is not common practice.



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

Where:[11]

$$PA_{a1} = \frac{Area_{a1}}{(Area_{a1} + Area_{a2} + \cdots + Area_{ay})}$$

$$PA_{a2} = \frac{Area_{a2}}{(Area_{a1} + Area_{a2} + \cdots + Area_{ay})}$$

$$PA_{ay} = \frac{Area_{ay}}{(Area_{a1} + Area_{a2} + \cdots + Area_{ay})}$$

And:

AR = Weighted average adoption rate in the region (%)
EA_{ay} = Existing adoption rate of proposed project activity *ay* in the region (%)
PA_{ay} = Ratio of proposed project-level adoption of activity *ay* relative to proposed project-level adoption of all activities in the region
$Area_{ay}$ = Area of proposed project-level adoption of activity *ay* in the region (hectares)
ay = 1, ..., *ay* proposed project activities ranked by area covered in the region, where 1 = largest area covered

Project instances and their associated practices are determined as not common practice by comparing it to the regional adoption rate of the practice of suite of practices in question. Where such an activity is determined to be adopted by more than 20% within the region, we will calculate the weighted average adoption rate of at least two (or more) predominant project activities within the project spatial boundary and that these practices are below the current threshold of 20% as set out in methodology VM0042. To calculate the weighted mean adoption rate in each region covered by the project area Equation 1 must be applied as seen below.

The first step in the analysis was to identify the predominant practices in the project. The three predominant practice categories are reduced tillage as either no till or minimum till, planting of cover crops and improved fertilizer management by using organic inputs instead of synthetic fertilizer (see Table 3.5.2 below). The tillage category was split into two categories as relevant data was available and to ensure that the no-till adoption rate was not applied to all reduced tillage scenarios. This scenario would result in the artificial lowering of adoption rates and would not be best practice in terms of ensuring conservativeness.

As per the methodology requirement, we determined the regional adoption rates at the provincial level for each of these practices. These adoption rates were based on available literature, as well as conservative (i.e., over-estimations) adoption rate estimates where literature values were not available on a provincial / regional / national level. For example, no cover crop adoption rate data was available locally. The published Findlater 2019 study as well as a survey by Hendrik Smit for the FAO in 2021 provided adoption rates for conservation agriculture at the provincial level in South Africa but no specific adoption rates for cover crops. Using the available adoption rates for conservation agriculture, we determined ultra-conservative adoption rates for cover crops per province. This was further supported by a signed attestation from a qualified independent local expert and confirmed our conservative approach. An example is that we use a 9.1% cover crop adoption rate in the KZN province which is higher than the 5% in the signed attestation by the qualified independent local expert for that same region. Similarly, the adoption rate for Organic Inputs was based on a qualified independent local expert attestation which was adjusted upwards for conservatism.

Table 3.5.2 Project activities adoption rates in the project used for quantification in Equation 1

Project Activity Practice Category	Specific project practice activity	% of hectares implementing the practice activity change	Included as a main category for adoption rate assessment?
Reduced tillage (No till or minimum tillage) and improved residue management	No till or reduced tillage**	40.9%	Yes
Improved crop planting and harvesting	Off-season cover cropping	41.1%	Yes
Improved fertilizer (organic or inorganic) and inputs management	Application of organic inputs e.g. compost, manure	15.8%	Yes
Improved grazing practices	Significant change in effective grazing days	12.6%	No

*** The "Reduced Tillage" category was then further split up into 2 sub-categories, being no till and minimum tillage (Table 3.5.3). This was done as more accurate data was available, and we conservatively included both so that the lower no-till adoption rate is not applied to all reduced tillage scenarios, artificially lowering net adoption rates. These sub-categories are also used in the regional adoption rates for the common practice assessment (Table 3.5.4). The three categories, including the two tillage sub-categories are also detailed in Section 6.1 for the parameter* ay.

Table 3.5.3 Regional Adoption Rates for the three predominant project practices

Province	Primary practice 1 (A) No Tillage - regional adoption rate	Primary practice 1 (B) Minimum Tillage - regional adoption rate	Primary practice 2 Cover cropping - regional adoption rate	Primary practice 3 Organic inputs - regional adoption rate
Gauteng	10.9%	18.5%	7.9%	10.0%

Kwa-Zulu Natal	12.5%	21.3%	9.1%	10.0%
North West	12.2%	20.7%	8.9%	10.0%
Mpumalanga	7.9%	13.4%	5.8%	10.0%
Free State	1.0%	1.7%	0.7%	10.0%

The following tables provide a detailed view of the common practice assessment in this project. It shows the different project activity combinations throughout the project fields and their respective adoption rates based on the figures in Table 3.5.2 above. Where practices were stacked, the respective adoption rates were multiplied by each other as specific adoption rates for combination practices were not available. Where only single practices are applied, the adoption rate of that single project activity must be <20% as per the table above. Therefore, minimum tillage in Kwa-Zulu Natal and North West provinces would not qualify or would require the adoption of other project activities in conjunction.

Table 3.5.4 Regional adoption rates based on documented research (EA_{ay})

Province	No Till	No Till & Improved Cropping	No Till & Organic Inputs	No Till & Improved Cropping & Organic Inputs	Minimum Tillage	Minimum Tillage & Improved Cropping	Minimum Tillage & Improved Cropping & Organic Inputs	Improved Cropping	Improved Cropping & Organic Inputs	Organic Inputs	No Adopted Practices within Main Categories *(conservative 100% adoption rate assumed)*
Gauteng	10.9%	0.9%	1.1%	0.1%	18.5%	1.5%	0.1%	7.9%	0.8%	10.0%	100.0%
KZN	12.5%	1.1%	1.3%	0.1%	21.3%	1.9%	0.2%	9.1%	0.9%	10.0%	100.0%
North West	12.2%	1.1%	1.2%	0.1%	20.7%	1.8%	0.2%	8.9%	0.9%	10.0%	100.0%
Mpumalanga	7.9%	0.5%	0.8%	0.0%	13.4%	0.8%	0.1%	5.8%	0.6%	10.0%	100.0%
Free State	1.0%	0.0%	0.1%	0.0%	1.7%	0.0%	0.0%	0.7%	0.1%	10.0%	100.0%

Table 3.5.5 Hectares on which practices have been adopted ($Area_{ay}$)

Province	No Till	No Till & Improved Cropping	No Till & Organic Inputs	No Till & Improved Cropping & Organic Inputs	Minimum Tillage	Minimum Tillage & Improved Cropping	Minimum Tillage & Improved Cropping & Organic Inputs	Improved Cropping	Improved Cropping & Organic Inputs	Organic Inputs	No Adopted Practices within Main Categories *(conservative 100% adoption rate assumed)*
Gauteng	277	295	258	0	0	0	0	0	0	0	0
KZN	155	43	16	865	0	933	533	690	107	123	259
North West	0	0	460	0	0	0	0	48	185	213	92
Mpumalanga	865	2,631	0	329	321	1,524	0	1,244	137	207	343
Free State	803	723	0	0	449	233	0	107	0	0	77
Total	2,100	3,692	734	1,194	770	2,690	533	2,089	429	543	772
Project Total	15,547										

Table 3.5.6 AR Computation (weighting of each individual practice activity / combination per province as a % of total hectares; multiplying by the respective adoption rates (Ea_{ay} x PA_{ay}))

Province	No Till	No Till & Improved Cropping	No Till & Organic Inputs	No Till & Improved Cropping & Organic Inputs	Minimum Tillage	Minimum Tillage & Improved Cropping	Minimum Tillage & Improved Cropping & Organic Inputs	Improved Cropping	Improved Cropping & Organic Inputs	Organic Inputs	No Adopted Practices within Main Categories *(conservative 100% adoption rate assumed)*
Gauteng	0.19%	0.02%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
KZN	0.12%	0.00%	0.00%	0.01%	0.00%	0.12%	0.01%	0.40%	0.01%	0.08%	1.67%
North West	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.03%	0.01%	0.14%	0.59%
Mpumalanga	0.44%	0.08%	0.00%	0.00%	0.28%	0.08%	0.00%	0.46%	0.01%	0.13%	2.21%
Free State	0.05%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.50%
Total	0.81%	0.10%	0.06%	0.01%	0.33%	0.19%	0.01%	0.90%	0.02%	0.35%	4.97%
Project Total	7.73%										

The overall weighted average adoption rate is **7.73%** which is below the allowed maximum of 20%. Please refer to the Additionality Report in the Appendices section supporting evidence, for further information regarding the literature, references, workings and overall description of the adoption rates and project specific activities. This effective weighted average adoption rate will further decrease as the adoption of project activities is continually expanded across our project area while non-project areas are not adopting such practices.

3.6 Methodology Deviations

This section briefly outlines and summarizes Orizon's methodology deviation for the emission calculations from livestock, primarily methane emissions. The current VM0042 guidance on livestock emission calculations does not take a time-factor into account for enteric emissions and methane emissions from manure deposition. Our methodology deviation simply re-instates the VM0042 V1.0 component of these calculations which ensures that livestock emissions are only accounted for when grazing on registered fields.

Any methodology deviation must adhere to the requirements of section 3.20 of v4.7 of the VCS Standard. We believe the deviation meets the standard's requirement of 3.20.1 as it does represent a deviation from the criteria and procedures relating to measurement of methane emissions from livestock as set out in methodology VM0042 v2.0. It also fulfils the requirement of 3.20.2 as it is a more accurate calculation of the methane emissions based on project activities and does not impact the conservativeness of the quantification of reductions or removals. It is, in fact, often more conservative as many of our farmers increase their grazing days without increasing the number of livestock. Under the current VM0042 calculations this would not result in an increase in methane emissions despite the increased time spent on these project fields. Our methodology deviation ensures that this would result in increased emissions and that the true impact of the project activities on livestock carrying capacity is measured. Finally, this methodology deviation has been included in the Validation & Verification report by the VVB for this monitoring period and will be reported on at each future verification, which fulfils the final requirement in section 3.20.3 of the VCS Standard v4.7.

The primary reason for this deviation is that there are non-project field dynamics which influence the livestock grazing data and that livestock are often only placed on project fields for short durations (weeks) in a season. Furthermore, most of our farmers are not increasing their livestock numbers significantly but rather are increasing the durations spent on the fields. Basing the emission estimations on annual figures without a day-based pro-rata adjustment would under-estimate these additional emissions arising from the increased livestock carrying capacity of the project fields due to project activities. The methodology deviation therefore maintains project conservatism.

Importantly, the deviation is applied to the baseline and project scenarios alike.

The methodology deviation follows the below structure:

- Firstly, each livestock group is defined and assessed independently (i.e., for the same farmer / project instance, the methodology deviation might apply to one livestock group but not another).
- The following applicability conditions are assessed to determine the most appropriate calculation of livestock emissions:

  - The % area of the entire farming operation represented by croplands, is less than 50%. This would indicate that the grassland component is the more material farming component and livestock dynamics are driven primarily from changes in grassland management and not cropland activities; or
  - Where the livestock group is only held for a portion of the year on the entire farming operations (i.e., project and non-project fields). In other words, the livestock are not in the control of the farmer participating in our project for the entire duration of the year / season (e.g., backgrounding of livestock for a portion of the year); or
  - Where the % area of the entire farming operation represented by croplands, is more than 50%, but the additional available biomass (or additional carrying capacity) from both grassland and cropland would have supported the increase in livestock numbers had baseline activities continued. In other words, the baseline activities were not a limiting factor to increasing livestock numbers. This is proven by determining the average carrying capacity in the area from available maps and comparing the remaining ungrazed residues in the baseline scenario against the additional feed requirements from the increased number of livestock.
- When one of the above-mentioned applicability conditions are met, we apply an amended livestock emissions calculation for methane only (for both enteric fermentation and manure deposition) by re-introducing a component to account for the days / fraction of a year for which the livestock spend their time on project fields (like V1 of VM0042). See Section 3.5 of the Methodology Deviation report for more details.
- Nitrous Oxide emissions remain as per the methodology as these equations already consider the number of grazing days with the parameter $MS_{bsl,l,i,t}$. This parameter is an annual fraction based on using the number of grazing days and converted to a percentage. Assuming all manure deposited is deposited on the project field for the entire year would result in a value of 1 being applied.
- Where the above conditions are not met, the latest calculations will be used as indicated by v2.0 of VM0042. This will include the methane emissions from the livestock for the full year even when the livestock only spend a fraction of their time on the qualifying project fields. This will be the case where livestock dynamics are predominantly resulting from changes in management on cropland fields which are included in the project.
- Finally, because of the livestock displacement leakage adjustment, this methodology deviation does not allow for any gain in carbon credits (VCUs issued) for a change in livestock numbers or grazing days by a project instance. Instead, the deviation aims to reflect the actual impact more closely on emissions from project activities from adjustments in grazing days. This is explained in more detail in the Methodology Deviation Report.

To provide further detail and better explain the necessity for this deviation we have provided an example of why this deviation is more accurate and ensures conservatism. Example: A farmer has

100 cattle on his farm all year round. He grazes them across the entire farm (i.e., grasslands away from the cultivated fields), and puts them onto maize residues after harvest for 30 days every year. Business is going well, and he buys another farm with another 100 head of cattle included on the newly purchased farm. The new farm consists of only grasslands (no croplands), meaning no additional registered project fields. He now puts all 200 head of cattle on the project fields for 15 days. The same quantity of residues are consumed on project fields as cattle are doubled but days are halved (i.e. the same effective grazing days). However, based on the new calculations in v2.0 of VM0042, the project scenario would include the emissions of 200 cattle for a full year and the project is rendered unfeasible. The issue is that there is no net change in the number of cattle in the area (the farm purchased already included these 100 cattle) and therefore no change in the emissions as the farmer has merely expanded his operation successfully by purchasing a neighboring farm. These external factors would unfairly compromise the carbon project. Our methodology deviation ensures that where it is evidenced that the increase in livestock numbers is not due to project activities or any factors relating to the project area, only the portion of the methane emissions for the time spent on the project fields is accounted for (in both the project and baseline) and it is therefore comparable.

All livestock emissions in the project currently meet the applicability conditions of the methodology deviation to calculate these emissions based only on the number of grazing days on the project fields. The result of the adjustment to grazing days increased project emissions as grazing days increased, but it increased fairness across project participants.

Please refer to the detailed Methodology Deviation Report in the Appendices section providing background regarding the definition and requirements of a methodology deviation as well as the changes made from v1.0 to v2.0 of methodology VM0042 with respect to methane emissions from enteric fermentation and manure deposition. Furthermore, we provide reasons for the necessity of the methodology deviation, specific examples from our project for which the calculation of these emissions unfairly results in a negative impact on the project instance, and we also provide different literature sources that support our reasoning and arguments for the methodology deviation. This document provides a detailed description of the methodology deviation including all relevant calculations and equations pertaining to the deviation.

4 IMPLEMENTATION STATUS

4.1 Implementation Status of the Project Activity

Since the project start date on 1 August 2018 several project activities have been implemented across 22 project instances across five provinces. At the end of the 2021/2022 monitoring period a total of 15,547 qualifying hectares had been included in the project across 905 fields. These activities contribute to the reduction and/or removal of GHG emissions in the project mainly by building up SOC in the soil but also through long-term reductions in CO_2, CH_4 and N_2O emissions through more sustainable practices.

The activity changes in the first monitoring period were:

1. Reduced tillage: This activity was implemented either as minimum tillage or no-till and a total of 40.9% of project hectares registered this regime change. As detailed in section 3.5, this category is further divided into two sub-categories, namely no till and minimum tillage.
2. Cover cropping: This activity is currently primarily carried out in the off-season (winter months) in the project area. There are however also some instances planting summer cover crops in the project area. Overall, 41.1% of project hectares recorded increased cover crops being planted in the off-season.
3. Organic inputs as improved fertilizer usage: This activity shifts farmers away from a heavy reliance on synthetic fertilizers and is the third most predominant practice in the project. Historically farmers in South Africa used animal manure much more readily than is the norm nowadays, largely due to a shift to synthetic fertilizers. In the project, amongst the initial instances, the adoption of this practice change was at 15.8% of project hectares.
4. Livestock improvements: 12.6% of hectares changed their livestock grazing days significantly. While there was a 18.0% increase in hectares migrated towards high-density rotational grazing practices.

For further information regarding leakage and the monitoring of this aspect for the project please refer to Section 1.18, 5.3, 6.3 and 7.3. Whilst we are monitoring leakage in the project area, it is unlikely to be of a material impact to the overall GHG emission quantifications. However, livestock displacement, monitoring of events where new organic amendments are used from outside the project area and a productivity analysis are all carried out as part of the leakage assessment analysis for this project. This will be an important and ongoing aspect of the project.

Monitoring non-permanence risks for this project is an important priority for Orizon as part of a multi-faceted approach to making this project successful for our farmers. The initial eligibility and viability check before a farmer signs the contractual agreement with Orizon are rigorous and the exclusion of many farmers with identified risks have already assisted in preventing loss events for two instances. These instances are not part of the project because of the pre-project risk analysis performed. Risks that are identified are mitigated as best possible with the help of the expertise in the team and our partners in the larger agricultural community. Overall, the project’s non-permanence risk stands at 15. This risk profile can change over time and with a detailed monitoring plan with several internal checks and an adaptive management strategy the aim is to ensure that any risks are mitigated or prevented as best possible.

Monitoring of project activities:

Monitoring of project activities was based on continuous farm visits, a rigorous soil sampling campaign, data collection from farmers throughout and subsequent to the monitoring periods, as well as supplemental satellite monitoring. The data gathering procedures can broadly be categorized into the following:

- **Farm record data collection** – Farm records were obtained for the majority of field events across the baseline and project periods. Refer to Section 3.4 for the description of the level of data obtained and hierarchy of data quality collected for the baseline. This strategy was also applicable to the project monitoring periods (i.e. the same level of quality data and data collection approaches were followed for the baseline and project periods). Refer also to Section 6.3.3 and 6.3.5 for more details.

- **Site visits & farmer interviews** – Annually, Orizon representatives along with some partner organizations perform at least 3-4 visits to each project participant. Data is collected on such visits and a general understanding is obtained around the practices implemented for that year. Challenges towards adopting project activities are assessed and solutions discussed with farmers.

- **Sampling campaign** – Sampling teams collect data on each sampling point visited (e.g. presence of soil cover residues, tillage status, crop type planted, etc.). This data is cross-referenced with management records for current and future monitoring periods. Refer to Section 6.3.4 for more details on the soil sampling campaign.

- **Satellite monitoring** – As a supplemental monitoring practice, cover crop presence, crop species, planting/harvesting timeframes, tillage status, etc. are reviewed by Orizon representatives for each farmer.

More details of the monitoring activities are provided in Section 6 of this document. A total of 31,082 events were recorded on Orizon's Data Collection Platform across the monitoring period. This includes 3,016 planting events; 3,030 harvesting events; 4,436 synthetic fertilizer application events; 230 organic input application events; 1,349 liming events; 12,535 spraying events; 1,233 cover crop planting events; 3,858 grazing events and 1,662 tillage events.

5 QUANTIFICATION OF ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

To ensure a consistent format throughout this document, the equation numbers, parameters, and descriptions are taken directly from the methodology. This section provides an overview of the relevant equations, justifications for choosing the relevant emission factors, default values and methodological choices for the estimation of the baseline emissions. The equations will be provided in detail with short descriptions of their use in the project for estimation of the baseline emissions.

Quantification Approach 1: using the RothC model in this project.

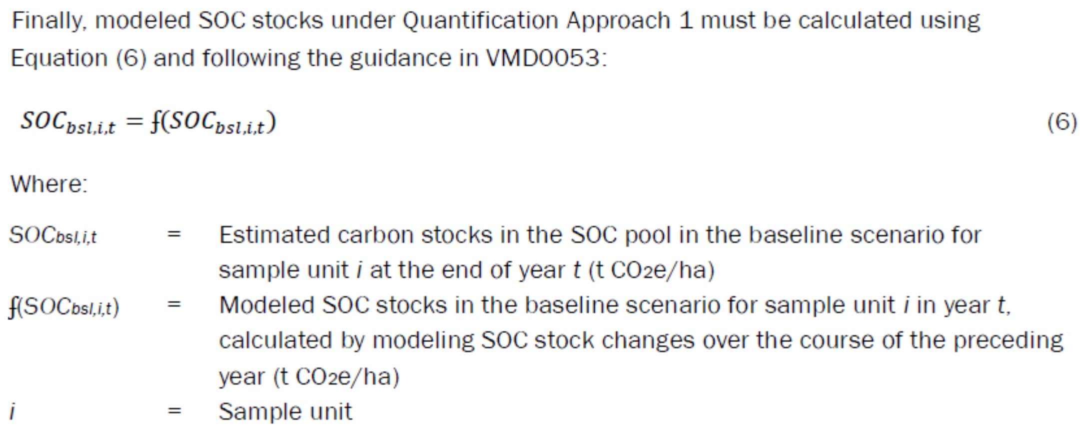
The baseline is modelled for each sample unit. The model serves to project future stock change/emissions resulting from the schedule of ALM activities taking place in the baseline scenario (derived in Section 6 of VM0042). Further guidance on biophysical model inputs is elaborated on in Table 6 in VM0042. More details regarding this process are provided in the model validation report.

Quantification Approach 3

The baseline is calculated for each field using the equations provided. Emissions resulting from the schedule of ALM activities taking place in the baseline scenario (derived in Section 6 in VM0042) are estimated using default emission factors and data are determined for each sample field at validation.

5.1.1 SOC stocks in the baseline

Baseline emissions for SOC are quantified using the RothC model following Quantification Approach 1 by following Equation 6.



Finally, modeled SOC stocks under Quantification Approach 1 must be calculated using Equation (6) and following the guidance in VMD0053:

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

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

The RothC model was used for the modelling component of this project to determine SOC stocks in the baseline and project scenarios. Due to the complexity of the model, it is not possible to provide a snapshot of values for the purposes of replicating a calculation. The model validation report provides a detailed description of the model, parameters used, project implementation and the outputs.

In quantifying the SOC stock changes, the methodology-provided back-modelling approach was used as samples were taken subsequent to the project start date. All samples were taken within +-5 years after the project start date, and back-modelled to t=0 ensuring that both the baseline and project tSOC are equal at the project start date. All samples were taken during 2023.

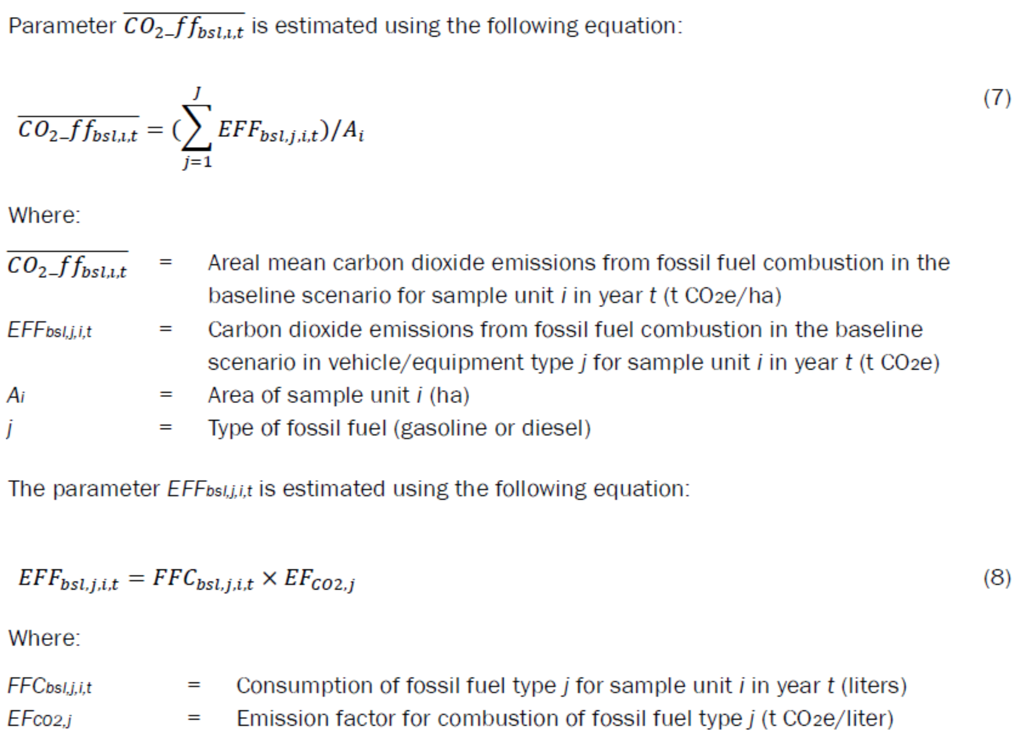
The back-modelling was a two-step process. The first step entailed running the model to equilibrium, while the second step used the equilibrium carbon pool sizes to initialise the calibrated model with the aim of matching the observed/sampled tSOC of the field at the sampling date. Since the implemented model's parameters and variables were known, the resulted SOC dynamics could be modelled from the project start date. This allowed Orizon to iterate this two-step approach, whereby the equilibrium SOC stocks were adjusted, by amending the C-input value used in the spin-up period, until the modelled SOC stock matched the field SOC stock at the date of sampling for the recorded management conditions. The point at which the equilibrium run ended was the starting point for the project and baseline scenarios. These scenarios then diverged based on the model parameter values and variables of each scenario. Baseline and project values were consistent at t=0 before diverging subsequent to this based on implemented project activities.

Analysis was performed on any outliers in the SOC modelling on the project and baseline scenarios. This analysis is described in more detail in Section 7.5.6.

5.1.2 Change in Carbon Stocks in Aboveground and Belowground Woody Biomass

Although this carbon pool is included in the project boundary, there are no events in the first monitoring period that triggered an emission calculation requirement for this pool. It is included in the PDMR for the purpose of future project instances where this calculation may be necessary. There will therefore be no example equation in section 7 relevant to this pool.

5.1.3 Estimated Fossil Fuel emissions in the baseline.



Parameter $\overline{CO_2\_ff_{bsl,i,t}}$ is estimated using the following equation:

$$\overline{CO_2\_ff_{bsl,i,t}} = (\sum_{j=1}^{J} EFF_{bsl,j,i,t})/A_i \tag{7}$$

Where:

$\overline{CO_2\_ff_{bsl,i,t}}$ = Areal mean carbon dioxide emissions from fossil fuel combustion in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$EFF_{bsl,j,i,t}$ = Carbon dioxide emissions from fossil fuel combustion in the baseline scenario in vehicle/equipment type *j* for sample unit *i* in year *t* (t CO_2e)

A_i = Area of sample unit *i* (ha)

j = Type of fossil fuel (gasoline or diesel)

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

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

Where:

$FFC_{bsl,j,i,t}$ = Consumption of fossil fuel type *j* for sample unit *i* in year *t* (liters)

$EF_{CO2,j}$ = Emission factor for combustion of fossil fuel type *j* (t CO_2e/liter)

The emission factor was sourced from the values provided in the methodology based on Table 3.3.1 Chapter 3 Volume 2 in IPCC (2019). Consumption for the different implements was calculated using average values adapted from the Department of Agriculture, Forestry and Fisheries Machinery Costs handbook that provides a detailed overview of fuel consumption, costs and other information for various implements and activity types.

5.1.4 Carbon Dioxide Emissions from Liming

Parameter $\overline{CO2\_lime_{bsl,i,t}}$ is estimated using the following equation:

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

Where:

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

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

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

Where:

$M_{Limestone,bsl,i}$ = Amount of calcitic limestone ($CaCO_3$) applied to sample unit *i* in year *t* (tonnes)

$EF_{Limestone}$ = Emission factor for calcitic limestone (0.12) (t C per t of limestone)

$M_{Dolomite,bsl,i}$ = Amount of dolomite ($CaMg(CO_3)_2$) applied to sample unit *i* in year *t* (tonnes)

$EF_{Dolomite}$ = Emission factor for dolomite (0.13) (t C per t of dolomite)

44/12 = Molar mass ratio of CO_2 to C applied to convert CO_2-C emissions to CO_2 emissions

The default values for the emission factors for limestone and dolomite were sourced from Section 11.3, Chapter 11, Volume 4 in IPCC (2019). Our farmers provided the type of liming application and the application rate (kg/ha) in their field records data. For liming applications with different percentage make ups of dolomite and limestone we calculated a weighted emission factor based on this percentage make-up of the product. The full list is available in the QA3 Emission Calculations document.

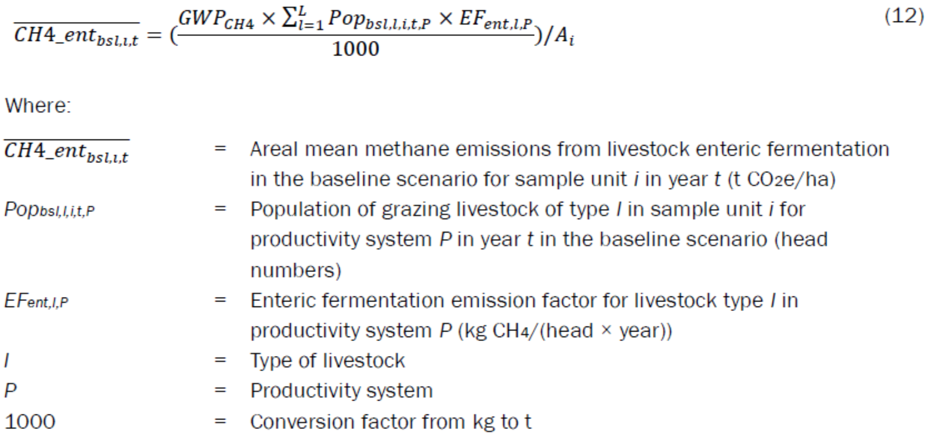
5.1.5 Methane Emissions from Livestock Enteric Fermentation

Due to the context of livestock in the project area, Orizon has applied a methodology deviation specifically aimed at the methane emissions from livestock. See section 3.6 for more details. For project instances where the methodology deviation applies, the following equation is used:

Equation 12 (as per deviation):

$$CH_{4\_ent,bsl,i,t} = \frac{GWP_{CH_4} \times \sum(Pop_{bsl,l,I,t,P} \times Days_{bsl,l,I,t,P} \times EF_{ent,I,P})}{1000 \times A_i}$$

For project instances where the methodology deviation is not applicable, the equations as per V2.0 of VM0042 have been applied:



$$\overline{CH4\_ent_{bsl,i,t}} = (\frac{GWP_{CH4} \times \sum_{l=1}^{L} Pop_{bsl,l,i,t,P} \times EF_{ent,l,P}}{1000})/A_i \quad (12)$$

Where:

$\overline{CH4\_ent_{bsl,i,t}}$ = Areal mean methane emissions from livestock enteric fermentation in the baseline scenario for sample unit *i* in year *t* (t CO_2e/ha)

$Pop_{bsl,l,i,t,P}$ = Population of grazing livestock of type *l* in sample unit *i* for productivity system *P* in year *t* in the baseline scenario (head numbers)

$EF_{ent,l,P}$ = Enteric fermentation emission factor for livestock type *l* in productivity system *P* (kg CH_4/(head × year))

l = Type of livestock

P = Productivity system

1000 = Conversion factor from kg to t

Population figures and the number of grazing days spent on the project fields were provided by our farmers in their field records data submissions. In this data there was also the requirement to provide the number of mature and young animals and their relative frame sizes for the purposes of determining average weight (applicable to manure deposition calculations below). The enteric fermentation emission factor values for different livestock types that were used followed the Tier 1 approach. This is because the livestock in this project are not intensively managed. Daily matter intake and other variables required to follow the Tier 2 approach are not possible due to the lack of required activity data for that level of approach. This is consistent for all default values for livestock in this project. This meant using the mean values from Tables 10.10 and 10.11 (Chapter 10, Volume 4 in IPCC, 2019), The values applicable to the region of Africa for Dairy Cattle and Other Cattle were used.

5.1.6 Methane Emissions from Manure Deposition

As with enteric fermentation, there is a methodology deviation applied to the calculation of quantifying the CH_4 emissions from manure deposition in the project area. Unlike enteric fermentation, there is no exclusion criteria. Applicability conditions, when met, result in the calculation also being done based on the number of grazing days on the project fields only as follows:

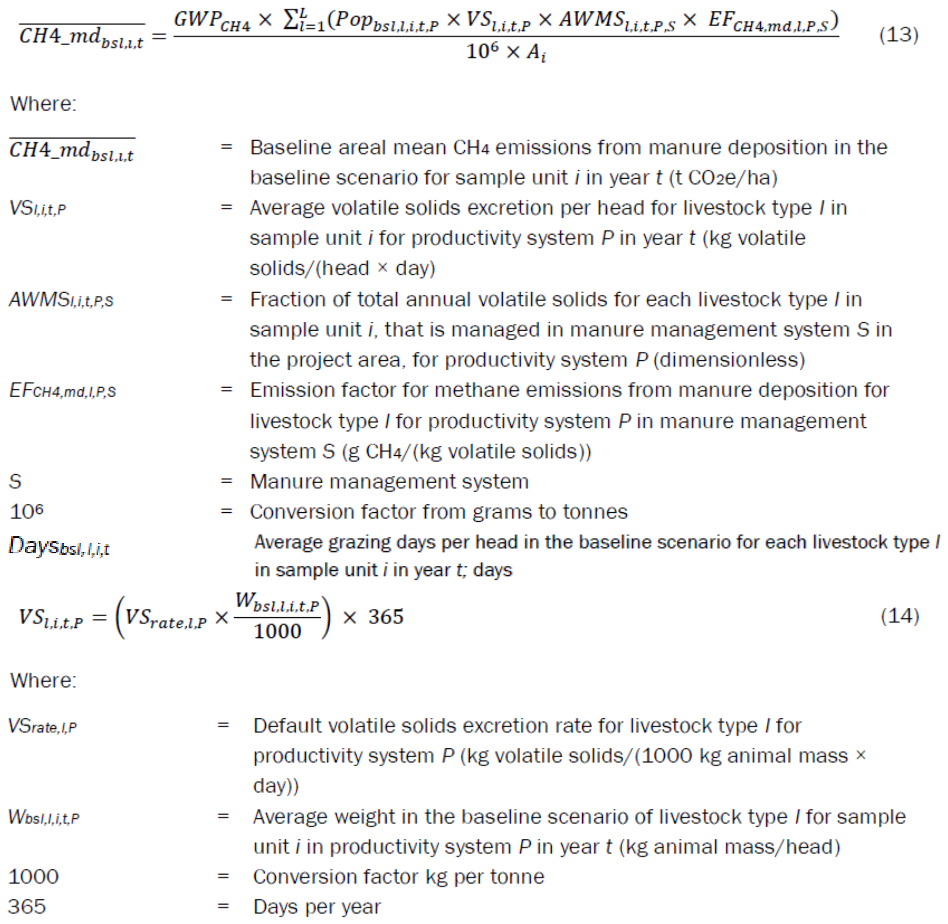
Equation 13 (as per the deviation):

$$CH_{4\_mdbsl,i,t} = GWP_{CH_4} \times \frac{\sum(Pop_{bsl,I,i,t,P} \times VS_{l,i,t,P} \times Days_{bsl,l,I,t,P} \times AWMS_{l,I,t,P,S} \times EF_{CH_4,md,l,P,S})}{10^6 \times A_i}$$

Equation 14 (as per the deviation):

$$VS_{l,I,t,P} = VS_{rate,l} \times \frac{W_{bsl,I,i,t}}{1000}$$

Where the applicability conditions are not met, the emissions are calculated as per the equations in V2.0 of VM0042.



$$\overline{CH4\_md_{bsl,\iota,t}} = \frac{GWP_{CH4} \times \sum_{l=1}^{L}(Pop_{bsl,l,i,t,P} \times VS_{l,i,t,P} \times AWMS_{l,i,t,P,S} \times EF_{CH4,md,l,P,S})}{10^6 \times A_i} \tag{13}$$

Where:

$\overline{CH4\_md_{bsl,\iota,t}}$ = Baseline areal mean CH4 emissions from manure deposition in the baseline scenario for sample unit *i* in year *t* (t CO2e/ha)

$VS_{l,i,t,P}$ = Average volatile solids excretion per head for livestock type *l* in sample unit *i* for productivity system *P* in year *t* (kg volatile solids/(head × day)

$AWMS_{l,i,t,P,S}$ = Fraction of total annual volatile solids for each livestock type *l* in sample unit *i*, that is managed in manure management system S in the project area, for productivity system *P* (dimensionless)

$EF_{CH4,md,l,P,S}$ = Emission factor for methane emissions from manure deposition for livestock type *l* for productivity system *P* in manure management system S (g CH4/(kg volatile solids))

S = Manure management system

10^6 = Conversion factor from grams to tonnes

$Days_{bsl,l,i,t}$ Average grazing days per head in the baseline scenario for each livestock type *l* in sample unit *i* in year *t;* days

$$VS_{l,i,t,P} = \left(VS_{rate,l,P} \times \frac{W_{bsl,l,i,t,P}}{1000}\right) \times 365 \tag{14}$$

Where:

$VS_{rate,l,P}$ = Default volatile solids excretion rate for livestock type *l* for productivity system *P* (kg volatile solids/(1000 kg animal mass × day))

$W_{bsl,l,i,t,P}$ = Average weight in the baseline scenario of livestock type *l* for sample unit *i* in productivity system *P* in year *t* (kg animal mass/head)

1000 = Conversion factor kg per tonne

365 = Days per year

Default values from IPCC Volume 4 Chapter 10 were applied for $VSrate_{l,P}$, $EF_{CH4,md,l,P,S}$ and $AWMS_{l,I,t,P,S.}$ following the Tier 1 approach. The emission factor for this specific calculation is sourced from Table 10.14 in Volume 4 Chapter 10 IPCC 2019. As the livestock currently in the project are all pasture/range/paddock the value of 0.6 is applied as per this table for this calculation regardless of productivity system. VSrate is sourced from Table 10.19 Volume 4 Chapter 10 IPCC 2019.

For the default value AWMS we applied a value of 1.0 throughout as the waste management system is the same throughout the project area for the livestock types and not separated into different categories as is the case in the values provided in Table 10a.6 through 10a.9 in Volume 4 Chapter 10 IPCC 2019 where this value is sourced from. In other words, the tables show that in in sub-Saharan Africa the value for Pasture/Range/Paddock Non-Dairy Cattle is 50% or a factor of 0.5. Our reasoning is that all the Non-Dairy Cattle found in the project area are Pasture/Range/Paddock and therefore a value of 1.0 is applied.

5.1.7 Methane Emissions from Biomass Burning

$$\overline{CH4\_bb_{bsl,i,t}} = \left(\frac{GWP_{CH4} \times \sum_{c=1}^{C} MB_{bsl,c,i,t} \times CF_c \times EF_{c,CH4}}{10^6}\right)/A_i \qquad (15)$$

Where:

$\overline{CH4\_bb_{bsl,i,t}}$ = Methane emissions in the baseline scenario from biomass burning for sample unit *i* in year *t* (t CO_2e/ha)

$MB_{bsl,c,i,t}$ = Mass of agricultural residues of type c burned in the baseline scenario for sample unit *i* in year *t* (kg)

CF_c = Combustion factor for agricultural residue type c (proportion of pre-fire fuel biomass consumed)

$EF_{c,CH4}$ = Methane emission factor for the burning of agricultural residue type c (g CH_4/kg dry matter burnt)

c = Type of agricultural residue

10^6 = Conversion fractor from grams to tonnes

This carbon source is included in the project boundary, however there were no events in the first monitoring period or in the historic look-back period of biomass burning. This calculation will therefore be done for future instances where biomass has been burnt, either planned or unplanned. As there are no events that used this calculation in the current monitoring period, it will also not appear in section 7.

5.1.8 Nitrous Oxide Emissions from Nitrogen Fertilizers and Nitrogen-Fixing Species

Quantification Approach 3

Nitrous oxide emissions due to nitrogen inputs to soils in the baseline scenario are estimated by applying Equation (17).

$$N2O\_soil_{bsl,i,t} = N2O\_fert_{bsl,i,t} + N2O\_md_{bsl,i,t} + N2O\_Nfix_{bsl,i,t} \tag{17}$$

Where:

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

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

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

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

Where nitrous oxide emissions due to fertilizer use are included in the project boundary per Table 3, they are quantified in the baseline scenario using Equations (18)–(24).

$$N2O\_fert_{bsl,i,t} = N2O\_fert_{bsl,direct,i,t} + N2O\_fert_{bsl,indirect,i,t} \tag{18}$$

Where:

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

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

Direct nitrous oxide emissions due to fertilizer use in the baseline scenario are quantified in Equations (19)–(21).

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

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

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

Where:

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

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

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

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

$M_{bsl,SF,i,t}$ = Mass of N-containing synthetic fertilizer type *SF* applied to sample unit *i* in year *t* in the baseline scenario (t fertilizer)

NC_{SF} = N content of synthetic fertilizer type *SF* (t N/t fertilizer)

$M_{bsl,OF,i,t}$ = Mass of N-containing organic fertilizer type *OF* applied to sample unit *i* in year *t* in the baseline scenario (t fertilizer)

NC_{OF} = N content of organic fertilizer type *OF* (t N/t fertilizer)

SF = Synthetic N fertilizer type

OF = Organic N fertilizer type

44/28 = Molar mass ratio of N_2O to N applied to convert N_2O-N emissions to N_2O emissions

Indirect nitrous oxide emissions due to fertilizer use in the baseline scenario are quantified in Equations (22)–(24).

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

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

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

Where:

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

$N2O\_fert_{bsl,volat,i,t}$ = Indirect nitrous oxide emissions produced from atmospheric deposition of N volatilized due to fertilizer use in the baseline scenario in sample unit *i* in year *t* (t CO_2e)

$N2O\_fert_{bsl,leach,i,t}$ = Indirect nitrous oxide emissions produced from leaching and runoff of N, in regions where leaching and runoff occurs, due to fertilizer use in the baseline scenario in sample unit *i* in year *t* (t CO_2e)

$Frac_{GASF,l,S}$ = Fraction of all synthetic N added to soils that volatilizes as NH_3 and NO_x for manure management system S and livestock type *l* (dimensionless)

$Frac_{GASM,l,S}$ = Fraction of all organic N added to soils and N in manure and urine deposited on soils that volatilizes as NH_3 and NO_x for manure management system S and livestock type *l* (dimensionless)

EF_{Nvolat} = Emission factor for nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces (t N_2O-N/(t NH_3-N + NO_x-N volatilized))

$Frac_{LEACH,l,S}$ = Fraction of N (synthetic or organic) added to soils and in manure and urine deposited on soils that is lost through leaching and runoff, in regions where leaching and runoff occurs, for manure management system S and livestock type *l* (dimensionless)

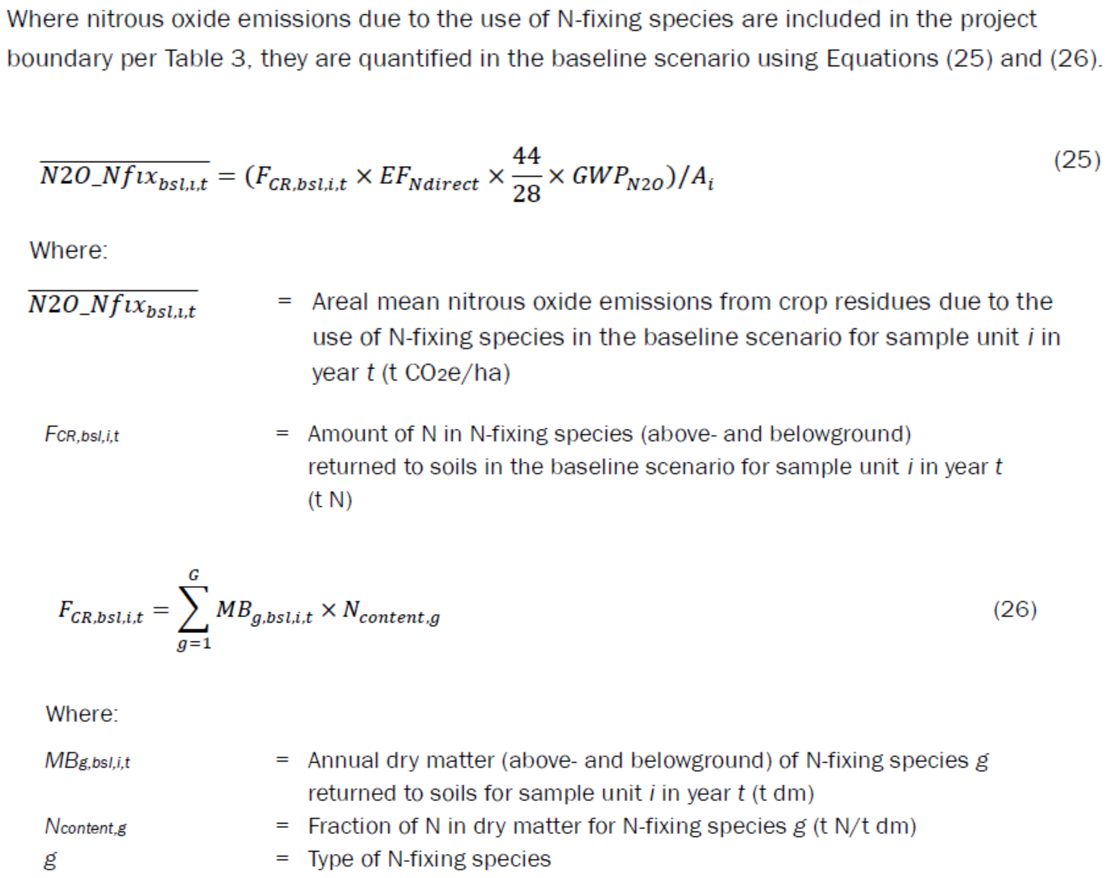
EF_{Nleach} = Emission factor for nitrous oxide emissions from leaching and runoff (t N_2O-N/t N leached and runoff)

For fertilizer emission calculations there are several default values used in the equations. $Frac_{GASF}$ is sourced from Table 11.3 IPCC (2019). For our calculations the disaggregated values were used as one can assign the various synthetic fertilizers to each of these IPCC categories. $Frac_{GASM}$ is sourced from Table 11.3 IPCC (2019). In Table 10.21 IPCC 2019, the source table for the emission factor for nitrous oxide emissions according to the methodology it states the following for pasture/range/paddock systems "Direct and indirect N_2O emissions associated with the manure deposited on agricultural soils and pasture, range, paddock systems are treated in Chapter 11, Section 11.2, N_2O emissions from managed soils." For this reason, we applied the default value of 0.21 from Table 11.3 to $Frac_{GASM}$. Other default values sourced from Table 11.3 are $Frac_{LEACH}$ with a value of 0 for dry climates and 0.24 for wet climates.

The emission factor for volatilization EF_{nvolat} is sourced from Table 11.3 as well and is disaggregated between wet climate with a value of 0.014 and dry climate with a value of 0.005. EF_{nleach} has a single value of 0.011 also from Table 11.3.

For direct emissions the emission factor is sourced from Table 11.1. $EF_{ndirect}$ is disaggregated with a value of 0.016 for synthetic fertilizer in a wet climate and 0.005 for all N inputs in dry climates including crop residues. Other N inputs other than synthetic fertilizer have a value of 0.006

applied if the instance is located on field considered a wet climate. Nitrogen content for organic fertilizers has been researched with numerous peer-reviewed papers sourced with values various organic amendments from compost to pig manure. For synthetic fertilizers our farmers provide the application rate, N% or if it is a ratio with P and K, the nutrient quantity, and the type of fertilizer. All these parameters, default values and emission factors are required to carry out the QA3 approach for quantifying the emissions from fertilizer applications in the project area.



Where nitrous oxide emissions due to the use of N-fixing species are included in the project boundary per Table 3, they are quantified in the baseline scenario using Equations (25) and (26).

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

Where:

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

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

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

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

For Nitrogen-fixing species Table 11.1a and Table 11.2 in Volume 4 Chapter 11 of IPCC 2019 are critical resources as especially for cover crops there is very little data available that allows for this calculation to be done. Table 11.1a is especially important in providing information regarding the nitrogen content of aboveground and belowground parts of the plants. Orizon has also developed a biomass tool that assists in determining the biomass for cover crops where the yield is unknown. This tool is used in determining the N_2O emissions from nitrogen-fixing species returned to the soils. $EF_{ndirect}$ for crop residues is sourced from Table 11.1 and a value of 0.005 is applied for a field in a dry climate and 0.006 for any fields in areas considered a wet climate. For cash crops such as soybeans the yield data is used to determine the mass of residues returned to the soil.

5.1.9 Nitrous Oxide Emissions from Manure Deposition

$$\overline{N2O\_md_{bsl,i,t}} = N2O\_md_{bsl,direct,i,t} + N2O\_md_{bsl,indirect,i,t} \quad (27)$$

Where:

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

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

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

Direct nitrous oxide emissions due to manure deposition in the baseline scenario are quantified using Equations (28) and (29).

$$\overline{N2O\_md_{bsl,direct,i,t,P,S}} = \frac{\sum_{l=1}^{L} F_{bsl,manure,l,i,t,P} \times EF_{N2O,md,l,S} \times 44/28 \times GWP_{N2O}}{1000 \ \times A_i} \quad (28)$$

$$F_{bsl,manure,l,i,t,P} = \left[\left(Pop_{bsl,l,i,t} \times Nex_{l,P}\right) \times \ AWMS_{l,i,t,P,S} \times MS_{bsl,l,i,t}\right] \quad (29)$$

Where:

$\overline{N2O\_md_{bsl,direct,i,t,P,S}}$ = Areal mean direct nitrous oxide emissions due to manure deposition in the baseline scenario for sample unit *i* for productivity system *P* and manure management system *S* in year *t* (t CO_2e/ha)

$F_{bsl,manure,l,i,t,P}$ = Amount of nitrogen in manure and urine deposited on soils by livestock type *l* for productivity system *P* in sample unit *i* in year *t* (kg N)

$Nex_{l,P}$ = Average annual nitrogen excretion per head of livestock type *l* for productivity system *P* (kg N deposited/(head × year))

$EF_{N2O,md,l,S}$ = Emission factor for nitrous oxide from manure and urine deposited on soils by livestock type *l* for manure management system *S* (kg N_2O-N/kg N input)

$MS_{bsl,l,i,t}$ = Baseline fraction of total annual N excretion for each livestock type *l* for sample unit *i* in year *t* that is deposited on the project area (%)

1000 = Conversion factor from kg to t

$MS_{bsl,l,l,t}$ is determined by the number of grazing days that the livestock spend on the field. AWMS, which has been explained in the methane emissions section, has a value of 1.0 assigned in the project area based on the current instances. $EF_{N2O,md,l,S}$ is sourced from Table 10.21 but based on the fact that for pasture/range/paddock livestock systems the IPCC recommends following Chapter 11, we have assigned the values from Table 11.1. $N_{exl,P}$ is sourced from Table 10.19

Volume 4 Chapter 10. Important consideration for these values is that they are per 1000 kg animal mass, and one needs data on the weight of the population to convert this value to the correct units for the purpose of the calculation.

Indirect nitrous oxide emissions due to manure deposition in the baseline scenario are quantified under Quantification Approach 3 using Equations (30)–(32).

$$\overline{N2O\_md_{bsl,indirect,i,t}} = (N2O\_md_{bsl,volat,i,t} + N2O\_md_{bsl,leach,i,t})/A_i \tag{30}$$

$$N2O\_md_{bsl,volat,i,t} = F_{bsl,manure,l,i,t,P} \times Frac_{GASM,l,S} \times EF_{Nvolat} \times \frac{44}{28} \times GWP_{N2O} \tag{31}$$

$$N2O\_md_{bsl,leach,i,t} = F_{bsl,manure,l,i,t,P} \times Frac_{LEACH,l,S} \times EF_{Nleach} \times \frac{44}{28} \times GWP_{N2O} \tag{32}$$

Where:

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

$N2O\_md_{bsl,volat,i,t}$ = Indirect nitrous oxide emissions produced from atmospheric deposition of N volatilized due to manure deposition for sample unit *i* in year *t* (t CO_2e)

$N2O\_md_{bsl,leach,i,t}$ = Indirect nitrous oxide emissions produced from leaching and runoff of N, in regions where leaching and runoff occurs, as a result of manure deposition for sample unit *i* in year *t*. Equal to zero where annual precipitation is less than potential evapotranspiration, unless irrigation is employed (t CO_2e)

For indirect N_2O emissions from manure deposition the default values $Frac_{GASM}$, EF_{nvolat}, $Frac_{LEACH}$, EF_{nleach} are the same as for fertilizer applications in the previous section.

5.1.10 Nitrous Oxide Emissions from Biomass Burning

Nitrous oxide emissions from biomass burning in the baseline scenario are quantified under Quantification Approach 3.

Parameter $\overline{N2O\_bb_{bsl,i,t}}$ is estimated using Equation (33).

$$\overline{N2O\_bb_{bsl,i,t}} = \left(\frac{GWP_{N2O} \times \sum_{c=1}^{C} MB_{bsl,c,i,t} \times CF_c \times EF_{c,N2O}}{10^6}\right)/A_i \tag{33}$$

Where:

$\overline{N2O\_bb_{bsl,i,t}}$ = Areal mean nitrous oxide emissions in the baseline scenario from biomass burning for sample unit *i* in year *t* (t CO_2e/ha)

$EF_{c,N2O}$ = Nitrous oxide emission factor for the burning of agricultural residue type c (g N_2O/kg dry matter burnt)

10^6 = Conversion factor from grams to tonnes

This carbon source is included in the project boundary, however there were no events in the first monitoring period or in the historic look-back period of biomass burning. This calculation will therefore be done for future instances where biomass has been burnt, either planned or unplanned. As there are no events that used this calculation in the current monitoring period, it will also not appear in section 7.

5.2 Project Emissions

Stock change/emissions in the SOC pool resulting from project scenario ALM activities are calculated or modelled based on monitored inputs. Project scenario CO_2, CH_4 and N_2O emissions must be quantified following the approaches found in Table 5 of VM0042 and using the equations provided in Section 8.2 of VM0042. For all equations, the subscript *bsl* must be substituted by *wp* to make it clear that the relevant values are being quantified for the project scenario. Further, as per Section 8.4.2 where livestock are included in the baseline, the project must use at a minimum the average livestock value from the historical look back period.

Quantification Approach 1

Model inputs must be collected following the guidance in Table 8 of VM0042.

Quantification Approach 3

Project emissions are calculated for each sample field using applicable default values and any monitored parameters. The most accurate available emission factor applicable to the project conditions must be used, in the following descending order of preference:

1) Where available, a project specific emission factor from a peer reviewed scientific publication must be used.

2) Where there is no relevant peer reviewed scientific literature, the project proponent may propose alternative sources of information (e.g., government databases, industry

publications) to establish the default factor(s) and must provide evidence that the alternative source of information is robust and credible (e.g., independent expert attestation).

3) Where no alternative information source is available that is applicable to the project conditions, projects may derive emission factors using activity data collected during the project by following the guidance to derive Tier 2 emission factors in the respective sections of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

4) Where projects justify a lack of sufficient activity data and project specific information sources, Tier 1 and Tier 1a emission factors from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories may be selected.

5.3 Leakage Emissions

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

The following equation is used for project instances where new manure, compost or biosolids are applied in the project that were not applied in the historical look back period. This due to the risk of activity shifting leakage.

The below equation estimates the leakage from imported manure, compost or biosolids that are diverted from other applications and could have led to an increase of SOC outside the project boundary in the absence of the project activity. While derived for manure, the equation is also conservatively applied to compost or biosolids in this methodology.

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

Where:

$LE_{OA,t}$ = Leakage from organic amendments in year *t* (t CO_2e)

$M\_OA_{wp,l,t}$ = Mass of organic amendment applied as fertilizer in the project area in year *t* (tonnes)

$CC_{wp,l,t}$ = Carbon content of organic amendment applied as fertilizer in the project area in year *t* (t C/t manure)

0.12 = Fraction of manure (i.e., organic amendment) carbon expected to remain in project area soils (unitless)

$\frac{44}{12}$ = Ratio of molecular weight of carbon dioxide to carbon

The above equation calculates the deduction that needs to be made to account for this type of leakage. In many instances the manure or compost applied in the project is produced on-site by the farmer. These are not considered for leakage.

For inputs purchased from external sources, the manure / compost was not previously used as a soil application and was in over-supply. Therefore, the remaining applications do not result in a leakage deduction. This has been evidenced in a separate organic inputs leakage assessment report.

The total possible leakage deduction should the above exception not have been met, would have been 895.1 tCO_2e.

5.3.2 Accounting for Leakage from Livestock Displacement

To avoid crediting emission reductions resulting from livestock displacement (i.e., lowering of CH_4 and N_2O emissions within the project area relative to the baseline by reducing the number of livestock within the project boundary), the number of livestock in the project scenario must not be lower than in the historic al look back period. W here livestock displacement occurs, CH_4 and N_2O emissions associated with livestock must continue to be counted in the project scenario (Sections 8.2.7 and 8.2.10) to account for potential emissions leakage.

Although some individual instances have decreased livestock grazing days, the aggregated project resulted in increased grazing days (increased by 16.25 days on average) and therefore increased livestock emissions.

Therefore, no livestock leakage deduction applies.

5.3.3 Leakage from Productivity Declines

Market leakage is likely to be negligible because the land remains in agricultural production in the project scenario. Further, producers are unlikely to implement and maintain ALM practices that result in productivity declines, since their livelihoods depend on crop harvests and/or livestock outputs as a source of income. Nevertheless, to ensure leakage is not occurring, the following steps must be completed every 10 years:

Step 1: Demonstrate that the productivity of each crop/livestock product has not declined by more than 5 percent in the project scenario by:

1) Comparing average with project productivity (excluding years with extreme weather events) during the project period to average baseline productivity during the historical look back period, by crop/livestock using Equation 35

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

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

Or

2) Comparing the ratio of average baseline productivity to average regional productivity during the historical look back period with the ratio of average with project productivity to average regional productivity during the project period by crop/livestock product, using Equation 36 and regional data from government (e.g., USDA Actual Production History (APH) data), industry, peer reviewed, academic, or international organization (e. FAO) sources.

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

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

New crop/livestock products introduced as part of the project (e.g., new crop in rotation, introduction of livestock) that are not present in the historical look back period should use regional data sources instead of project specific data sources to determine historical productivity of the crop/livestock product and set $P_{bsl,p}$ equal to $RP_{bsl,p}$

With-project productivity averages must be based on data collected in the previous 10 years. Productivity averages must not include data that are more than 10 years old. Where productivity has improved, stayed constant or declined by less than 5 percent for a crop/livestock product, no further action is needed. Where a reduction in productivity of greater than 5 percent is observed in one or more crop/livestock products, complete Step 2 for these products.

Step 2:

Determine whether the crop/livestock productivity decline was caused by a short-term productivity decrease by repeating the calculation in Step 1 excluding all data inputs from the first three years of project implementation. Where the with-project productivity of the crop/livestock product with the first three years removed is within 5 percent of the baseline productivity of the same crop/livestock product, no further action is needed. Where a reduction in productivity of greater than 5 percent is still observed in one or more crop/livestock products, complete Step 3 for these products.

Step 3: Determine whether the productivity decline is limited to a certain combination of factors by stratifying the analysis by:

1) Practice change category,
2) Practice change category combinations,
3) Crop type,
4) Soil type, and/or
5) Climatic zone.

Where the productivity decline is limited to a certain combination of factors, that combination becomes ineligible for future crediting. For example, where a 10 percent decline in corn yields was observed and stratification showed that the yield decline was linked to fertilizer rate reductions, rate reduction practices on corn fields would no longer be eligible for future crediting. Where the project proponent is unable to isolate the source(s) of leakage through stratification the entire crop/livestock product becomes ineligible for future crediting.

Using Equation 35 for the monitoring period 1 August 2018 – 31 July 2022 we have determined the following ΔP values for the main cash crop types prevalent in the project so far.

<u>Table 5.3.1 Productivity analysis of the different cash crops in the project area</u>

Cash Crop Type	Baseline Yield (t/ha)	Project Yield (t/ha)	ΔP (%)
Maize	7.12	7.81	9.69
Soybean	2.44	2.79	14.34

Sunflower	1.39	1.88	35.25
Wheat	4.64	4.62	-0.43

The analysis shows that for this monitoring period there are no reductions of >5% so far in the major cash crop types present in the project. This supports the statement that it is unlikely that there will be productivity declines in the project scenario. This statement is further supported by the fact that the IALM practices implemented in the project help improve soil health. Improved soil health is at the core of sustainable agriculture such as conservation and regenerative agriculture. Sustainable agriculture's focus point is to enhance productivity through the sustainable management of natural resources (Blignaut et al 2015). Degraded soil over time leads to a drop in productivity (Kooper 2020). IALM practices implemented in the project improve the water-holding capacity of the soil which helps in reducing the likelihood of productivity declines when compared to soils in conventional agriculture that have a lower water-holding capacity which results in compromises in yield, productivity and can impact food security of a region *(Thierfelder, C & Wall, P.C., 2009)*. These are some of the reasons that we do not expect productivity declines throughout the project.

The weighted average net increase in yield was 9.9%. However, some of this effect was due to seasonality due to two above-average seasons in the monitoring period. When removing the effects of this seasonality, the net increase in the weighted average yield across the four main cash crops was 3.5% when comparing the average project yields to the average baseline yields.

5.4 Estimated GHG Emission Reductions and Carbon Dioxide Removals

The below table shows emission reductions / removals with negative values representing reductions in emissions from the baseline to the project. Detailed example equations are shown in section 7.5. The below values are aggregated values which are split across the calendar years in equal proportions based on the months of each season included in each calendar year. The table is updated to reflect our new estimates for periods from 2022 onwards, while periods before 2022 represent actual figures.

Table 5.4.1: Estimated reductions and removals in the first crediting period.

Vintage period	Estimated baseline emissions (tCO_2e)	Estimated project emissions (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated uncertainty deductions (tCO_2e)	Estimated buffer pool allocation (tCO_2e)	Estimated reduction VCUs (tCO_2e)	Estimated removal VCUs – before buffer pool deduction (tCO_2e)	Estimated total VCU issuance – after buffer pool allocations (tCO_2e)
01-Aug-2018 to 31-Dec-2018)	5,593	(7,973)	0	2,204	2,302	148	(11,510)	9,061

01-Jan-2019 to 31-Dec-2019	13,134	(29,748)	0	6,895	7,203	28	(36,015)	28,784
01-Jan-2020 to 31-Dec-2020	13,593	(47,537)	0	9,796	10,234	(166)	(51,168)	41,100
01-Jan-2021 to 31-Dec-2021	16,019	(57,130)	0	11,812	12,340	363	(61,700)	48,998
01-Jan-2022 to 31-Dec-2022	21,412	(64,468)	0	13,913	13,954	709	(72,676)	58,013
01-Jan-2023 to 31-Dec-2023	32,118	(62,066)	0	15,305	15,175	1,064	(79,944)	63,705
01-Jan-2024 to 31-Dec-2024	42,008	(67,188)	0	17,512	18,295	(209)	(91,475)	73,389
01-Jan-2025 to 31-Dec-2025	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2026 to 31-Dec-2026	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2027 to 31-Dec-2027	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2028 to 31-Dec-2028	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2029 to 31-Dec-2029	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2030 to 31-Dec-2030	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2031 to 31-Dec-2031	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2032 to 31-Dec-2032	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2033 to 31-Dec-2033	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431

01-Jan-2034 to 31-Dec-2034	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2035 to 31-Dec-2035	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2036 to 31-Dec-2036	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2037 to 31-Dec-2037	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2038 to 31-Dec-2038	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2039 to 31-Dec-2039	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2040 to 31-Dec-2040	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2041 to 31-Dec-2041	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2042 to 31-Dec-2042	45,000	(78,104)	0	19,403	20,270	(2,350)	(101,351)	83,431
01-Jan-2043 to 31-Jul-2043	26,250	(45,561)	0	11,318	11,824	(1,371)	(59,121)	48,668
Total	**980,126**	**(1,787,541)**	**0**	**438,004**	**456,190**	**(41,734)**	**(2,287,929)**	**1,873,473**

6 MONITORING

6.1 Data and Parameters Available at Validation

The following section comprises tables showing the data and parameters at validation and that remain constant throughout the crediting period of the project.

The baseline is dynamic per field, based on the actual historic schedule of activities for each field in the look-back period, as suggested by Section 6 within VM0042 v2.0. Where data was provided in the below table, it should be noted that this data pertains to the per-field activities within this look-back period. As there are project instances which only joined the carbon project in the later seasons of the total monitoring period (e.g. 2020/21), there are baseline years for these fields which are during/after 2018/19. Therefore, trend analysis cannot be performed without context of the hectares included for the historic look-back schedule of activities assessment per season, as an increasing trend in the total lime applied may be due to increased hectares under assessment rather than actual increases per hectare. The following hectares provide context and represent the total hectares included in the baseline assessment period in the development of the schedule of activities:

	2014/ 15	2015/ 16	2016/ 17	2017/ 18	2018/ 19	2019/ 20	2020/ 21	2021/ 22
Hectares	4,292	9,732	9,833	11,477	2,072	2,046	328	-

Effectively, when viewing the below data tables, the trend must be viewed in context of these initially increasing hectares followed by a decrease. For example, livestock numbers in 2020/21 will be very low and no values will be shown for 2021/22. This correlates to the end of the baseline assessment period for those farmers with a 2021/22 project start date.

Due to the complexity of a grouped project and the detailed data we are collecting, it is in many cases impracticable to determine a single value per parameter. We have documented parameter tables and calculation logic within this report and more detailed info in separate reports accompanying this submission. We have also included (where possible) average / weighted average values per parameter below and broken them up into as much detail as possible.

Data / Parameter	*AR*
Data unit	Percent
Description	Weighted average adoption rate
Equations	(1)
Source of data	Calculated for the project across the group or all activity instances
Value applied	7.73%
Justification of choice of data or description of measurement methods and procedures applied	Calculated by using Equation 1 in VM0042. The regional adoption rates were based on available literature, as well as conservative (i.e., over-estimations) adoption rate estimates where literature values were not available on a provincial / regional / national level. For example, no cover crop data was available locally, so a signed attestation from a qualified independent local expert was used in conjunction with literature to ensure the experts estimates were conservative.
Purpose of Data	Common Practice Assessment (Additionality)

Comments	Note that grouped projects must include one or more sets of eligibility criteria for the inclusion of new project activity instances ensuring that new project activity instances have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area (see latest version of the VCS Standard).

Data / Parameter	EA_{ay}
Data unit	Percent
Description	Adoption rate of the y most common (by area covered) proposed project activity in the region
Equations	(1)
Source of data	Per province represented in the initial instances, 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. Where all the above sources are unavailable, a signed and dated attestation statement from a qualified independent local expert.
Value applied	For No Till: Gauteng 10.9% Kwa-Zulu Natal 12.5% North West 12.2% Mpumalanga 7.9% Free State 1.0% For Min Till: Gauteng 18.5% Kwa-Zulu Natal 21.3% North West 20.7% Mpumalanga 13.4% Free State 1.7% For Cover Cropping: Gauteng 7.9%

	Kwa-Zulu Natal 9.1% North West 8.9% Mpumalanga 5.8% Free State 0.7% For Organic Inputs: Gauteng 10.0% Kwa-Zulu Natal 10.0% North West 10.0% Mpumalanga 10.0% Free State 10.0%
Justification of choice of data or description of measurement methods and procedures applied	These values were calculated based on several different literature sources including peer-reviewed literature.
Purpose of Data	Common Practice Assessment (Additionality)
Comments	None

Data / Parameter	$Area_{ay}$
Data unit	Hectares
Description	Area of proposed project-level adoption of each activity
Equations	Equation 1
Source of data	Farm records and project activity commitments
Value applied	See Table 3.5.5 for the range of values for the different activities.
Justification of choice of data or description of measurement methods and procedures applied	The areas are based on the two (or more) most predominant project activities in the region. The areas of the fields have been reviewed by Orizon to ensure the area calculations are correct.
Purpose of Data	Common Practice Assessment (Additionality)
Comments	None

Data / Parameter	ay
Data unit	unitless
Description	Proposed project activity commitments $a1$ to ay, where $a1$ covers the largest area in the project region
Equations	(1)
Source of data	Documentation of activities (intended farm management change, for example target fertilizer application rate) to be implemented in the project for each sample unit
Value applied	$a1A$ = no tillage a1B = minimum tillage $a2$ = cover cropping $a3$ = organic inputs
Justification of choice of data or description of measurement methods and procedures applied	Based on field records provided by our farmers for the events and applications on each project field in each season.
Purpose of Data	Common practice assessment, basis for parameters $Area_{ay}$ and PA_{ay}
Comments	Appendix 1 lists the main categories of practices expected to enhance SOC stocks and/or reduce GHG emissions from soils under a broad range of cropping and livestock systems. This list is non-exhaustive. Note that grouped projects must include one or more sets of eligibility criteria for the inclusion of new project activity instances ensuring that new project activity instances have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area (see latest version of the VCS Standard).

Data / Parameter	$FFC_{bsl,j,i,t}$
Data unit	Liters
Description	Consumption of fossil fuel type j (gasoline or diesel) for sample unit i in year t in the baseline scenario

Equations

(8)

Source of data

Values are based on the various events recorded for each season for each field. There were c. 21,183 events across all participating fields in the baseline period.

Each event has its own consumption rate based on the type of event/implement, with values adapted from the Department of Agriculture, Forestry and Fisheries – Guide to machinery costs. For crop duster airplane fuel consumption, the sources include peer-reviewed literature and several other sources.

Department of Agriculture, Forestry and Fisheries (DAFF), October 2014, Guide to Machinery Costs, Pretoria, South Africa. Available at www.daff.gov.za/publications ISBN 978-1-86871-402-5

Value applied

Common Farming Fuel-related Activities

Activity	Fuel Consumption (l/ha)
Spray	1.94
Plant	2.56
Fertilizer/Lime spreading	6.89
Harvest	15.33

Common Tillage Activities

Tillage Type	Fuel Consumption (l/ha)
Mouldboard plough	16.16
Heavy disk (one-way or offset)	6.19
Chisel plough	6.66
Ripper plough	9.11
Light disc harrow	2.65

Other Fuel Consumption Activities

Activity	Fuel Consumption (l/ha)
Mowing	4.85
Raking	4.85
Baling	8.31

The average consumption (litres/ha) across our project area in the respective baseline reference years, repeated across the project period were as follows:

2018/19 season	2019/20 season	2020/21 season	2021/22 season
45.03	45.06	43.49	45.40

	The categories for our calculation currently include tillage activity, planting activity, spraying activity, and harvesting activity with associated values for each category based on the type of machinery used. Please see Section 8 Appendices – QA3 Emission Calculations report Table 8 for all applicable fuel usage per hectare values.
Justification of choice of data or description of measurement methods and procedures applied	Fossil fuel consumption can be monitored, or the amount of fossil fuel combusted can be estimated using fuel efficiency (for example l/100 km, l/t-km, l/hour) of the vehicle and the appropriate unit of use for the selected fuel efficiency (for example km driven if efficiency is given in l/100 km).
Purpose of Data	Calculation of baseline emissions
Comments	Peer-reviewed published data may be used to determine fuel efficiency.

<table>
<tr><td>Data / Parameter</td><td>$M_{Limestone,bsl,i,t}$ and $M_{Dolomite,bsl,i,t}$</td></tr>
<tr><td>Data unit</td><td>Tonnes/year</td></tr>
<tr><td>Description</td><td>Amount of calcitic limestone ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$) applied to sample unit <i>i</i> in year <i>t</i> in the baseline scenario</td></tr>
<tr><td>Equations</td><td>(10)</td></tr>
<tr><td>Source of data</td><td>Farmer field records, such as prescription maps, excel records or machine data.</td></tr>
<tr><td>Value applied</td><td>
<p>Amount of calcitic limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$) applied to sample unit <i>i</i> in year <i>t</i></p>
<p>There were a total of 1,022 liming events recorded in the various baseline look-back periods of all farmers across the years.</p>
<p>The total liming applications (mixes of gypsum, dolomite, calcitic and carrier sand) are detailed below, at an average of 0.93t/ha across the baseline period:</p>
<table>
<tr><th></th><th>2014/ 15</th><th>2015/ 16</th><th>2016/ 17</th><th>2017/ 18</th><th>2018/ 19</th><th>2019/ 20</th><th>2020/ 21</th><th>2021/ 22</th></tr>
<tr><td>Total t applied</td><td>3,856</td><td>11,638</td><td>10,526</td><td>8,618</td><td>1,002</td><td>982</td><td>293</td><td>-</td></tr>
</table>
<p>Calcic limestone ($CaCO_3$) applications (only including the calcitic portion of the product) are detailed below [$M_{Limestone,bsl,i,t}$], at an average of 0.66t/ha across the baseline period:</p>
<table>
<tr><th></th><th>2014/ 15</th><th>2015/ 16</th><th>2016/ 17</th><th>2017/ 18</th><th>2018/ 19</th><th>2019/ 20</th><th>2020/ 21</th><th>2021/ 22</th></tr>
</table>
</td></tr>
</table>

Total t applied	3,289	9,361	5,893	5,947	781	691	270	-

Dolomite ($CaMg(CO_3)_2$) applications (only including the calcitic portion of the product) are detailed below [$M_{Dolomite,bsl,i,t}$], at an average of 0.12t/ha across the baseline period:

	2014/ 15	2015/ 16	2016/ 17	2017/ 18	2018/ 19	2019/ 20	2020/ 21	2021/ 22
Total t applied	297	676	2,214	1,226	171	259	5.12	-

Justification of choice of data or description of measurement methods and procedures applied	All limestone and dolomite applied to soils should be included, even the proportion applied in mixture with fertilizers. Use of oxides (e.g., CaO) and hydroxides of lime for soil liming is not required to be included in the calculations to estimate CO_2 emissions from liming. Because these materials do not contain inorganic carbon, CO_2 is not released following soil application; it is only produced during material manufacture.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	$Pop_{bsl,l,i,t,P}$
Data unit	Head
Description	Population of grazing livestock of type *l* in the baseline scenario in sample unit *i* for productivity system *P* in year *t*
Equations	(12), (13), (29)
Source of data	Information provided by farmers in their field records.
Value applied	Variable, depends on specific data obtained from the farmer for each livestock event on the specific project field. For the initial project instances, there were 2,641 individually recorded livestock grazing events during the baseline look-back period for the establishment of the historic schedule of activities. These included mostly Beef Cattle, with some Dairy Cattle and Sheep. The average grazing days / ha across the baseline period was 96.87 days/ha (calculated as the effective average when converting all livestock units to an equivalent unit based on their relative daily intake).

	2014/15 season	2015/16 season	2016/17 season	2017/18 season	2018/19 season	2019/20 season	2020/21 season	2021/22 season
Beef Cattle	3,177	4,737	8,263	7,309	774	555	-	-
Dairy Cattle	-	-	-	199	273	273	273	-

Sheep	-	1,885	1,860	2,728	146	49	-	-

The above table shows the mature livestock populations across the baseline years. Note that the hectares assessed as baseline periods increase with time as the historic look-back period starts for the specific project instances as/when they are added to the project; or decrease as the baseline assessment period ends and the project period starts (i.e. The increase from 0 to 199 dairy cattle does not necessarily mean that new dairy cattle were introduced to the project area, but rather that the baseline assessment period for that dairy-owning farmer started in the 2017/18 season. Similarly, no livestock in 2021/22 does not mean that our project participants do not have livestock in that season, but that these are included in the project parameter $Pop_{wp,l,i,t,P}$).

The average $Pop_{bsl,l,i,t,P}$ per hectare across the baseline period was 0.624, 0.026 and 0.168 for Beef Cattle, Dairy Cattle and Sheep respectively.

Livestock populations for purposes of SOC modelling and emissions quantifications were further disaggregated by relative frame size and maturity (i.e. age). And other info, such as supplemental feed, whether they only spend a portion of the day on the project area, the grazing density, etc. was also collected per grazing event.

Justification of choice of data or description of measurement methods and procedures applied	The number of head of livestock in each year of the baseline period is provided by each farmer in the data that they submit.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e/t CH_4
Description	Global warming potential for CH_4
Equations	(11)-(13), (15)

Source of data	*IPCC Fifth Assessment Report* (IPCC, 2013)
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	The data source is determined by VM0042. VCS Standard v4.7, Section 3.15.4 requires that CH_4 must be 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. For GHG emission reductions occurring prior to 1 January 2021 CH_4 can be converted using the 100-year global warming potential derived from the IPCC Fourth Assessment Report or those derived from AR5 as per VCS Standard v4.7, Section 3.15.4.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	$Days_{bsl,l,i,t,P}$
Data unit	Days
Description	Average grazing days per head in the baseline scenario inside sample unit *i* for each livestock type *l* in productivity system *P* in year *t*
Equations	(12), (13), (29)
Source of data	Information provided by farmers in the farmer data field records.
Value applied	Variable depends on specific data obtained from the farmer for each livestock event on the specific project field. For the initial project instances, there were 2,641 individually recorded livestock grazing events during the baseline look-back period for the establishment of the historic schedule of activities. These included mostly Beef Cattle, with some Dairy Cattle and Sheep. The average grazing days / ha across the baseline period was 96.87 days/ha (calculated as the effective average when converting all livestock units to an equivalent unit based on their relative daily intake). As the number of grazing days varies per event, it is impracticable to display/summarise all of these values. For the fields which were grazed, grazing timeframes per field grazing event typically ranged from just a few days to more than 180

	days, depending on the field size and available fodder. Average grazing timeframes in the Baseline Period were 73.96 days per grazing event.
Justification of choice of data or description of measurement methods and procedures applied	The number for each livestock type in each year of the baseline period is provided by each farmer. This is applicable for livestock events that meet the requirements of the methodology deviation only.
Purpose of Data	Calculation of baseline emissions
Comments	None

<table>
<tr><td>Data / Parameter</td><td>$W_{bsl,l,i,t,P}$</td></tr>
<tr><td>Data unit</td><td>kg animal mass/head</td></tr>
<tr><td>Description</td><td>Average weight in the baseline scenario of livestock type <i>l</i> for sample unit <i>i</i> in productivity system <i>P</i> in year <i>t</i></td></tr>
<tr><td>Equations</td><td>(14)</td></tr>
<tr><td>Source of data</td><td>Farmers provide an average weight class that the livestock are assigned to in their field records.</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th>Livestock Type</th><th>Small (kg)</th><th>Medium (kg)</th><th>Large (kg)</th></tr>
<tr><td>Dairy Cattle</td><td>325</td><td>550</td><td>700</td></tr>
<tr><td>Other Cattle</td><td>325</td><td>550</td><td>700</td></tr>
<tr><td>Sheep</td><td>37.5</td><td>70</td><td>90</td></tr>
<tr><td>Goats</td><td>35</td><td>60</td><td>75</td></tr>
<tr><td>Pigs</td><td>100</td><td>200</td><td>250</td></tr>
<tr><td>Chicken Broilers</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Chicken Laying</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Other (Indicate in comment)</td><td>Unknown – requires farmer specific inputs</td><td>Unknown – requires farmer specific inputs</td><td>Unknown – requires farmer specific inputs</td></tr>
</table>
</td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>See “Source of data”</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

Data / Parameter	$MB_{bsl,c,i,t}$
Data unit	Kilograms
Description	Mass of agricultural residues of type c burned in the baseline scenario for sample unit i in year *t*
Equations	(15), (33)
Source of data	Management records of tonnes harvested. Management records or NDVI of burning residues. Volume 4 Chapter 11 Table 11.1a (IPCC, 2019). Values for Ratio of above-ground residue dry matter to harvested yield
Value applied	0 (Zero) The value applied is dependent on the residue type. No biomass burning activities took place in the baseline or project activities for the first issuance.
Justification of choice of data or description of measurement methods and procedures applied	It is assumed that 100% of aboveground biomass is burned in both the baseline and with project cases.
Purpose of Data	Calculation of baseline emissions
Comments	Mass of residues burned is a function of the amount of aboveground biomass, the removal of aboveground biomass, and whether or not remaining residues are burned. It is assumed that 100 percent of aboveground biomass is burned in the baseline scenario.

Data / Parameter	GWP_{N2O}
Data unit	t CO_2e / t N_2O
Description	Global warming potential for N_2O
Equations	(16), (19), (23)-(25), (28), (31)-(33)
Source of data	IPCC Fifth Assessment Report (IPCC, 2013)
Value applied	265

<table>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>See source of data above. Unless otherwise directed by the VCS

Program, VCS Standard v4.7, Section 3.5.14 requires that N_2O must be 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. For GHG emission reductions occurring prior to 1 January 2021 N_2O can be converted using the 100-year global warming potential derived from the IPCC Fourth Assessment Report or those derived from AR5 as per VCS Standard v4.7, Section 3.15.4.</td></tr>
<tr><td>Purpose of Data</td><td>Calculation of baseline and project emissions</td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>$M_{bsl,SF,i,t}$</td></tr>
<tr><td>Data unit</td><td>t fertilizer</td></tr>
<tr><td>Description</td><td>Mass of N-containing synthetic fertilizer type SF applied in sample unit i in year t in the baseline scenario</td></tr>
<tr><td>Equations</td><td>(20)</td></tr>
<tr><td>Source of data</td><td>Information provided by farmers in their field records.</td></tr>
<tr><td>Value applied</td><td>Various values provided per event based on management records.

There were 3,752 different synthetic fertilizer events recorded in the baseline, including pre-planting fertilizer applications, with-planting fertilizer applications and top-dressing events.

<table>
<tr><th></th><th>2014/ 15</th><th>2015/ 16</th><th>2016/ 17</th><th>2017/ 18</th><th>2018/ 19</th><th>2019/ 20</th><th>2020/ 21</th><th>2021/ 22</th></tr>
<tr><td>Total kg applied</td><td>1,833,481</td><td>3,208,525</td><td>3,821,273</td><td>3,713,104</td><td>689,797</td><td>708,828</td><td>148,547</td><td>-</td></tr>
<tr><td>Average kg / ha</td><td>427.14</td><td>329.69</td><td>388.61</td><td>323.53</td><td>332.85</td><td>346.52</td><td>453.41</td><td>-</td></tr>
</table>
Note: the above table only includes N-applications in the baseline seasons. The initial increasing trend and eventual reducing trend are a result of increasing and decreasing baseline hectares under assessment as project instances are included across time with their various project start dates.

Across the baseline, the average N-containing fertilizer applied was 355.04 kg/ha.</td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>For baseline emission calculations, the farmers provide information on the rate, timing, and type of fertilizer for each instance included in the project.</td></tr>
</table>

Purpose of Data	Calculation of baseline emissions
Comments	None

<table>
<tr><td>Data / Parameter</td><td>$M_{bsl,OF,i,t}$</td></tr>
<tr><td>Data unit</td><td>t fertilizer</td></tr>
<tr><td>Description</td><td>Mass of N-containing organic fertilizer type <i>OF</i> applied in the baseline scenario in sample unit <i>i</i> in year <i>t</i></td></tr>
<tr><td>Equations</td><td>(21)</td></tr>
<tr><td>Source of data</td><td>Information provided by farmers in the farmer data field records that provide the application rate of the organic amendment application.</td></tr>
<tr><td>Value applied</td><td>
<p>Various values provided per event based on management records.</p>
<p>There were exactly 50 different organic inputs application events recorded in the baseline.</p>
<table>
<tr><th></th><th>2014/ 15</th><th>2015/ 16</th><th>2016/ 17</th><th>2017/ 18</th><th>2018/ 19</th><th>2019/ 20</th><th>2020/ 21</th><th>2021/ 22</th></tr>
<tr><td>Total kg applied</td><td>-</td><td>-</td><td>-</td><td>132,171</td><td>395,543</td><td>264,343</td><td>791,086</td><td>-</td></tr>
<tr><td>Average kg / ha</td><td>-</td><td>-</td><td>-</td><td>11.52</td><td>190.86</td><td>129.23</td><td>2,414.65*</td><td>-</td></tr>
</table>
<p>*The high average value was only for one farmer on 2 separate fields where a lot of organic inputs were added as a once-off addition.</p>
<p>Across the baseline, the weighted average N-containing organic fertilizer applied was only 39.80 kg/ha.</p>
</td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>For baseline emission calculations, the farmers provide information on the rate, timing, and type of fertilizer for each instance included in the project.</td></tr>
<tr><td>Purpose of Data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

Data / Parameter	$MB_{g,bsl,i,t}$
Data unit	t dm
Description	Annual aboveground and belowground dry matter of N-fixing species *g* returned to soils in the baseline scenario for sample unit *i* in year *t*

<table>
<tr><td>Equations</td><td>(26)</td></tr>
<tr><td>Source of data</td><td>Yield data obtained from farmer’s management records / yield maps along with NDVI analysis of cover crop presence.
Volume 4 Chapter 11 Table 11.1a (IPCC, 2019)</td></tr>
<tr><td>Value applied</td><td>Various values provided per event based on management records. There were 2,517 different harvesting events recorded in the baseline and 160 cover crop planting events. The data collected from these events (e.g. yield, crop type, harvest dates, cover crop species, etc.), along with NDVI analysis were used to calculate the t dm returned to the soil.
<table>
<tr><th></th><th>2014/ 15</th><th>2015/ 16</th><th>2016/ 17</th><th>2017/ 18</th><th>2018/ 19</th><th>2019/ 20</th><th>2020/ 21</th><th>2021/ 22</th></tr>
<tr><td>tDM</td><td>10,737</td><td>27,534</td><td>24,712</td><td>32,513</td><td>2,609</td><td>1,273</td><td>441</td><td>-</td></tr>
</table></td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>The value of $MB_{g,bsl,i,t}$ is determined using ratios and constants provided by Table 11.1a in Volume 4, Chapter 11 (IPCC, 2019). Please see in the calculation workbooks “Biomass Tool” and QA3 review for the calculations in detail.</td></tr>
<tr><td>Purpose of Data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

Data / Parameter	$MS_{bsl,l,i,t}$
Data unit	Fraction of N deposited
Description	Fraction of nitrogen excretion of livestock type *l* that is deposited in sample unit *i* in year *t* in the baseline scenario
Equations	(29)
Source of data	Data is sourced according to the guidance in Box 1 of VM0042. The farmer data sheet provides information specific to the number of grazing days that livestock spent on the sample units included in the project instances. This data forms part of the calculation for $MS_{bsl,l,i,t}$.
Value applied	Variable, depends on specific data obtained from the farmer for each livestock event on the specific project field. For the initial project instances, there were 2,641 individually recorded livestock grazing events during the baseline look-back period for the establishment of the historic schedule of activities. These included mostly Beef Cattle, with some Dairy Cattle and Sheep. The average grazing days / ha across the baseline period was 96.87 days/ha (calculated as the effective average when

	converting all livestock units to an equivalent unit based on their relative daily intake). As the number of grazing days varies per event, it is impracticable to display/summarise all of these values. For the fields which were grazed, grazing timeframes per field grazing event typically ranged from just a few days to more than 180 days, depending on the field size and available fodder. Average grazing timeframes in the Baseline Period were 73.96 days per grazing event. The fraction of N deposited would be calculated as each event's total days on project fields as a ratio over 365 days. Therefore, the average value would be approximately 0.2026 (73.96 days / 365 days), although this varies greatly per farm and grazing event.
Justification of choice of data or description of measurement methods and procedures applied	The fraction of nitrogen deposited on the project area is determined based on the amount of time spent grazing on the project area during year *t* for each livestock type *l*. In the absence of data available according to Box 1 (or to conservatively reduce the effort of project development), a value of 1 may be applied with no additional support. This would conservatively assume that the livestock deposited 100% of their excreted N on the project area for the entirety of year *t*. In our project, the farmers provide the number of grazing days in the baseline period where it is relevant to their management practices e.g. Cattle feeding on residues.
Purpose of Data	Calculation of baseline emissions
Comments	None

<table>
<tr><td>Data / Parameter</td><td>$P_{bsl,p}$</td></tr>
<tr><td>Data unit</td><td>Output (e.g., kg)/ha</td></tr>
<tr><td>Description</td><td>Average productivity for product <i>p</i> during the historical look-back period</td></tr>
<tr><td>Equations</td><td>(35), (36)</td></tr>
<tr><td>Source of data</td><td>See Box 1
Management records on yields provided by farmers where relevant in their data submission.</td></tr>
<tr><td>Value applied</td><td><table>
<tr><th>Major Cash Crop Type</th><th>Baseline Yield (t/ha)</th></tr>
<tr><td>Maize</td><td>7.12</td></tr>
<tr><td>Soybean</td><td>2.44</td></tr>
<tr><td>Sunflower</td><td>1.39</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td><table><tr><td>Wheat</td><td>4.64</td></tr></table></td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>Average productivity for each livestock/crop product following guidance in Section 8.4.3. Use of cash crop yields to determine whether a greater than 5% reduction in productivity in the first analysis.</td></tr>
<tr><td>Purpose of Data</td><td>Determination of baseline productivity for future market leakage analysis</td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>$RP_{bsl,p}$</td></tr>
<tr><td>Data unit</td><td>Productivity (e.g., kg) per hectare</td></tr>
<tr><td>Description</td><td>Average regional productivity for product <i>p</i> during the historical look-back period</td></tr>
<tr><td>Equations</td><td>(36)</td></tr>
<tr><td>Source of data</td><td>Secondary evidence sources of regional productivity (e.g., peer-reviewed science, industry associations, international databases, Government databases). Used the Grain SA database for cash crop yields dating back to the 2012/2013 season.</td></tr>
<tr><td>Value applied</td><td>Values were obtained per province, per crop type from the above source.
<table>
<tr><td></td><td>Maize</td><td>Soybean</td><td>Sunflower</td><td>Wheat</td></tr>
<tr><td>Free State</td><td>4.966</td><td>1.920</td><td>1.462</td><td>3.798</td></tr>
<tr><td>Gauteng</td><td>5.878</td><td>2.190</td><td>1.177</td><td>6.273</td></tr>
<tr><td>Kwa-Zulu Natal</td><td>6.864</td><td>3.389</td><td>N/A</td><td>6.155</td></tr>
<tr><td>Mpumalanga</td><td>6.188</td><td>2.003</td><td>1.262</td><td>6.390</td></tr>
<tr><td>North West</td><td>4.129</td><td>2.190</td><td>1.343</td><td>6.060</td></tr>
</table>
For application of these to the baseline (where farm records were not available), the provincial data was used. Where fields are irrigated, data from the Census of commercial agriculture 2017 (Financial and production statistics) report by the Department of Statistics and Department of Agriculture was used which results in higher yields than the above. For purposes of productivity comparisons for leakage considerations, the above values were weighted by the % of project area in each province to obtain comparable values to the project as a whole.</td></tr>
</table>

Justification of choice of data or description of measurement methods and procedures applied	Average regional productivity for each livestock/crop product following guidance in Section 8.4.3
Purpose of Data	Determination of baseline productivity ratio for future market leakage analysis
Comments	None

Data / Parameter	*A*
Data unit	Hectare (ha)
Description	Project area
Equations	(54), (57), (59), (61)
Source of data	Measured in project area
Value applied:	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547
Justification of choice of data or description of measurement methods and procedures applied	Delineation of the project area may use a combination of GIS coverages, ground survey data, remote imagery (satellite or aerial photographs) and other appropriate data. Any imagery or GIS datasets used must be geo-registered referencing corner points, landmarks, or other intersection points.
Purpose of Data	Calculation of baseline and project emissions
Comments	Other units used to determine project area (e.g., acres) must be converted to hectares.

6.2 Data and Parameters Monitored

Where applicable, the parameters listed below are provided in the monitoring report for 1 August 2018 – 31 July 2022.

Due to the complexity of a grouped project, it is in many cases impracticable to determine a single value per parameter. We have documented all parameter tables and calculation logic in separate reports accompanying this submission.

Data / Parameter	Ƒ($SOC_{bsl,i,t}$)
Data unit	t CO_2e/ha

Description	Modeled SOC stocks in the baseline scenario for sample unit i at time t, calculated by modeling SOC stock changes over the course of the preceding year
Equations	(6)
Source of data	See VMD0053
Description of measurement methods and procedures to be applied	Modeled SOC stocks in the baseline scenario are determined according to the following equation: $SOC\_soil_{bsl,i,t} = f\ soc\ (Val\ A_{bsl,i,t},\ \ Val\ B_{\ bsl,i,t},\ldots)$ Where: $SOC_{\ bsl,i,t}$: Modeled SOC stocks in the baseline scenario for sample unit *i* at time *t* (t CO_2e/ha) $f\ soc$: Model predicting carbon dioxide emissions from the soil organic carbon pool (t CO_2e/unit area) $Val\ A_{bsl,i,t}$: Value of model input variable A in the project scenario for sample unit *i* at time *t* (units unspecified) $Val\ B_{\ bsl,i,t}$: Value of model input variable B in the project scenario for sample unit *i* at time *t* (units unspecified) See Box 1 for sources of data and description of measurement methods and procedures to be applied to obtain values for model input variables.
Frequency of monitoring/recording	Measurements must be conducted at least every five years. Modeling as means of monitoring must be conducted prior to each verification event where verification occurs more frequently than once every five years.
QA/QC procedures to be applied	Standard QA/QC procedures for soil inventory including field data collection and data management must be applied. Use or adaptation of QA/QCs available from published handbooks, such as those published by FAO and available on the FAO Soils Portal, or from the IPCC GPG LULUCF 2003 is recommended. Refer to Sampling Strategy Report for more details.
Purpose of data	Calculation of baseline emissions following Quantification Approach 1
Calculation method	Not applicable
Comments	The SOC stocks at time *t* = 0 are calculated based on directly measured SOC content and bulk density at *t* = 0 or (back-) modeled to *t* = 0 from measurements within ±5 years of *t* = 0.

	See Section 8.2.1 for requirements for SOC content and bulk density measurements.

Data / Parameter	*i*
Data unit	Dimensionless
Description	Sample unit: defined area that is selected for measurement and monitoring, such as a field or stratum; see also definition in Section 3
Equations	(6)–(33), (40)–(50)
Source of data	Determined in project area
Description of measurement methods and procedures to be applied	The sample unit is determined prior to verification based on our stratification and sampling procedures. Strata are defined based on management practice and soil property clusters, after which random samples are generated on each stratum based on the hectares included in the strata.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	See Sampling Strategy Report.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	*A*i
Data unit	Hectare
Description	Area of sample unit *i*
Equations	(7), (9), (12), (13), (15), (19), (22), (25), (28), (30), (33), (40) - (50)
Source of data	Measurement of each sample unit within the project area
Description of measurement methods and procedures to be applied	The sample unit area is measured prior to verification using Orizon's data collection platform to obtain field boundaries.

	A python script calculates the area of the recorded boundaries using the locally appropriate EPSG:9221 Hartebeeshoek Coordinate Reference System (CRS). These hectares are reconciled with the area calculated by QGIS using the same CRS.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Field boundaries are reviewed by Orizon representatives after submission by the farmer and signed off by 2 Orizon representatives after ensuring compliance with Verra requirements, such as accurate external field boundaries, no non-cropland area / buildings / trees, etc.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	Other units used to determine area (e.g., acres) must be converted to hectares.

Data / Parameter	j
Data unit	Dimensionless
Description	Type of fossil fuel combusted
Equations	(7), (8)
Source of data	Determined in sample unit i
Description of measurement methods and procedures to be applied	Following the process as per Box 1 in VM0042, Orizon will collect the necessary fossil fuel data by recording farmer data, using an attestation form and/or farm management records. Fossil fuel type is determined prior to verification.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	See Box 1. As per Box 1, only appropriate sources of both qualitative and quantitative data from the farmers applicable to fossil fuel usage will be used. This data specifically will come from the management practices implemented by each farmer on the project instances each year.

Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$EF_{CO2,j}$
Data unit	t CO_2e/liter
Description	Emission factor for the type of fossil fuel *j* (gasoline or diesel) combusted
Equations	(8)
Source of data	Table 3.3.1 Volume 2 Chapter 3 (IPCC, 2019)
Description of measurement methods and procedures to be applied	For gasoline EF_{CO2}=0.002810 t CO_2e per liter. For diesel EF_{CO2}=0.002886 t CO_2e per liter. For biodiesel EF_{CO2}=0.00081
Justification of choice of data or description of measurement methods and procedures applied	See source of data above For our project instances diesel is the most likely fossil fuel that is used in the project. We have however also included the value for gasoline and biodiesel for any instances where this is used.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	See "Source of data"
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)

Data / Parameter	$FFC_{wp,j,i,t}$
Data unit	Liters

Description	Consumption of fossil fuel type j for sample unit i in year t in the project scenario
Equations	Equation 5
Source of data	Values are based on the various events recorded for each season for each field. There were c. 24,481 events across all participating fields in the baseline period. Each event has its own consumption rate based on the type of event/implement, with values adapted from the Department of Agriculture, Forestry and Fisheries – Guide to machinery costs. For crop duster airplane fuel consumption, the sources include peer-reviewed literature and several other sources. Values have been adapted from the Department of Agriculture, Forestry and Fisheries – Guide to machinery costs. For crop duster airplane fuel consumption, the sources include peer-reviewed literature and several other sources.
Description of measurement methods and procedures to be applied	Fossil fuel consumption may be monitored, or the amount of fossil fuel combusted may be estimated using fuel efficiency (for example l/100 km, l/t-km, l/hour) of the vehicle type and the appropriate unit of use for the selected fuel efficiency (for example km driven if efficiency is given in l/100 km).
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of project emissions
Calculation method	Fuel efficiency factors may be obtained from Chapter 3, Volume 2 of IPCC (2019).
Comments	For all equations, the subscript *bsl* must be substituted by *wp* to make clear that the relevant values are being quantified for the project scenario

Data / Parameter	$EF_{Limestone}$ and $EF_{Dolomite}$
Data unit	t C/(t limestone or dolomite)
Description	Emission factor for the application of calcitic limestone (CaCO3) and dolomite (CaMg(CO3)2) (i.e., liming)
Equations	(10)

Source of data	Farmer field records of the type of liming applied. Section 11.3, Chapter 11, Volume 4 in IPCC (2019)
Description of measurement methods and procedures to be applied	IPCC (2019) values: for calcitic limestone *EFLimestone* = 0.12 t C/t limestone, for dolomite, *EFDolomite* = 0.13 t C/t dolomite.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	See "Source of Data" and Section 8.3 under Quantification Approach 3
Purpose of Data	Calculation of baseline emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$EF_{ent,l,P}$
Data unit	kg CH_4/(head x year)
Description	Enteric emission factor for livestock type *l* and productivity system *P*
Equations	(12)
Source of data	See Section 8.3 under Quantification Approach 3. Where no alternative information source is available that is applicable to the project conditions, project proponents may derive emission factors for each category of livestock estimated based on the gross energy intake and methane conversion factor for the category by following the guidance under "Tier 2 Approach for Methane Emissions from Enteric Fermentation" in Section 10.3.2, Chapter 10, Volume 4 of IPCC (2019). Where project proponents can justify a lack of sufficient activity data and project-specific information sources, Tier 1 and Tier 1a enteric fermentation emission factors from Tables 10.10 or 10.11, Chapter 10, Volume 4 in IPCC (2019) may be selected.
Description of measurement methods and procedures to be applied	When using emission factors from Tables 10.10 and 10.11 (Chapter 10, Volume 4 in IPCC, 2019), the region most applicable to the project area must be selected. The tabulations in Annex 10A.1 (IPCC, 2019) provide details of the underlying animal characteristics such as weight, growth rate and milk production used to develop the emission factors. Where project activities lead to agricultural systems transitioning from local low input

	productivity systems to higher productivity systems, more than one emission factor given for a specific animal category may be applied.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	See "Source of data" and Section 8.3 under Quantification Approach 3
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$Days_{wp,i,l,t,P}$
Data unit	Days
Description	Average grazing days per head in the baseline scenario inside sample unit i for each livestock type l in productivity system P in year t
Equations	(12), (13), (29)
Source of data	Information provided by farmers in the farmer data submission phase.
Description of measurement methods and procedures to be applied	Record livestock grazing days by type
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete or continuous numeric variables) on agricultural management practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications).

Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	This parameter applies as per the methodology deviation for livestock events in the project area.

Data / Parameter	$Pop_{wp,l,l,t,P}$
Data unit	Head
Description	Population of grazing livestock of type *l* in the project scenario in sample unit *i* for productivity system *P* in year *t*
Equations	(12), (13), (29)
Source of data	See Box 1 Information provided by farmers in the farmer data sheet field records.
Description of measurement methods and procedures to be applied	Record of number of grazing livestock by type. Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete, or continuous numeric variables) on ALM practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications).
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete or continuous numeric variables) on agricultural management practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g. management logs, receipts or invoices, farm equipment specifications). Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of project emissions
Calculation method	Not applicable

Comments	For all equations, the subscript *bsl* must be substituted by *wp* to make clear that the relevant values are being quantified for the project scenario.

Data / Parameter	l
Data unit	Dimensionless
Description	Type of livestock
Equations	(12)–(14), (24), (29), (32), (34)
Source of data	Determined in sample unit *i*
Description of measurement methods and procedures to be applied	Use of the relevant livestock data submitted by each farmer as part of the Farmer data sheet (Farm Management Records) as per Box 1 in VM0042. Livestock type is determined prior to verification.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	As per Box 1, only appropriate sources of both qualitative and quantitative data from the farmers applicable to livestock type will be used. This data specifically will come from the livestock management practices implemented by each farmer on the project instances each year.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	P
Data unit	Unitless
Description	Productivity system
Equations	(12), (28), (29)
Source of data	Subsection “Definitions of High and Low Productivity Systems,” Section 10.2, Chapter 10, Volume 4 of IPCC (2019)

Description of measurement methods and procedures applied	When using emission factors from IPCC (2019), project proponents must differentiate between high- and low productivity systems for each livestock species to define value from Lookup Tables 10A.1 to 10A.9. Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. See also Box 1.
Frequency of monitoring/recording	To confirm that productivity system remains the same, monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently. Any changes to the productivity system must be documented in each monitoring report.
QA/QC procedures applied	See "Source of data" and Section 8.3 under Quantification Approach 3
Purpose of data	Calculation of baseline and project emissions
Calculation method	Following descriptions in IPCC (2019), basic population estimates may be applied (see "Source of data").
Comments	Please refer to Section 7.1 for further details regarding the values applied for this parameter in the project.

Data / Parameter	$AWMS_{l,l,t,P,S}$
Data unit	Dimensionless
Description	Fraction of total annual volatile solids for each livestock type *l* that is managed in manure management system *S* in the project area, for productivity system *P*
Equations	(13), (29)
Source of data	See Section 8.3 under Quantification Approach 3. Where project proponents can justify a lack of sufficient activity data and project-specific information sources, Tier 1 average values for animal waste management systems (manure management systems) from Tables 10A.6 to 10A.9, Chapter 10, Volume 4 in IPCC (2019) may be selected.

Description of measurement methods and procedures applied	As emissions from manure management systems are highly temperature dependent, the climate zone associated with the entire project area where manure is managed must be considered.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures applied	See "Source of data" and Section 8.3 under Quantification Approach 3
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$EF_{CH4,md,l,P,S}$
Data unit	g CH_4 / (kg volatile solids)
Description	Emission factor for methane emissions from manure deposition for livestock type *l* in productivity system *P* and manure management system *S*
Equations	(13)
Source of data	See Section 8.3 under Quantification Approach 3. Where no information source is available that is applicable to the project conditions, projects may derive emission factors based on project-specific manure characteristics and animal waste management system characteristics following the guidance under Tier 2 in Section 10.4.2, Chapter 10, Volume 4 of IPCC (2019). Where project proponents are able to justify a lack of sufficient activity data and project-specific information sources, Tier 1 and Tier 1a from Tables 10.14 and 10.15, Chapter 10, Volume 4 in IPCC (2019) may be selected.
Value applied	The emission factor is determined based on livestock type. Excluding livestock types listed in Table 10.15 in Chapter 10, Volume 4 (IPCC, 2019), a value of 0.6 is applied for all animals in both low and high productivity pasture, range, and paddock systems per Table 10.14 of the same chapter.

Description of measurement methods and procedures applied	See “Source of data”
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures applied	See “Source of data” and Section 8.3 under Quantification Approach 3
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	S
Data unit	Unitless
Description	Manure management system
Equations	(13), (23), (24), (28), (29)
Source of data	Table 10.18, Chapter 10, Volume 4 in IPCC (2019)
Description of measurement methods and procedures applied	See Section 8.3 under Quantification Approach 3. When using methane and nitrous oxide emission factors from IPCC (2019), project proponents must differentiate between manure management systems to define value from Lookup Tables 10.14 and 10.17. The referenced table of IPCC (2019) provides Tier 1a emission factors, which consider different aeration and mixing regimes as well as other factors such as water content, thus influencing CH_4 and N_2O emissions differently.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures applied	See “Source of data” and Section 8.3 under Quantification Approach 3

Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$VS_{rate,l}$
Data unit	kg volatile solids/(1000 kg animal mass x day)
Description	Default volatile solids excretion rate for livestock type *l* and productivity system *P*
Equations	(14)
Source of data	See Section 8.3 under Quantification Approach 3. Where no information source is available that is applicable to the project conditions, projects may derive default factors using Equation 10.24 in Chapter 10, Volume 4 in IPCC (2019). Where project proponents are able to justify a lack of sufficient activity data and project-specific information sources, Tier 1 and Tier 1a from Table 10.13a, Chapter 10, Volume 4 in IPCC (2019) may be selected.
Description of measurement methods and procedures applied	The volatile solids excretion rate is determined based on livestock type. Where agricultural systems are differentiated into low and high productivity systems in Table 10.13a in Chapter 10, Volume 4 in IPCC (2019), the mean value may be selected.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures applied	See "Source of data" and Section 8.3 under Quantification Approach 3
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$W_{wp,l,i,t,P}$
Data unit	kg animal mass/head

<table>
<tr><td>Description</td><td>Average weight in the baseline scenario of livestock type l for sample unit i in productivity system P in year t</td></tr>
<tr><td>Equations</td><td>(14)</td></tr>
<tr><td>Source of data</td><td>Farmers provide an average weight class that the livestock are assigned to in their field records. Estimation based on management records from project area.</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th>Livestock Type</th><th>Small (kg)</th><th>Medium (kg)</th><th>Large (kg)</th></tr>
<tr><td>Dairy Cattle</td><td>325</td><td>550</td><td>700</td></tr>
<tr><td>Other Cattle</td><td>325</td><td>550</td><td>700</td></tr>
<tr><td>Sheep</td><td>37.5</td><td>70</td><td>90</td></tr>
<tr><td>Goats</td><td>35</td><td>60</td><td>75</td></tr>
<tr><td>Pigs</td><td>100</td><td>200</td><td>250</td></tr>
<tr><td>Chicken Broilers</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Chicken Laying</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Other (Indicate in comment)</td><td>Unknown – requires farmer specific inputs</td><td>Unknown – requires farmer specific inputs</td><td>Unknown – requires farmer specific inputs</td></tr>
</table>
</td></tr>
<tr><td>Description of measurement methods and procedures applied</td><td>Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete or continuous numeric variables) on ALM practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications).</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.</td></tr>
<tr><td>QA/QC procedures applied</td><td>Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline and project emissions</td></tr>
<tr><td>Calculation method</td><td>Not applicable</td></tr>
</table>

Comments	None

Data / Parameter	CF_c
Data unit	Proportion of pre-fire fuel biomass consumed
Description	Combustion factor for agricultural residue type *c*
Equations	(15), (33)
Source of data	Table 2.6, Chapter 2, Volume 4 in IPCC (2019)
Description of measurement methods and procedures applied	The combustion factor is selected based on the agricultural residue type burned
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures applied	See "Source of data" and Section 8.3 under Quantification Approach 3
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$EF_{c,CH4}$
Data unit	g CH_4/kg dry matter burnt
Description	Methane emission factor for the burning of agricultural residue type *c*
Equations	(15)
Source of data	Table 2.5, Chapter 2, Volume 4 in IPCC (2019)
Value applied	The emission factor is selected based on the agricultural residue type burned
Description of measurement methods and procedures applied	See source of data above

Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures applied	Guidance provided in IPCC, 2003 Section 5.5 or IPCC, 2000 Chapter 8 must be applied.
Purpose of Data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	c
Data unit	Dimensionless
Description	Type of agricultural residue
Equations	(15), (33)
Source of data	Determined in sample unit *i*
Description of measurement methods and procedures to be applied	See Box 1. Agricultural residue type is determined prior to verification.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Guidance provided in IPCC, 2003 Section 5.5 or IPCC, 2000 Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$MB_{wp,c,I,t}$
Data unit	Kilograms
Description	Mass of agricultural residues of type *c* burned in the project for sample unit *i* in year *t*

Equations	(15), (33)
Source of data	Management records of tons harvested. Volume 4 Chapter 11 Table 11.1a (IPCC, 2019). Values for Ratio of above-ground residue dry matter to harvested yield
Description of measurement methods and procedures to be applied	Estimate the aboveground biomass of grassland before burning for at least three plots (1m x 1m). The difference of the aboveground biomass is the aboveground biomass burnt
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	For all equations, the subscript *bsl* must be substituted by *wp* to make clear that the relevant values are being quantified for the project scenario There were no recorded burning events in the monitoring period, therefore a value of zero is applied.

Data / Parameter	$EF_{Ndirect}$
Data unit	t N_2O-N/t N applied
Description	Emission factor for direct nitrous oxide emissions from N additions from synthetic fertilizers, organic amendments and crop residues
Equations	(19), (25)
Source of data	Volume 4 Chapter 11 Table 11.1 (IPCC, 2019)
Description of measurement methods and procedures to be applied	See “Source of data”
Value applied	Where project proponents can justify a lack of sufficient activity data and project-specific information sources, an appropriate disaggregated Tier 1 value from Table 11.1, Chapter 11, Volume 4 in IPCC (2019) may be selected.

	A value of 0.01 is applied for N additions from synthetic fertilizers, organic amendments and crop residues, and N mineralized from mineral soil because of loss of SOC. Disaggregated values may be used as follow: • A value of 0.016 is applied for inputs of synthetic fertilizer and fertilizer mixtures that include both synthetic and organic forms of N. in wet climates • A value of 0.006 is applied for other N input as organic amendments, animal manures, N in crop residues and mineralized N from SOC decomposition in wet climates • A value of 0.005 is applied to all N inputs in dry climates A value of 0.004 is applied for manure from cattle (dairy, non-dairy and buffalo), poultry and pigs. Disaggregated values may be used as follow: • A value of 0.016 is applied for inputs of synthetic fertilizer and fertilizer mixtures that include both synthetic and organic forms of N in wet climates • A value of 0.006 is applied for other N input as organic amendments, animal manures, N in crop residues and mineralized N from SOC decomposition in wet climates • A value of 0.005 is applied to all N inputs in dry climates A value of 0.004 is applied for manure from cattle (dairy, non-dairy and buffalo), poultry and pigs. Disaggregated values may be used as follow: • A value of 0.006 is applied for wet climates • A value of 0.002 is applied for dry climates. A value of 0.003 is applied for manure from sheep and ‘‘other animals
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC, 2003 Section 5.5 or IPCC, 2000 Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable

Comments	The emission factor is applicable to N additions from mineral fertilizers, organic amendments and crop residues, and N mineralized from mineral soil as a result of loss of SOC. Wet climates occur in temperate and boreal zones where the ratio of annual precipitation to potential evapotranspiration is greater than 1, and in tropical zones where annual precipitation is greater than 1000 mm. Dry climates occur in temperate and boreal zones where the ratio of annual precipitation to potential evapotranspiration is less than 1, and in tropical zones where annual precipitation is less than 1000 mm.

Data / Parameter	NC_{SF}
Data unit	t N / t fertilizer
Description	N content of synthetic fertilizer type *SF*
Equations	(20)
Source of data	Information provided by farmers in the farmer data sheet that include N content of fertilizer and where possible the chemical formulas for the different fertilizers used.
Description of measurement methods and procedures to be applied	N content is determined following fertilizer manufacturer’s specifications.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently. Parameter value must be updated when synthetic fertilizer product is changed or when new manufacturer’s specifications are issued.
QA/QC procedures to be applied	See “Source of data” and Section 8.3 under Quantification Approach 3
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	*SF*
Data unit	Dimensionless

Description	Type of synthetic N fertilizer
Equations	*(20)*
Source of data	Determined in sample unit *i*
Description of measurement methods and procedures to be applied	See Box 1. Synthetic fertilizer type is determined prior to verification.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$M_{wp,SF,I,t}$
Data unit	t fertilizer
Description	Mass of N-containing synthetic fertilizer *SF* applied in the project for sample unit *i* in year *t*
Equations	(20)
Source of data	Information provided by farmers in the farmer data sheet field records.
Description of measurement methods and procedures to be applied	Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete, or continuous numeric variables) on ALM practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications).
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.

QA/QC procedures to be applied	Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete, or continuous numeric variables) on agricultural management practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications). Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	For all equations, the subscript *bsl* must be substituted by *wp* to make clear that the relevant values are being quantified for the project scenario.

Data / Parameter	NC_{OF}
Data unit	t N / t fertilizer
Description	N content of organic fertilizer type O*F*
Equations	(21)
Source of data	Peer-reviewed published data may be used. For example, default manure N content may be selected from Edmonds et al. (2003) cited in US EPA (2011) or other regionally appropriate sources such as the European Environment Agency.
Description of measurement methods and procedures to be applied	See “Source of data”
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently. Parameter value must be updated when organic fertilizer product is changed, or as new default values become available in peer-reviewed publications or databases.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline emissions
Calculation method	Not applicable

Comments	None

Data / Parameter	*OF*
Data unit	Dimensionless
Description	Type of organic N fertilizer
Equations	*(21)*
Source of data	Determined in sample unit *i*
Description of measurement methods and procedures to be applied	See Box 1. Organic fertilizer type is determined prior to verification.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$M_{wp,OF,I,t}$
Data unit	t fertilizer
Description	Mass of N containing organic fertilizer type *OF* applied in the project for sample unit i in year t
Equations	(21)
Source of data	Information provided by farmers in the farmer data sheet field records.
Description of measurement methods and procedures to be applied	Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete, or continuous numeric variables) on ALM practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant

	monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications).
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently. Recorded annually as part of the farmer data sheet
QA/QC procedures to be applied	Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete, or continuous numeric variables) on agricultural management practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications). Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	For all equations, the subscript *bsl* must be substituted by *wp* to make clear that the relevant values are being quantified for the project scenario.

Data / Parameter	$Frac_{GASF,l,S}$
Data unit	Dimensionless
Description	Fraction of all synthetic N added to soils that volatilizes as NH_3 and NO_x for livestock type *l* and manure management system *S*
Equations	(23)
Source of data	Volume 4 Chapter 11 Table 11.3 (IPCC, 2019)
Description of measurement methods and procedures to be applied	Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete, or continuous numeric variables) on ALM practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications). See “Source of data”
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable

	to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC, 2003 Section 5.5 or IPCC, 2000 Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$Frac_{GASM}$
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 for livestock type l and manure management system S
Equations	(23), (31)
Source of data	Volume 4 Chapter 11 Table 11.3 (IPCC, 2019) Also See Section 8.3 under Quantification Approach 3. When no information source is available that is applicable to the project conditions, project proponents may define value from Lookup Table 10.22, Chapter 10, Volume 4 in IPCC (2019).
Description of measurement methods and procedures to be applied	See "Source of data"
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC, 2003 Section 5.5 or IPCC, 2000 Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$Frac_{LEACH}$

Data unit	Dimensionless
Description	Fraction of N (synthetic or organic) added to soils and N in manure and urine deposited on soils that is lost through leaching and runoff, in regions where leaching and runoff occurs.
Equations	(24), (32)
Source of data	See Section 8.3 under Quantification Approach 3. When no information source is available that is applicable to the project conditions, project proponents may define value from Lookup Table 11.3, Chapter 11, Volume 4 in IPCC (2019).
Description of measurement methods and procedures to be applied	When using values from IPCC (2019), for wet climates and for dry climate regions where irrigation (other than drip irrigation) is used, a value of 0.24 is applied. For all other dry climate regions, a value of zero is applied.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC, 2003 Section 5.5 or IPCC, 2000 Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	Wet climates occur in temperate and boreal zones where the ratio of annual precipitation to potential evapotranspiration is greater than 1, and in tropical zones where annual precipitation is greater than 1000 mm. Dry climates occur in temperate and boreal zones where the ratio of annual precipitation to potential evapotranspiration is less than 1, and in tropical zones where annual precipitation is less than 1000 mm.

Data / Parameter	EF_{Nleach}
Data unit	t N_2O-N / t N leached and runoff
Description	Emission factor for nitrous oxide emissions from leaching and runoff
Equations	(24), (32)
Source of data	See Section 8.3 under Quantification Approach 3. When no information source is available that is applicable to the project

	conditions, project proponents may define value from Lookup Table 11.3, Chapter 11, Volume 4 in IPCC (2019).
Description of measurement methods and procedures to be applied	See “Source of data”
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC, 2003 Section 5.5 or IPCC, 2000 Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$MB_{g,wp,i,t}$
Data unit	t dm
Description	Annual dry matter, including aboveground and below ground, of N-fixing species *g* returned to soils for sample unit *i* in year *t*
Equations	(26)
Source of data	Aboveground and belowground dry matter in N-fixing species *g* returned to soil may be directly measured or peer-reviewed published data may be used.
Description of measurement methods and procedures to be applied	Information will be monitored via direct consultation with, and substantiated with a written attestation from, the farmer or landowner of the sample unit. Any quantitative information (e.g., discrete, or continuous numeric variables) on ALM practices must be supported by one or more forms of documented evidence pertaining to the selected sample unit and relevant monitoring period (e.g., management logs, receipts or invoices, farm equipment specifications).
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.

Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	For all equations, the subscript *bsl* must be substituted by *wp* to make clear that the relevant values are being quantified for the project scenario.

Data / Parameter	$N_{content,g}$
Data unit	t N/t dm
Description	Fraction of N in dry matter for N-fixing species *g*
Equations	(26)
Source of data	See Section 8.3 under Quantification Approach 3. When no information source is available that is applicable to the project conditions, project proponents may define value from Lookup Table 11.2, Chapter 11, Volume 4 in IPCC (2019).
Description of measurement methods and procedures to be applied	The fraction of N in dry matter is determined based on the N-fixing species type.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	g
Data unit	Dimensionless
Description	Type of N-fixing species
Equations	*(26)*
Source of data	Determined in sample unit i

Description of measurement methods and procedures to be applied	See Box 1. N-fixing species type is determined prior to verification.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$EF_{N2O,md,l,S}$
Data unit	kg N_2O-N/kg N input
Description	Emission factor for nitrous oxide from manure and urine deposited on soils by livestock type *l* and manure management system S
Equations	(28)
Source of data	See Section 8.3 under Quantification Approach 3. Where project proponents can justify a lack of sufficient activity data and project-specific information sources, Tier 1 and Tier 1a from Table 10.21, Chapter 10, Volume 4 in IPCC (2019) may be selected.
Description of measurement methods and procedures to be applied	See "Source of data"
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable

Comments	None

Data / Parameter	$N_{exl,P}$
Data unit	kg N deposited/(head x year)
Description	Annual average nitrogen excretion per head of livestock type *l* in productivity system *P*
Equations	(29)
Source of data	See Section 8.3 under Quantification Approach 3. Where no alternative information source is available that is applicable to the project conditions, project proponents may derive default factors using Equations 10.31 or 10.31a in Chapter 10, Volume 4 in IPCC (2019). Where project proponents can justify a lack of sufficient activity data and project-specific information sources, Tier 1 and Tier 1a from Table 10.19, Chapter 10, Volume 4 in IPCC (2019) may be selected.
Description of measurement methods and procedures to be applied	See "Source of data"
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	EF_{Nvolat}
Data unit	t N_2O-N /(t NH_3-N + NO_x-N volatilized)
Description	Emission factor for nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces
Equations	(23), (31)

Source of data	See Section 8.3 under Quantification Approach 3. When no information source is available that is applicable to the project conditions, project proponents may define value from Lookup Table 11.3, Chapter 11, Volume 4 in IPCC (2019).
Description of measurement methods and procedures to be applied	See "Source of data"
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$EF_{c,N20}$
Data unit	g N_2O/kg dry matter burnt
Description	Nitrous oxide emission factor for the burning of agricultural residue type *c*
Equations	(33)
Source of data	See Section 8.3 under Quantification Approach 3. When no information source is available that is applicable to the project conditions, project proponents may define value from Lookup Table 2.5, Chapter 2, Volume 4 in IPCC (2019)
Description of measurement methods and procedures to be applied	The emission factor is selected based on the agricultural residue type.
Frequency of monitoring/recording	Source of data for emission factor must be monitored every five years and must be updated when more accurate data applicable to the project conditions becomes available following the guidance in Section 8.3 under Quantification Approach 3.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of baseline and project emissions

Calculation method	Not applicable
Comments	None

Data / Parameter	*M_OAwp,l,t*
Data unit	Tons
Description	Mass of organic amendment applied as fertilizer on the project area in year t
Equations	(34)
Source of data	Management records from project area
Description of measurement methods and procedures to be applied	For manure application, data should be disaggregated for each livestock type l
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of leakage from application of new organic amendments from outside of the project area
Calculation method	Not applicable
Comments	None

Data / Parameter	*CCwp,l,t*
Data unit	t C/t manure
Description	Carbon content of manure from livestock type *l* applied as fertilizer on project area in year *t*
Equations	(34)
Source of data	See Box 1
Description of measurement methods and procedures to be applied	Record of carbon content of manure

Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Data will be sourced from peer-reviewed literature and IPCC reports and applied accordingly. If new research emerges, this will be applied prior to subsequent verification events and whenever new instances are added. Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Calculation of project emissions from leakage
Calculation method	Not applicable
Comments	None

Data / Parameter	$P_{wp,p}$
Data unit	Output (e.g., kg) /ha
Description	Average productivity for product p during the project period
Equations	(35), (36)
Source of data	Farm productivity (e.g., yield) records
Description of measurement methods and procedures to be applied	Measured using locally available technologies (e.g., mobile weighing devices, commercial scales, storage volume measurements, fixed scales, weigh scale tickets, etc.)
Frequency of monitoring/recording	Each growing season Yields must be measured each growing season. The average productivity for a specific crop will be calculated for the project period between leakage calculation events at each leakage calculation event, which occur every 10 years.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.
Purpose of data	Determination of project productivity for market leakage analysis
Calculation method	Not applicable (measured)
Comments	None

Data / Parameter	P

Data unit	Categorical variable
Description	Crop/livestock product
Equations	(35), (36)
Source of data	Farmers provide information regarding crop and livestock practices relevant to the project
Description of measurement methods and procedures to be applied	Not applicable
Frequency of monitoring/recording	Each growing season. Market leakage analysis will be conducted every 10 years.
QA/QC procedures to be applied	See Box 1
Purpose of data	Identification of crop/livestock product for market leakage analysis
Calculation method	Not applicable
Comments	None

Data / Parameter	*RPwp,p*
Data unit	Output (e.g., kg)/ha
Description	Average regional productivity for product p during the same years as the project period
Equations	*(36)*
Source of data	Regional productivity data from government (e.g., USDA Actual Production History data), industry, published, academic or international organization (e.g., FAO) sources.
Description of measurement methods and procedures to be applied	Not applicable
Frequency of monitoring/recording	Market leakage analysis will be conducted every 10 years.
QA/QC procedures to be applied	Guidance provided in IPCC (2003) Section 5.5 or IPCC (2000) Chapter 8 must be applied.

Purpose of data	Determination of project productivity ratio for market leakage analysis
Calculation method	Not applicable
Comments	None

Data / Parameter	$\overline{\mathrm{SOCbsl}, \imath, \mathrm{t}}$
Data unit	t CO_2eha
Description	Areal mean SOC stocks in the baseline scenario for sample unit *i* in year *t*
Equations	(40)
Source of data	Modeled in the project area
Description of measurement methods and procedures to be applied	See parameter table for ƒ$SOC_{bsl,i,t}$ above for modeled SOC stocks under QA 1.
Frequency of monitoring/recording	Measurements must be conducted at least every five years. Modeling as means of monitoring must be conducted prior to each verification event where verification occurs more frequently than once every five years. SOC stocks in the baseline scenario for sample unit i must be reported every five years or more frequently.
QA/QC procedures to be applied	See Section 8.2.1 and, for Quantification Approach 1, VMD0053
Purpose of data	Calculation of baseline emissions
Calculation method	Not applicable
Comments	SOC stocks at time *t* = 0 are calculated based on directly measured SOC content and bulk density at *t* = 0 or (back-) modeled to *t* = 0 from measurements collected within ±5 years of *t* = 0. This initially measured SOC is the same in both the baseline and project scenarios at the outset of the project (i.e., SOC*wp*,*i*,0 = SOC*bsl*,*i*,0) in Quantification Approach 1.

Data / Parameter	$\overline{\mathrm{SOCbsl}, \imath, \mathrm{t} - 1}$
Data unit	t CO_2e/unit area

Description	Areal mean SOC stocks in the baseline scenario for sample unit *i* in year *t* − 1
Equations	(40)
Source of data	Modeled in the project area
Description of measurement methods and procedures to be applied	See parameter table for $\overline{SOCbsl,i,t}$
Frequency of monitoring/recording	Measurements must be conducted at least every five years. Modeling as means of monitoring must be conducted prior to each verification event where verification occurs more frequently than once every five years. SOC stocks in the baseline scenario for sample unit i must be reported every five years or more frequently.
QA/QC procedures to be applied	See Section 8.2.1 and, for Quantification Approach 1, VMD0053
Purpose of data	Calculation of baseline emissions
Calculation method	Not applicable
Comments	See parameter table for $\overline{SOCbsl,i,t}$ See Section 8.2.1 for requirements for SOC content and bulk density measurements

Data / Parameter	$\overline{SOCwp,i,t}$
Data unit	t CO_2e/unit area
Description	Areal mean SOC stocks in the project scenario for sample unit *i* in year *t*
Equations	*(40)*
Source of data	Modeled in the project area
Description of measurement methods and procedures to be applied	Modeled SOC stocks in the project scenario are determined following the guidance in VMD0053 and according to the following equation: $f(SOCwp,i,t)=fSOC(Var\ Awp,i,t,Var\ Bwp,i,t,\ldots)$ Where: $f(SOCwp,i,t)$ Modeled carbon dioxide emissions from SOC pool in the project for sample unit *i* at time *t* (t CO_2e/ha)

	$fSOC$ Model predicting carbon dioxide emissions from the SOC pool (t CO_2e/ha) $Val\ Awp,i,t$ Value of model input variable A in the project scenario for sample unit i at time t (units unspecified) $Val\ Bwp,i,t$ Value of model input variable B in the project scenario for sample unit i at time t (units unspecified) See Box 1 for sources of data and description of measurement methods and procedures to be applied to obtain values for model input variables.
Frequency of monitoring/recording	Measurements must be conducted at least every five years. Modeling as means of monitoring must be conducted prior to each verification event where verification occurs more frequently than once every five years.
QA/QC procedures to be applied	See Section 8.2.1 and for Quantification Approach 1, VMD0053
Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	Initially measured SOC stocks are the same in both the baseline and project scenarios at the outset of the project (i.e., $SOCwp,i,0 = SOCbsl,i,0$) under Quantification Approach 1. SOC stocks at time $t = 0$ are calculated based on directly measured SOC content and bulk density at $t = 0$ or (back-) modeled to $t = 0$ from measurements collected within ±5 years of $t = 0$. SOC stocks in the project scenario for sample unit i must be reported every five years or more frequently under Quantification Approaches 1 and 2.

Data / Parameter	$\overline{SOCwp, ı, t} - 1$
Data unit	t CO_2e/unit area
Description	Areal mean SOC stocks in the project scenario for sample unit i in year $t-1$
Equations	*(40)*
Source of data	Modeled in the project area
Description of measurement methods and procedures to be applied	See parameter table for $\overline{SOCwp, i, t}$

Frequency of monitoring/recording	Measurements must be conducted at least every five years. Modeling as means of monitoring must be conducted prior to each verification event where verification occurs more frequently than once every five years.
QA/QC procedures to be applied	See parameter table for $\overline{\mathrm{SOCwp, i, t}}$
Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	See parameter table for $\overline{\mathrm{SOCwp, i, t}}$

Data / Parameter	$\overline{\Delta C_{TREE,bsl,i,t}}$
Data unit	T CO_2e/ha
Description	Areal mean change in carbon stocks in trees in the baseline
Equations	Section 8.2.2 and (42)
Source of data	Determined in project area
Description of measurement methods and procedures to be applied	Calculated using the CDM A/R Tools Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities and Simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities implemented on lands other than wetlands.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	See description of measurement methods and procedures to be applied
Purpose of data	Calculation of baseline emissions
Calculation method	See description of measurement methods and procedures to be applied
Comments	Not applicable in this monitoring period

Data / Parameter	$\overline{\Delta C_{SHRUB,bsl,i,t}}$
Data unit	tCO_2e/ha
Description	Areal mean change in carbon stocks in trees in the baseline

Equations	Section 8.2.2 and (43)
Source of data	Determined in project area
Description of measurement methods and procedures to be applied	Calculated using the CDM A/R Tools Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities and Simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities implemented on lands other than wetlands.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years or prior to each verification event where verification occurs more frequently.
Value applied	See description of measurement methods and procedures to be applied
Monitoring equipment	Calculation of baseline emissions
QA/QC procedures to be applied	See description of measurement methods and procedures to be applied
Purpose of data	Not applicable in this monitoring period
Calculation method	T CO_2e/ha
Comments	Not applicable in this monitoring period

Data / Parameter	$\overline{\Delta \mathrm{C}_{TREE,\mathrm{wp},\imath,\mathrm{t}}}$
Data unit	T CO_2e/ha
Description	Areal mean change in carbon stocks in trees in the baseline
Equations	Section 8.2.2 and (42)
Source of data	Determined in project area
Description of measurement methods and procedures to be applied	Calculated using the CDM A/R Tools Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities and Simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities implemented on lands other than wetlands.
Frequency of monitoring/recording	Monitoring must be conducted at least every five years or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	See description of measurement methods and procedures to be applied
Purpose of data	Calculation of baseline emissions

Calculation method	See description of measurement methods and procedures to be applied
Comments	Not applicable in this monitoring period

Data / Parameter	$\overline{\Delta C_{SHRUB,\mathrm{wp,i,t}}}$
Data unit	T CO_2e/ha
Description	Areal mean change in carbon stocks in trees in the baseline
Equations	Section 8.2.2 and (43)
Source of data	Determined in project area
Description of measurement methods and procedures to be applied	Calculated using the CDM A/R Tools Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities and Simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities implemented on lands other than wetlands.
Monitoring equipment	Monitoring must be conducted at least every five years or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	See description of measurement methods and procedures to be applied
Purpose of data	Calculation of baseline emissions
Calculation method	See description of measurement methods and procedures to be applied
Comments	Not applicable in this monitoring period

Data / Parameter	•
Data unit	Dimensionless
Description	Gas or pool
Equations	(51)–(54), (57), (65)
Source of data	Determined in sample unit *i*
Description of measurement methods and procedures to be applied	Only SOC pool assessed

Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Not applicable
Purpose of data	Calculation of baseline and project emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$\bar{\Delta}_{\bullet,t}$ and $\bar{\bullet}_t$
Data unit	t CO_2e/unit area
Description	Mean emission reductions from pool or source ●, or stock of pool ●, in year *t*
Equations	(53), (54), (65)
Source of data	Calculated from modeled or calculated values in the project area
Description of measurement methods and procedures to be applied	Value of 10.51 tCO_2e / ha across the project period calculated. Detailed calculations are made available in the “Net Emission Reductions & Uncertainty” workbook
Frequency of monitoring/recording	Calculations and recording must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
QA/QC procedures to be applied	Comparison of project results with values from peer-reviewed literature under similar conditions. Raw data from laboratory analysis as well as calculation spreadsheets and/or computer code used for calculations must be provided as requested by the VVB.
Purpose of data	Calculation of emission reductions
Calculation method	The mean emission reductions from pool or source •, or stock of pool •, at time *t* are estimated using unbiased statistical approaches, such as from Cochran (1977). Application of this methodology may employ sample units of unequal sizes, which would necessitate proper weighting of samples in deriving means.
Comments	None

Data / Parameter	*Buffer*$_{,t}$
Data unit	tCO_2e
Description	Number of buffer credits to be contributed to the AFOLU pooled buffer account in year *t*
Equations	Equation 87
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	Non-permanence risk of 20% to be applied applying the VCS AFOLU Non-Permanence Risk Tool
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event where verification occurs more frequently.
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
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

6.3 Monitoring Plan

The monitoring plan has been designed to provide an overview of Orizon's operations specific to this project. This section is a summary of the key components of monitoring, outlining our hands-on approach and direct involvement with our farmers. Key components of the monitoring plan that are detailed in the following sections include:

1. Descriptions of the methods used for generating/measuring, recording, storing, aggregating, collating, and reporting data and parameters.
2. The organizational structure, responsibilities and competencies of the personnel that carried out monitoring activities.

3. Policies for oversight and accountability of monitoring activities; procedures for internal auditing, QA/QC, identified non-conformities and the way in which the internal auditing process was handled.
4. Implementation of sampling approaches and their related aspects as well as whether the requirements for these have been met.
5. Monitoring of the different aspects related to productivity across the grouped project.

Our commitment to a robust monitoring plan encompasses both direct engagement with farmers for in-depth, contextual understanding and the continuous enhancement of remote monitoring technologies for efficiency, scalability, and improved data-driven decision-making. This hybrid approach ensures a holistic and comprehensive assessment of our CarbonCrop Rewards Programme while fostering a collaborative partnership with our farmers for sustainable success.

6.3.1 Organizational Structure

The organizational structure of Orizon is designed to ensure effective management, close collaboration with farmers, and strategic partnerships with key stakeholders. The monitoring and implementation of project activities in this grouped project as well as all data collection, internal auditing of the data and dissemination of information is co-ordinated by Orizon with certain team members being involved in several different aspects of the project. The following section provides an overview of the Organization and the responsibilities within the team with regards to monitoring specifically.

Within Orizon there are Account Managers for each of our clients. The following aspects are important components in their work and contribute to professional monitoring of the project activities and data received from the farmers:

1. **Account Managers with High Engagement:** Our dedicated account managers play a pivotal role in fostering strong relationships with farmers. Each account manager oversees a limited number of farmers and hectares to ensure personalized attention and effective support. With a commitment of more than three visits per year, they engage directly with farmers, providing guidance, support, and monitoring progress on implementing regenerative practices.
2. **Manageable Workload:** Limiting the number of farmers and hectares per account manager allows for a manageable workload. This ensures that account managers can dedicate sufficient time and attention to each farmer, facilitating effective implementation and monitoring of regenerative agriculture practices.
3. **Continuous Upskilling of Account Managers:** We prioritize the professional development of our account managers. Continuous training and upskilling programs are provided to equip them with the latest knowledge and tools in regenerative agriculture, soil health, carbon sequestration techniques, and effective farmer engagement strategies.

4. **Qualified Account Managers:** Our account managers are selected based on their qualifications, expertise, and experience in agriculture, environmental sciences, or related fields. Their diverse backgrounds and specialized knowledge contribute to providing tailored guidance and support to farmers.
5. **Strategic Partnerships:** Collaboration with various partner organizations forms a crucial aspect of our structure. These partners include cover crop seed companies, biological product companies, agricultural consulting firms, and other relevant stakeholders. These collaborations enable us to access expertise, resources, and innovative solutions that supplement our efforts in promoting regenerative practices and enhancing agricultural sustainability.

6.3.2 Upskilling and Training

The upskilling and training of our farmers is a core aspect of our monitoring of the project and aims to create the best environment for our farmers to succeed in their regenerative journey. Our approach involves different areas to enhance knowledge, promote best practices and foster an environment of continuous learning and improvement amongst our farmers. Some notable aspects of this upskilling and training include:

1. **Partnership training sessions**: Orizon conducted a comprehensive multi-day training session with farmers (including our current clients) from one of our biggest partners. This is an important avenue of farmer engagement and project implementation.
2. **Regular farm visits:** This is one of the foundations of our hands on approach when it comes to the relationships we are building with our farmers and future clients. Our team conducts frequent farm visits, directly engaging with farmers to provide guidance, troubleshoot issues, and observe firsthand the implementation of regenerative practices.
3. **WhatsApp group for farmer engagement:** We have established a WhatsApp group connecting farmers (not only those currently in the project). This platform serves as a dynamic space for sharing challenges, solutions, and intriguing observations. It fosters peer-to-peer learning and creates a supportive community where ideas are exchanged freely.
4. **Formal Training Program Development:** Orizon is diligently working on setting up a formal training program as there is a need for more training within the greater farming community regarding regenerative agriculture. This program will cover various aspects of regenerative agriculture and with the help of experts in the field will aim to bring more farmers into the regenerative fold in the future.
5. **Participation at Farmers Days:** Actively engaging in farmers' days and inviting our clients to these events has been very rewarding. With consistently high attendance rates, these events facilitate knowledge exchange, networking, and exposure to the latest trends and innovations in agriculture as well as providing our clients with important updates regarding the project.

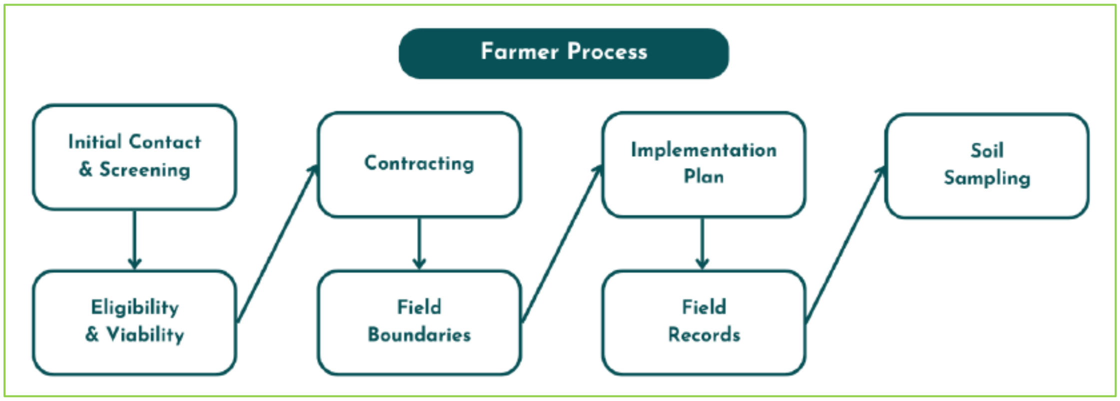
6. **Online courses and other tools:** To further augment learning opportunities, we encourage participation in online courses like the Soil Food Web course. These courses offer flexible learning platforms accessible to farmers, providing specialized knowledge to enhance their understanding of soil health and regenerative practices.
7. **Regenerative-minded agricultural consultants:** We connect our farmers and those not part of the programme with regenerative-minded consultants who bring specialized expertise. These consultants provide valuable guidance and support, aligning with our commitment to assisting farmers in making a success of their transition to more sustainable farming practices.

6.3.3 Signing up process, data collection, gap filling and Orizon software

Please refer to the document Orizon CarbonCrop Programme – Farmer Process and Field Records. This document contains commercially sensitive information and is therefore not shown here but has been submitted to the VVB.

However, the approach is summarised below:

The onboarding process followed when farmers show interest in Orizon's CarbonCrop Programme is illustrated below. Contact with farmers is typically made through word of mouth (referral by other farmers on the programme or by their consultants). All communications throughout the process are documented on Orizon's Platform. Multiple farm visits occur in the early stages of the onboarding process and throughout data collection across the monitoring period.



The Eligibility & Viability step ensures that the data-intensive process will be worthwhile for farmers and Orizon. The step ensures that farmers intend to adopt sufficient qualifying project practices such that the expected revenues from carbon credits will be sufficient to cover project and implementation costs and monitoring efforts.

Contracting involves an explanation of the Agreement to the farmer and the signing of the Carbon Development Agreement via DocuSign after sufficient time is given to the farmers to review contract details.

The implementation step involves careful planning of the implementation & scaling of project activities and the way in which data will be collected.

Field records involves the data collection of all relevant field activities across the baseline and project periods.

Following this, sufficient information is available to stratify the project area and determine the soil sampling strategy and locations.

Gap-Filling Procedures:

Where there are gaps in the farmer's data, the following gap-filling procedures are followed:

- Single Missing Data Points
  - Where single values for a field are missing (e.g. a single yield value for a field in a season), averages from other similar data points is used (e.g. the average yield for that crop in that season for other fields belonging to that farmer).
  - An attestation is obtained from the farmer to confirm its reasonability.
- Data Extrapolation
  - Where values are not available for an entire season (e.g. yield values are obtained for all seasons except one due to lost data), average values are indicated by the farmer and assessed for reasonability against the average data from the other seasons.
  - An attestation is obtained from the farmer to confirm its reasonability.
- Data Generation
  - In rare cases where no data is available for a type of field event, this is typically based on agronomist / qualified independent local expert recommendations
  - For example, where no chemical sprays were recorded, an expert recommendation is received for a spraying programme. This is compared to other data received for its consistency.
  - An attestation is obtained from the farmer to confirm its reasonability.
- Regional Baselines
  - In cases where a field does not have any data available before project implementation, it is assumed that the pre-project activities would have been implemented and therefore, a regional baseline is assigned to the field in line with the Box 1 hierarchy of VM0042.

- The regional baseline is based on attestations from expert qualified independent local experts as well as regional (provincial) data, in line with point 3 and 4 of Box 1 of VM0042.

These gap-filling procedures only had to be applied in a few cases as field records were generally available.

6.3.4 Stratification and soil sampling

Please refer to the document Orizon CarbonCrop Programme – Soil Sampling and Stratification. This document contains commercially sensitive information and is therefore not shown here but has been submitted to the VVB.

However, the approach is summarised below:

All project fields are grouped into field clusters based on management practice similarities. These clusters are further divided into strata based on the dominant soil carbon driving properties of each individual field. Each stratum is sampled in accordance with its size with larger strata containing more sample locations than smaller strata. The sample locations are randomized and will remain the same throughout the project crediting periods.

The Stratification and Sample Point Determination Design effectively follows a 6-step approach, summarised as:

1. Defining farms within the project boundaries (Each farming operation is defined separately – i.e. a stratum cannot contain fields from two separate farming operations)
2. Mapping fields (Fields provided by project participants are disaggregated further into the smallest unit of similar management. Detailed field mapping by trained Orizon staff to ensure field integrity, such as accurate external boundaries and internal boundaries to remove trees, contours/terraces, roads, pivots, buildings, etc.)
3. Defining clusters of fields (Management clusters are separate fields which are managed and will be managed similarly – i.e. whether irrigated or dryland, same rotation is followed, similar tillage practices followed, cover cropping strategy, grazing strategy, etc. These field groups form the first phase of stratification, ensuring that there are no large variations in past or planned management practices between stratum)
4. Delineating strata per field cluster (Field clusters based on management practices are then further divided into stratum based on dominant soil properties, such as clay and topography. This analysis is done using SRTM 3 arcsecond elevation data and SoilGrids2.0)
5. Randomized sampling per stratum (the number of samples is based on the strata size and locations are determined using a random point script in QGIS. These points are saved and uploaded onto Fulcrum for sampling by the soil sampling teams)

6. Sampling top-up assessment (where it is determined that the number of samples or strata is insufficient for a farmer, this may be topped up to include a higher sampling density than applied on average)

Sampling:

Each sample point contains 4 sub-samples within a 10m radius of the pre-determined sampling location. Sampling teams record the location of the sample through the Fulcrum application, along with details of the location, field observations, photos of the sample, etc.

Soil surface organic materials are cleared before sampling and an AMS corer is used for all sub-samples on all sampling points (except where the soil type results in ineffective sampling with this equipment). Therefore, the in-field volume of the sample is known at each location and a bulk density can be determined based on this after laboratory analysis is performed. Where the AMS corer does not result in a good sample (e.g. high clay content where the corer is not filled), other methods to ensure in-field volumes are known include a bulk density ring and a water-volume determination method of an augered hole. Therefore, SOC and soil mass are always obtained from the same sample.

Samples are taken to a depth of 30cm as a single core. Split depths will be taken in future sampling events to allow comparison of SOC stocks on an Equivalent Soil Mass (ESM) basis to match the effective mass / ha of the fine soil of the first sampling event.

Re-sampling will be performed every 3-4 years on a rotational basis, while some locations will be sampled annually to obtain more detailed SOC trends across time and aid in future model calibrations.

Samples are stored in cool & dark conditions, within aerated plastic bags and shipped to the laboratory within 5 days after sampling.

Laboratory procedures:

All analysis is being performed by the same laboratory to ensure consistency in analysis. The lab performs drying, sieving (of 2mm fragments) and homogenizing procedures consistently in line with best practices and the laboratory's SOPs.

A "fizz" test using hydrochloric acids is performed on a subset of samples from each farmer and sampling batch to determine the presence of inorganic carbonates. If any sample showed a presence of inorganic carbonates, all samples are tested for carbonates and, where present, the inorganic soil carbon component is measured.

All weights before and after drying and before and after sieving for >2mm fragments are recorded by the laboratory.

Dry Combustion is used for testing Soil Organic Carbon using a LECO instrument.

Processing & Quality Control:

Received laboratory results are assessed by Orizon staff for its integrity and any outliers or inconsistencies are investigated. Other quality control tests initiated by Orizon, such as split samples and repeat analysis, are performed regularly in addition to the laboratory's internal controls.

Results are processed to calculate the bulk density and tSOC/ha of the soil at the time of sampling. The ESM to be achieved on a subsequent sampling event is also recorded.

Reports are generated and discussed with each farmer to further identify any anomalies and ensure the results make sense based on their observations.

Further details are included in the "Orizon CarbonCrop Programme – Soil Sampling and Stratification" report and calculations of soil carbon and laboratory analysis in the "Orizon Sample List - 2023 (Final)" workbook.

6.3.5 QA/QC Processes for Data Review and Integrity Processes

Please refer to the document Orizon CarbonCrop Programme – QA & QC. This document contains commercially sensitive information and is therefore not shown here but has been submitted to the VVB.

However, the approach is summarised below:

QA/QC procedures are incorporated in every element of Orizon's processes, from the first contact with farmers, to the project planning, to the project implementation, data collection, data processing, etc. It is impracticable to list all of these specific QA/QC controls, and therefore, only a few approaches and examples are mentioned below:

- Internal review & sign off (e.g. each field boundary must be signed off by 2 Orizon staff members before being included in the project)
- Trend analysis is performed as a high-level reasonability check on all key indicators (e.g. yields across time)
- Careful planning (e.g. farm visits are carefully planned to ensure they are optimised)
- Designed processes (i.e. each process is designed and involves templates or Orizon platform designs which are repeatable to ensure consistency)
- Workbook integrity checks (i.e. each workbook contains many integrity checks which give feedback on any errors which do not follow pre-designed rules/thresholds)

- Double verification (i.e. each field record obtained from a farmer is verified twice (e.g. cover crop planting record and NDVI assessment), unless the initial evidence is of sufficient quality (e.g. a yield map obtained directly from the farmer's machine records))
- Site visits (multiple annual site visits ensure we are in constant communication with farmers and are able to identify any concerns)
- Training (e.g. soil sampling teams undergo a full day of technical training followed by a week of in-field training to ensure consistency)

The above are just a few ways in which quality of the project is ensured.

6.3.6 Calculations and Modelling Processes

Please refer to the document Orizon CarbonCrop Programme – Calculations & Modelling Process Flow. This document contains commercially sensitive information and is therefore not shown here but has been submitted to the VVB.

However, the approach is summarised below:

Collected data (i.e. field events per field) is all recorded on Orizon's platform. This forms the foundation of all GHG emission changes and SOC stock changes calculations and modelling. Section 7 contains a breakdown of this process. As a basic overview, the following procedures are planned and performed:

1. Data collection & verification procedures
2. Data integrity review procedures
3. Emissions calculations and SOC modelling using the validated model on a farmer-level
4. Calculations and modelling integrity checks and sign-off
5. Farmer emissions data aggregation across the grouped project

SOC modelling is performed using the validated RothC model (validated by an Independent Model Expert (IME) and the VVB). Future versions / updates of this model will be re-validated by an IME. Results are checked for integrity and reasonability.

Non-SOC calculations (i.e. QA3 calculations) are performed on the Orizon Platform by the coded emissions calculations and lookup tables. These calculations are re-performed as an integrity check in the "Farmer Emissions Summary" workbooks for each farmer as an integrity check. These are based on the calculation rules of VM0042 and the specific lookup tables for local applicable values as determined through our literature review.

Trend analysis is performed on all emissions by farmer and by emissions category to ensure they are in line with our expectations (e.g. an increase in livestock grazing days will result in increased livestock-related emissions in the project).

The Outputs from the “Farmer Emissions Summary” workbooks from each farmer are combined into a single excel workbook combining all results from all farmers (“Net Emission Reductions & Uncertainty Workings - July2022” workbook). At a grouped project level, uncertainty deductions, buffer credits and leakage considerations are computed.

The “Collective Farmer Data (July 2022 Monitoring)” workbook complements the “Net Emission Reductions & Uncertainty Workings - July2022” workbook and serves the main purpose of interpreting grouped level data and categorizing all fields into different PC-CFG combinations for purposes of calculating uncertainty.

6.3.7 Monitoring of livestock and other productivity-related parameters in the project

Monitoring of productivity will be an ongoing process. In addition to training of Orizon staff to identify any factors which could indicate a productivity issue should be investigated (such as observation of badly performing cash crops or indications by the farmers during site visits that their yields are dropping, etc.), annual assessments relating to productivity will also be performed, including:

- An annual literature and research review of the short-, medium- and long-term effect of the project practices on yields and livestock productivity.
- An analysis of the aggregated yield and livestock data provided by farmers annually and the comparison of trends of the yields of project participants against trends, in line with the equations (35) and (36) of VM0042 v2.0

In addition to ex post assessments of productivity, Orizon also continuously engages with farmers to ensure the successful implementation of project activities and the limitation of any negative impacts on yields, and to improve on-farm productivity relating to crops and livestock.

Livestock are an integral part of the project and an important component of Orizon’s overall responsibilities in terms of the monitoring of this project. Livestock data (animal numbers, grazing dates, livestock type & frame size, etc.) is directly obtained from farmer records and consultations. Orizon will continue to monitor livestock numbers by obtaining stock count sheets, monthly excel records, records of sales, veterinary visits, number of deaths and births recorded and other forms of farm record data that is provided. Livestock groups were and will be inspected by Orizon representatives.

The productivity of cash crops will be monitored through yield data. For each project instance, where possible, this data is obtained and monitored at the field level from farm records for the baseline (historical look-back period) and the project scenario. This data will be collected on an annual basis to continue the monitoring of the project activities’ impact on productivity to ensure that no significant (>5%) yield losses take place. Where analysis is required compared to regional data (when introducing a new crop/livestock product not present in the historical look-back period) this data is obtained from GrainSA who provide annual data on yields of various crops at a provincial level. This is monitored annually, and the leakage analysis is done at a minimum every 10 years as required by the methodology.

7 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

The quantification of GHG emissions reductions and removals have several process steps and workbooks associated with each step. The complexity of the project and inclusion of multiple instances make it difficult to show aggregated values for each parameter.

Therefore, this Project Description provides summaries of results and an example flow of the calculations for certain events while the supporting reports and workbooks provide detailed calculations and reconciliations of all quantifications.

The process is outlined below, and a split is shown between workbooks and processes which are performed for every project instance and those which are performed once for the aggregated project:

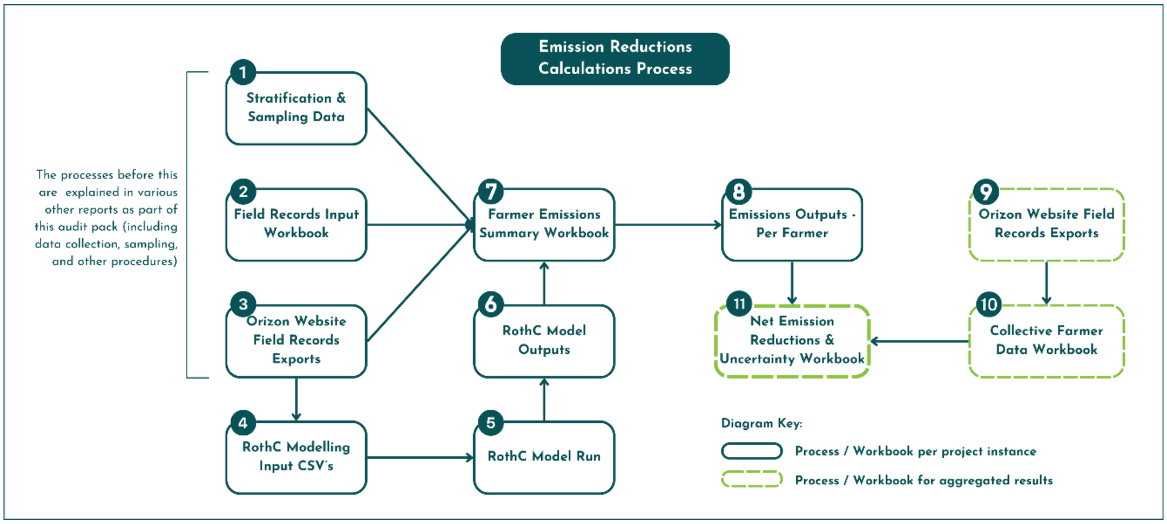
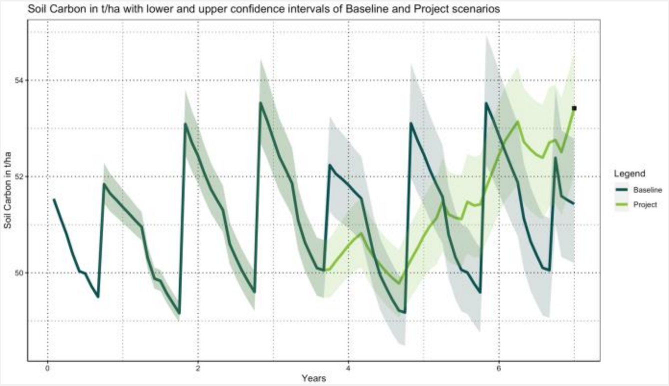


Figure 7.1: Process flow for the calculation of project emission reductions and removals

Process number & name	Details of workbook / process	Workbook name/s

[1] Stratification & Sampling Data	• Shows all strata codes, sample codes, sample locations, associated fields, sample results, etc. • Provides the data export from Fulcrum, an app in which all sampling activities were recorded • Shows calculations of rocky fragments, net bulk density, total soil stocks, total SOC stocks, etc. based on sample results • Lists equipment used, number of sub-samples / cores in the composite and sample depth per sample, along with all other relevant details	Orizon Sample List – 2023 (Final)
[2] Field Records Input Workbook	• Lists all fields, hectares, field-level project start dates, field inclusion, etc. • Contains the field records data per farmer across all activities (tillage, cash crops, cover crops, fertilizer applications, liming, livestock movements, etc.) – per field included in the project • Contains the farmer's stratification data from the R-scripts and QGIS processes followed • Runs integrity checks on the data	*[Per Farmer]* Field Records Inputs – Farmer Name
[3] Orizon Website Field Records Exports	• Lists each event recorded on Orizon's data collection platform, with its associated details, such as: ○ For each individual grazing event, the field, season, start date, end date, livestock type, frame size, number of mature animals, number of young animals are listed ○ For each fertilizer event, the field, season, application date, application rate, product type, nutrient mix, portion of field applied, application method, etc., are listed • Exports also include a "QA3 Data" csv which calculates the non-SOC emissions of each event in line with the Quantification Approach 3 guidelines	A csv per farmer per type of field activity is exportable from Orizon's data collection platform
[4] RothC Modelling Input CSV's	• Contains input values required by RothC in a csv format (primarily yields, cover crop biomass, livestock grazing days, organic inputs, etc.) • Contains monthly time steps with all data for that month being aggregated • Contains the sampling data used to initiate the model, or to back-model to the project start date • Inputs are based on the field on which the sample was taken A separate report is available which details the rules around the RothC csv generation.	A csv per sample point is exportable from Orizon's data collection platform in a format which is readable by the calibrated RothC model

[5] RothC Model Run	• The model is run per individual sampling point using the RothC Modelling Input CSVs described above • The process is semi-automated, running all sample points with their respective associated field data and sampling data for a farmer within a few minutes	n/a
[6] RothC Model Outputs	• The csv contains data on the sample codes, monthly modelled values for the project scenario and the baseline scenario • The graph illustrates the movements in SOC and allows for a quick sense check of the results • Below is an example graph from the outputs folder of a farmer included in the project:  	A csv per sample point is exported by the RothC model, along with a graph of the baseline and project SOC movements and a csv listing all the results from all samples of a farmer
[7] Farmer Emissions Summary Workbook	• Data for each farmer was copied into a template workbook which brings together all data to calculate net emission reductions and perform several other checks • The non-SOC emissions are exported from the website and uploaded into this workbook where automated checks are run which effectively re-calculate the emissions of each recorded event, showing the calculation logic • The SOC emission flux is calculated by obtaining the RothC results in csv format, after which the workbook automates the calculation by calculating average SOC differences per strata (for all samples within the strata) and applies the average results to the hectares of the entire strata • The primary purpose is to calculate net emission reductions and provide exportable summary tables of these which can be used in a combined document to calculate grouped project aggregate emission reductions / removals • The secondary purposes of the document are to: ○ Review exported website data against the field records input excel per farmer	*[Per Farmer]* Farmer Emissions Summary – Farmer Name

	○ Run integrity checks to ensure sample codes, hectares, strata, RothC results, etc. all align ○ Run integrity checks ensuring starting SOC is the same in the project and in the baseline amongst many other checks ○ Provide graphs of field record activities and emission trends to ensure the results are in line with our expectations	
[8] Emissions Outputs	• An extract of the Output tabs of the Farmer Emissions Summary workbook	*[Per Farmer]* Final Output – Farmer Name
[9] Orizon Website Field Records Outputs	• Similar to document [3], but a complete dump including all 22 farmers within the project	Exportable from the website
[10] Collective Farmer Data Workbook	• Contains the dump of all events on all project fields across all types of field activities (from mm irrigated, chemical sprays, grazing events, tillage passes, etc.) • Runs analyses on the events, hectares of each type of event, etc. • Allows for the categorization of fields into PC-CFG combinations for uncertainty considerations and into practice activity groups for additionality calculations • Assesses adoption rates per geographic area, productivity, etc. • Provides an exportable data sheet which is imported into the final document [11]	Collective Farmer Data
[11] Net Emission Reductions & Uncertainty Workbook	• Imports all SOC and non-SOC related emissions per farmer and summarizes the results • Performs integrity checks to ensure data integrity remained throughout the process, reconciling emissions, total hectares per season, number of fields, number of samples, hectares per strata, etc. • Computes the uncertainty deduction by assessing the total variance across all strata to arrive at a sampling error and combining with a model prediction error weighted for the activities occurring in the project • Calculates net VCUs showing all summarized results	Net Emission Reductions & Uncertainty Workbook

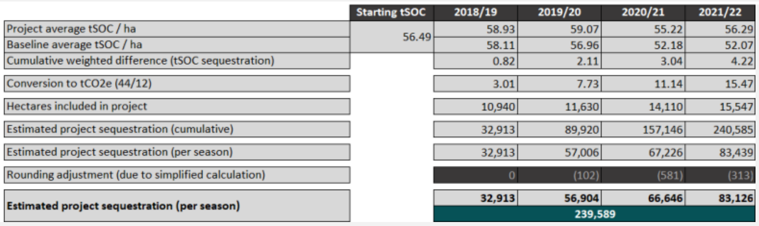
For calculations where Quantification Approach 3 was applied, IPCC default values were applied using the Tier 1 method. This was necessitated by the lack of data available for a Tier 2 approach.

Due to the data structure and aggregation of multiple project instances, most parameter values could not be summarised into a single value for the purposes of this report. For example, biomass of N-fixing species returned to the soil includes residues and root biomass from legumous cash crops, as well as the ungrazed biomass of legumous cover crops. The emissions computations were performed by our software per single event, and it is impracticable to aggregate all data across all events.

As a more practical solution, and to aid the understanding of our processes, an example equation is provided in each emission category section below. These examples are presented to provide the reader with the logic flow and a simplistic view of the calculation approach to make sense of what is a complex project involving several different project activities across 22 project instances. The workbooks provide summaries as well as event-level emission computations and details parameters on a more disaggregated basis. More details regarding the specific data and parameters used in the calculations can also be found in section 7.1 below.

The equations from the methodology have been presented in section 5 and the format will follow the same order of emissions categories in section 7.2 to 7.5. The example equations consist of values taken from one of our project instances.

7.1 Data and Parameters Monitored

<table>
<tr><td>Data / Parameter</td><td>Ƒ($SOC_{bsl,i,t}$)</td></tr>
<tr><td>Data unit</td><td>t CO_2e/ha</td></tr>
<tr><td>Description</td><td>Modeled SOC stocks in the baseline scenario for sample unit i at time t, calculated by modeling SOC stock changes over the course of the preceding year</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th></th><th>Starting tSOC</th><th>2018/19</th><th>2019/20</th><th>2020/21</th><th>2021/22</th></tr>
<tr><td>Project average tSOC / ha</td><td>56.49</td><td>58.93</td><td>59.07</td><td>55.22</td><td>56.29</td></tr>
<tr><td>Baseline average tSOC / ha</td><td></td><td>58.11</td><td>56.96</td><td>52.18</td><td>52.07</td></tr>
<tr><td>Cumulative weighted difference (tSOC sequestration)</td><td></td><td>0.82</td><td>2.11</td><td>3.04</td><td>4.22</td></tr>
<tr><td>Conversion to tCO2e (44/12)</td><td></td><td>3.01</td><td>7.73</td><td>11.14</td><td>15.47</td></tr>
<tr><td>Hectares included in project</td><td></td><td>10,940</td><td>11,630</td><td>14,110</td><td>15,547</td></tr>
<tr><td>Estimated project sequestration (cumulative)</td><td></td><td>32,913</td><td>89,920</td><td>157,146</td><td>240,585</td></tr>
<tr><td>Estimated project sequestration (per season)</td><td></td><td>32,913</td><td>57,006</td><td>67,226</td><td>83,439</td></tr>
<tr><td>Rounding adjustment (due to simplified calculation)</td><td></td><td>0</td><td>(102)</td><td>(581)</td><td>(313)</td></tr>
<tr><td rowspan="2">Estimated project sequestration (per season)</td><td rowspan="2"></td><td>32,913</td><td>56,904</td><td>66,646</td><td>83,126</td></tr>
<tr><td colspan="4">239,589</td></tr>
</table>
Note that the amounts are also not indicative of actual SOC values as farmers of lower average SOC were added in later years, decreasing the average SOC in those years (e.g. 2020/21 onwards) artificially. The tables are shown for reconciliation purposes.</td></tr>
<tr><td>Comments</td><td>The SOC stocks at time <i>t</i> = 0 are calculated based on directly measured SOC content and bulk density at <i>t</i> = 0 or (back-)</td></tr>
</table>

	modeled to *t* = 0 from measurements within ±5 years of *t* = 0. See Section 8.2.1 for requirements for SOC content and bulk density measurements.

Data / Parameter	*i*
Data unit	Dimensionless
Description	Sample unit: defined area that is selected for measurement and monitoring, such as a field or stratum; see also definition in Section 3
Value applied	650 samples for SOC modelling All 905 fields included for non-SOC monitoring
Comments	None

Data / Parameter	*Ai*
Data unit	Hectare
Description	Area of sample unit *i*
Value applied	15,547 ha in total (area per field sampled and area per strata provided in detailed workbooks). Average of 23.92 ha per sample. Average of 17.18 ha per field. A sample unit was sampled in a 10m radius circle, with all calculations and modelling being performed on a “per hectare” basis
Comments	Other units used to determine area (e.g., acres) must be converted to hectares.

Data / Parameter	*j*
Data unit	Dimensionless
Description	Type of fossil fuel combusted
Value applied	Fuel types in the project instances: • Diesel • Gasoline • Biodiesel (only in 1 instance for a portion of fuel used in both baseline and project scenarios)

Comments	None

Data / Parameter	$EF_{CO2,j}$
Data unit	t CO_2e/liter
Description	Emission factor for the type of fossil fuel *j* (gasoline or diesel) combusted
Value applied	For gasoline EF_{CO2}=0.002810 t CO_2e per liter. For diesel EF_{CO2}=0.002886 t CO_2e per liter. For biodiesel EF_{CO2}=0.00081
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)

<table>
<tr><td>Data / Parameter</td><td>$FFC_{wp,j,i,t}$</td></tr>
<tr><td>Data unit</td><td>Liters</td></tr>
<tr><td>Description</td><td>Consumption of fossil fuel type j for sample unit i in year t in the project scenario</td></tr>
<tr><td>Value applied</td><td>
Common Farming Fuel-related Activities
<table>
<tr><th>Activity</th><th>Fuel Consumption (l/ha)</th></tr>
<tr><td>Spray</td><td>1.94</td></tr>
<tr><td>Plant</td><td>2.56</td></tr>
<tr><td>Fertilizer/Lime spreading</td><td>6.89</td></tr>
<tr><td>Harvest</td><td>15.33</td></tr>
</table>
Common Tillage Activities
<table>
<tr><th>Tillage Type</th><th>Fuel Consumption (l/ha)</th></tr>
<tr><td>Mouldboard plough</td><td>16.16</td></tr>
<tr><td>Heavy disk (one-way or offset)</td><td>6.19</td></tr>
<tr><td>Chisel plough</td><td>6.66</td></tr>
<tr><td>Ripper plough</td><td>9.11</td></tr>
<tr><td>Light disc harrow</td><td>2.65</td></tr>
</table>
Other Fuel Consumption Activities
<table>
<tr><th>Activity</th><th>Fuel Consumption (l/ha)</th></tr>
<tr><td>Mowing</td><td>4.85</td></tr>
<tr><td>Raking</td><td>4.85</td></tr>
</table>
</td></tr>
</table>

Baling	8.31

The average consumption (litres/ha) across our project area in the respective project years were as follows:

2018/19 season	2019/20 season	2020/21 season	2021/22 season
41.75	35.53	36.87	38.55

The categories for our calculation currently include tillage activity, planting activity, spraying activity, and harvesting activity with associated values for each category based on the type of machinery used.

Please see Section 8 Appendices – QA3 Emission Calculations report Table 8 for all applicable fuel usage per hectare values.

Comments

Data / Parameter

$M_{Limestone,wp,i,t}$ and $M_{Dolomite,wp,i,t}$

Data unit

Tonnes/year

Description

Amount of calcitic limestone ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$) applied to sample unit *i* in year *t* in the baseline scenario

Value applied

Amount of calcitic limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$) applied to sample unit *i* in year *t*

There were a total of 1,349 liming events recorded in the project periods of all farmers across the years.

The total liming applications (mixes of gypsum, dolomite, calcitic and carrier sand) are detailed below, at an average of 0.87t/ha across the project period:

	2014/ 15	2015/ 16	2016/ 17	2017/ 18	2018/ 19	2019/ 20	2020/ 21	2021/ 22
Total t applied	-	-	-	-	11,820	8,863	11,319	13,667

Calcic limestone ($CaCO_3$) applications (only including the calcitic portion of the product) are detailed below [$M_{Limestone,wp,i,t}$], at an average of 0.63t/ha across the project period:

	2014/ 15	2015/ 16	2016/ 17	2017/ 18	2018/ 19	2019/ 20	2020/ 21	2021/ 22
Total t applied	-	-	-	-	9,605	6,228	7,068	10,039

	Dolomite ($CaMg(CO_3)_2$) applications (only including the calcitic portion of the product) are detailed below [$M_{Dolomite,wp,i,t}$], at an average of 0.10t/ha across the project period:

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Total t applied	-	-	-	-	545	1,101	2,155	1,289

Comments	

Data / Parameter	$EF_{Limestone}$ and $EF_{Dolomite}$
Data unit	t C/(t limestone or dolomite)
Description	Emission factor for the application of calcitic limestone (CaCO3) and dolomite (CaMg(CO3)2) (i.e., liming)
Value applied	Value defined per type of product. Information provided in the supporting documents – QA3 Emission Calculations. Raw CaCO3 and CaMg(CO3)2 used the default values of 0.12 and 0.13 respectively. However, in practice the product types contain only around 70 – 90% calcitic or dolomitic lime. Therefore, an effective emission factor was calculated per type of product.
Comments	

Data / Parameter	$EF_{ent,l,P}$
Data unit	kg CH_4/(head x year)
Description	Enteric emission factor for livestock type *l* and productivity system *P*
Value applied	

Livestock Type	Value
Dairy cattle	76
Other cattle	52
Sheep	7
Swine	1.25
Goats	7

Comments	For all livestock events we have used the amended calculation as per the Methodology Deviation where only the grazing days spent on the project field are accounted for in the emissions calculations.

Data / Parameter	$Days_{wp,I,l,t,P,S}$

Data unit	Days
Description	Average grazing days per head in the project scenario inside sample unit *i* for each livestock type *l* in year *t*
Value applied	Variable, depends on specific data obtained from the farmer for each livestock event on the specific project field. For the initial project instances, there were 3,585 individually recorded livestock grazing events during the project period. These included mostly Beef Cattle, with some Dairy Cattle and Sheep. The average grazing days / ha across the project period was 113.12 days/ha (calculated as the effective average when converting all livestock units to an equivalent unit based on their relative daily intake). As the number of grazing days varies per event, it is impracticable to display/summarise all these values. For the fields which were grazed, grazing timeframes per field grazing event typically ranged from just a few days to more than 180 days, depending on the field size and available fodder. Average grazing timeframes in the Project Period were 68.30 days per grazing event, sometimes with multiple grazing events per field on cover crops.
Comments	Farmer data field records provides the number of days for grazing events per livestock group.

<table>
<tr><td>Data / Parameter</td><td>$Pop_{wp,l,l,t,P}$</td></tr>
<tr><td>Data unit</td><td>Head</td></tr>
<tr><td>Description</td><td>Population of grazing livestock of type l in the project scenario in sample unit i for productivity system P in year t</td></tr>
<tr><td>Value applied</td><td>Variable, depends on specific data obtained from the farmer for each livestock event on the specific project field.
For the initial project instances, there were 3,585 individually recorded livestock grazing events during the project period. These included mostly Beef Cattle, with some Dairy Cattle and Sheep. The average grazing days / ha across the project period was 113.12 days/ha (calculated as the effective average when converting all livestock units to an equivalent unit based on their relative daily intake).
<table>
<tr><th></th><th>2014/15 season</th><th>2015/16 season</th><th>2016/17 season</th><th>2017/18 season</th><th>2018/19 season</th><th>2019/20 season</th><th>2020/21 season</th><th>2021/22 season</th></tr>
<tr><td>Beef Cattle</td><td>-</td><td>-</td><td>-</td><td>-</td><td>6,737</td><td>8,668</td><td>8,863</td><td>9,937</td></tr>
</table>
</td></tr>
</table>

Dairy Cattle	-	-	-	-	61	197	400	474
Sheep	-	-	-	-	3,464	3,777	4,924	6,568

The above table shows the mature livestock populations across the project years. Note that the hectares increase with time as project instances are added to the project.

The average $Pop_{wp,l,i,t,P}$ per hectare across the project period was 0.655, 0.022 and 0.359 for Beef Cattle, Dairy Cattle and Sheep respectively.

Livestock populations for purposes of SOC modelling and emissions quantifications were further disaggregated by relative frame size and maturity (i.e. age). And other info, such as supplemental feed, whether they only spend a portion of the day on the project area, the grazing density, etc. was also collected per grazing event.

Comments	Farmer data field records provides the livestock populations for grazing events per livestock group.

Data / Parameter	*l*
Data unit	Dimensionless
Description	Type of livestock
Value Applied	Cattle – Beef Cattle – Dairy Sheep Goats Pigs Chicken Broilers Chicken Laying
Comments	For cattle, sheep, pigs and goats there are further classifications for average weight i.e., small, medium and large with associated kg weights based on data provided by our farmers.

Data / Parameter	P
Data unit	Unitless

Description	Productivity system
Value applied	The mean values from the relevant IPCC tables have been applied for the first monitoring period for default values where IPCC has values for high, low, and mean for productivity systems.
Comments	Due to a lack of data specific to livestock in the project due to the management systems of livestock on pasture in South Africa. We have applied the mean values as this is more conservative than applying the lower values generally for low productivity systems, which most of our instance potentially would qualify for if the data was available to make the classification.

Data / Parameter	$AWMS_{l,l,t,P,S}$
Data unit	Dimensionless
Description	Fraction of total annual volatile solids for each livestock type *l* that is managed in manure management system *S* in the project area, for productivity system *P*
Value applied	1.0
Comments	All manure deposited in our project instances is in the same manure management system category, per livestock group. For example, cattle manure applied all comes from the same manure management system category as does the chicken litter that is applied. We have therefore applied the 100% value to this parameter.

Data / Parameter	$EF_{CH4,md,l,P,S}$
Data unit	g CH_4 / (kg volatile solids)
Description	Emission factor for methane emissions from manure deposition for livestock type *l* in productivity system *P* and manure management system *S*
Value applied	0.6
Comments	The emission factor is determined based on livestock type. A value of 0.6 is applied for all animals in both low and high productivity pasture, range, and paddock systems per Table 10.14 of the same

	chapter. All livestock in the project instances thus far are pasture based.

Data / Parameter	*S*
Data unit	Unitless
Description	Manure management system
Value applied	Pasture/range/paddock (PRP) as per Table 10.18 Volume 4 Chapter 10 IPCC (2019)
Comments	The manure management system in the project instances is pasture/range/paddock based on the livestock spending all their time on the non-project and project fields and not housed anywhere.

Data / Parameter	$VS_{rate,l}$
Data unit	kg volatile solids/(1000 kg animal mass x day)
Description	Default volatile solids excretion rate for livestock type *l* and productivity system *P*
Value applied	See table below
Comments	Source: Mean values from Table 10.13a Volume 4 Chapter 10 IPCC (2019)

Livestock Type	Value
Dairy Cattle	18.20
Other Cattle	12.00
Sheep	8.30
Goats	10.40
Pigs	7.20
Chicken - Broilers	15.90
Chicken - Laying	10.20

Data / Parameter	$W_{wp,l,i,t,P}$
Data unit	kg animal mass/head
Description	Average weight in the baseline scenario of livestock type *l* for

<table>
<tr><td></td><td>sample unit <i>i</i> in productivity system <i>P</i> in year <i>t</i></td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><td>Livestock Type</td><td>Small (kg)</td><td>Medium (kg)</td><td>Large (kg)</td></tr>
<tr><td>Dairy Cattle</td><td>325</td><td>550</td><td>700</td></tr>
<tr><td>Other Cattle</td><td>325</td><td>550</td><td>700</td></tr>
<tr><td>Sheep</td><td>37.5</td><td>70</td><td>90</td></tr>
<tr><td>Goats</td><td>35</td><td>60</td><td>75</td></tr>
<tr><td>Pigs</td><td>100</td><td>200</td><td>250</td></tr>
<tr><td>Chicken Broilers</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Chicken Laying</td><td>1</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

Data / Parameter	CF_c
Data unit	Proportion of pre-fire fuel biomass consumed
Description	Combustion factor for agricultural residue type *c*
Value applied	Various
Comments	Values taken from Table 2.6, Chapter 2, Volume 4 in IPCC (2019). No burning events in the initial instances in the project and baseline periods.

Data / Parameter	$EF_{c,CH4}$
Data unit	g CH_4/kg dry matter burnt
Description	Methane emission factor for the burning of agricultural residue type *c*
Value applied	Various
Comments	Values taken from Table 2.5, Chapter 2, Volume 4 in IPCC (2019). No burning events in the initial instances in the project and baseline periods.

Data / Parameter	*C*
Data unit	Dimensionless
Description	Type of agricultural residue
Value applied	Various
Comments	No burning events in the initial instances in the project and baseline periods.

Data / Parameter	$MB_{wp,c,l,t}$
Data unit	Kilograms
Description	Mass of agricultural residues of type c burned in the project for sample unit i in year t
Value applied	0
Comments	Determined either by estimated yields for that season (cash crops more likely to have this data) or through use of our biomass tool to estimate amount of aboveground dry matter present when the fire occurred. No burning events in the initial instances in the project and baseline periods.

Data / Parameter	$EF_{Ndirect}$
Data unit	t N_2O-N/t N applied
Description	Emission factor for direct nitrous oxide emissions from N additions from synthetic fertilizers, organic amendments, and crop residues
Value applied	A value of 0.01 is applied for N additions from synthetic fertilizers, organic amendments and crop residues, and N mineralized from mineral soil as a result of loss of SOC. Disaggregated values were used as follow: • A value of 0.016 is applied for inputs of synthetic fertilizer and fertilizer mixtures that include both synthetic and organic forms of N. in wet climates • A value of 0.006 is applied for other N input as organic amendments, animal manures, N in crop residues and mineralized N from SOC decomposition in wet climates

	• A value of 0.005 is applied to all N inputs in dry climates
	• A value of 0.003 is applied for manure from sheep and ‘‘other animals”
	• For manure from cattle (dairy, non-dairy and buffalo), poultry and pigs, disaggregated values were used as follow:
	    • A value of 0.006 is applied for wet climates
	    • A value of 0.002 is applied for dry climates

Comments	Where project proponents can justify a lack of sufficient activity data and project-specific information sources, an appropriate disaggregated Tier 1 value from Table 11.1, Chapter 11, Volume 4 in IPCC (2019) may be selected. The emission factor is applicable to N additions from mineral fertilizers, organic amendments and crop residues, and N mineralized from mineral soil as a result of loss of SOC. Wet climates occur in temperate and boreal zones where the ratio of annual precipitation to potential evapotranspiration is greater than 1, and in tropical zones where annual precipitation is greater than 1000 mm. Dry climates occur in temperate and boreal zones where the ratio of annual precipitation to potential evapotranspiration is less than 1, and in tropical zones where annual precipitation is less than 1000 mm. See Table 22 in QA3 Emission Calculations document for the comprehensive list of values for synthetic and organic fertilizers. See Table 29 in QA3 Emission Calculations document for the comprehensive list of values for manure deposition by livestock. See Table 25 in QA3 Emission Calculations document for the comprehensive list of values for n-fixing species.

Data / Parameter	NC_{SF}
Data unit	t N / t fertilizer
Description	N content of synthetic fertilizer type *SF*
Value applied	Various, depending on the product and event details. There are 4,436 synthetic fertilizer application events in the project period with varying rates of N-content in the 105 different products/mixes used. Each individual event’s product ratios have been used in the calculation of this parameter.

	Average N-content of all fertilizer applied in the project was 19.47% (i.e. NC_{SF} = 0.1947). The most commonly applied fertilizer was Urea (42% of all fertilizer quantities) where the N-content is 46% (i.e. NC_{SF} = 0.46)
Comments	The nitrogen content is dependent on the ratio of the nutrients in NPK fertilizers for example, % amount of nutrients per kilogram fertilizer or if not in a ratio, then the % N such as in Urea.

Data / Parameter	SF
Data unit	Dimensionless
Description	Type of synthetic N fertilizer
Value applied	• Urea • Ammonium-based • Nitrate-based • Ammonium nitrate-based • Mix (Aggregated value) • Unknown / Not Applicable (Aggregated value)
Comments	In our project there are various synthetic fertilizers that have been categorized into the above IPCC categories in order to use the disaggregated values for FracGASF in Table 11.3 in Volume 4 Chapter 11 IPCC (2019) for more accurate calculation of emissions.

Data / Parameter	$M_{wp,SF,I,t}$
Data unit	t fertilizer
Description	Mass of N-containing synthetic fertilizer SF applied in the project for sample unit i in year t
Value applied	Various values provided per event based on management records. There were 4,436 different synthetic fertilizer events recorded in the project period, including pre-planting fertilizer applications, with-planting fertilizer applications and top-dressing events.

	2014/ 15	2015/ 16	2016/ 17	2017/ 18	2018/ 19	2019/ 20	2020/ 21	2021/ 22
Total kg applied	-	-	-	-	3,750,018	4,122,176	5,200,105	5,015,301

<table>
<tr><td></td><td>
<table>
<tr><td>Average
kg / ha</td><td>-</td><td>-</td><td>-</td><td>-</td><td>342.77</td><td>354.43</td><td>368.54</td><td>322.59</td></tr>
</table>
<p>Note: hectares increase as project instances are included across time with their various project start dates. Therefore, an increasing trend on a total basis is not indicative of increased average fertilizer applications on project fields.</p>
<p>Note: Only applications in the project period are included above, therefore the nil values before 2018/19 are only as these applications would be included in the baseline.</p>
<p>Across the project period, the average N-containing fertilizer applied was 346.32 kg/ha.</p>
</td></tr>
<tr><td>Comments</td><td>Based on farmer field record data of application rate and type of synthetic fertilizer. Calculated using application rate, nutrient quantity, and ratio of elements within the nutrient quantity.</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>NC_{OF}</td></tr>
<tr><td>Data unit</td><td>t N / t fertilizer</td></tr>
<tr><td>Description</td><td>N content of organic fertilizer type OF</td></tr>
<tr><td>Value applied</td><td>
<p>There are 230 organic input events recorded in the project period across the fields, each with its own specific product type and consequent N%. Examples:</p>
<table>
<tr><th>Organic Fertilizer Type</th><th>Effective Nitrogen %</th></tr>
<tr><td>Compost (Dry)</td><td>3.2</td></tr>
<tr><td>Cattle Manure (Composted)</td><td>0.8</td></tr>
<tr><td>Chicken Litter (Composted)</td><td>1.2</td></tr>
</table>
<p>Average N% of all organic inputs applied across the project was c. 1.91% (i.e. NC_{OF} = 0.0191)</p>
</td></tr>
<tr><td>Comments</td><td>See Table 22 of QA3 Emission Calculations document for the comprehensive list of organic fertilizers and associated effective nitrogen content and its source reference.</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>OF</td></tr>
<tr><td>Data unit</td><td>Dimensionless</td></tr>
<tr><td>Description</td><td>Type of organic N fertilizer</td></tr>
<tr><td>Value applied</td><td>Various types based on the inputs in the field records. There are 230 organic input events across the project period. These</td></tr>
</table>

	included Cattle Manure (Composted), Chicken Manure (Composted), Chicken Litter (Air-dried), Compost (Dry), Chicken Manure (Stock-piled), Cattle Manure (Stock-piled), Cattle Manure (Fresh).
Comments	See Table 22 of QA3 Emission Calculations document for the comprehensive list of organic fertilizer types.

<table>
<tr><td>Data / Parameter</td><td>$M_{wp,OF,I,t}$</td></tr>
<tr><td>Data unit</td><td>t fertilizer</td></tr>
<tr><td>Description</td><td>Mass of N containing organic fertilizer type <i>OF</i> applied in the project for sample unit i in year t</td></tr>
<tr><td>Value applied</td><td>Various values provided per event based on management records.
There were 230 different organic inputs application events recorded in the baseline.
<table>
<tr><th></th><th>2014/ 15</th><th>2015/ 16</th><th>2016/ 17</th><th>2017/ 18</th><th>2018/ 19</th><th>2019/ 20</th><th>2020/ 21</th><th>2021/ 22</th></tr>
<tr><td>Total kg applied</td><td>-</td><td>-</td><td>-</td><td>-</td><td>127,293</td><td>2,724,621</td><td>7,777,955</td><td>14,347,076</td></tr>
<tr><td>Average kg / ha</td><td>-</td><td>-</td><td>-</td><td>-</td><td>11.64</td><td>234.27</td><td>551.24</td><td>922.81</td></tr>
</table>
Across the project period, the average N-containing organic fertilizer applied was 478.23 kg/ha across all project hectares (i.e. not per hectare where organic inputs were actually applied). In the 2021/22 project period the average application rate was 922.81kg/ha, up from 39.80 on average in the baseline.</td></tr>
<tr><td>Comments</td><td>Based on farmer field record data of application rate per hectare. The amount of N is calculated by multiplying the application rate per hectare by the effective N content to determine the amount of N/ha.</td></tr>
</table>

Data / Parameter	$Frac_{GASF,I,S}$
Data unit	Dimensionless
Description	Fraction of all synthetic N added to soils that volatilizes as NH_3 and NO_x for livestock type *I* and manure management system *S*
Value applied	Urea = 0.15 Ammonium-based = 0.08 Nitrate-based = 0.01

	Ammonium nitrate-based = 0.05 Mix (Aggregated value) = 0.11 Unknown / Not Applicable = 0.11
Comments	None

Data / Parameter	*Frac*$_{GASM}$
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 for livestock type *l* and manure management system *S*
Value applied	0.21
Comments	Table 10.21 Volume 4 Chapter 10 IPCC (2019) states for all Pasture/Range/Paddock manure management systems that: Direct and indirect N_2O emissions associated with the manure deposited on agricultural soils and pasture, range, paddock systems are treated in Chapter 11, Section 11.2, N_2O emissions from managed soils. According to this guidance and with all our livestock being managed on a PRP basis, we applied the value in Table 11.3 Volume 4 Chapter 11 IPCC (2019) for Frac$_{GASM}$.

Data / Parameter	*Frac*$_{LEACH}$
Data unit	Dimensionless
Description	Fraction of N (synthetic or organic) added to soils and N in manure and urine deposited on soils that is lost through leaching and runoff, in regions where leaching and runoff occurs.
Value applied	Dry climate = 0 Wet climate = 0.24
Comments	Wet climates occur in temperate and boreal zones where the ratio of annual precipitation to potential evapotranspiration is greater than 1, and in tropical zones where annual precipitation is greater than 1000 mm. Dry climates occur in temperate and boreal zones where the ratio of annual precipitation to potential

	evapotranspiration is less than 1, and in tropical zones where annual precipitation is less than 1000 mm.

Data / Parameter	EF_{Nleach}
Data unit	t N_2O-N / t N leached and runoff
Description	Emission factor for nitrous oxide emissions from leaching and runoff
Value applied	0.011
Comments	Table 11.3 Volume 4 Chapter 11 IPCC (2019)

<table>
<tr><td>Data / Parameter</td><td>$MB_{g,wp,i,t}$</td></tr>
<tr><td>Data unit</td><td>t dm</td></tr>
<tr><td>Description</td><td>Annual dry matter, including aboveground and below ground, of N-fixing species g returned to soils for sample unit i in year t</td></tr>
<tr><td>Value applied</td><td>Various values provided per event based on management records. There were 3,036 different harvesting events recorded in the project period and 1,233 cover crop planting events. The data collected from these events (e.g. yield, crop type, harvest dates, cover crop species, etc.), along with NDVI analysis were used to calculate the t dm returned to the soil.
<table>
<tr><th></th><th>2014/ 15</th><th>2015/ 16</th><th>2016/ 17</th><th>2017/ 18</th><th>2018/ 19</th><th>2019/ 20</th><th>2020/ 21</th><th>2021/ 22</th></tr>
<tr><td>tDM</td><td>-</td><td>-</td><td>-</td><td>-</td><td>26,823</td><td>27,962</td><td>37,951</td><td>44,498</td></tr>
</table></td></tr>
<tr><td>Comments</td><td>Use of our biomass tool with certain assumptions (Table 11.2 and Table 11.1a Volume 4 Chapter 11 IPCC (2019)) to determine the mass of the above-ground dry matter.

See table 26 of QA3 Emission Calculations document for a comprehensive table of the default values used in the calculations.</td></tr>
</table>

Data / Parameter	$N_{\text{content},g}$
Data unit	t N/t dm
Description	Fraction of N in dry matter for N-fixing species *g*
Value applied	Various ratios depending on the crop type. There were 3,036 different harvesting events recorded in the project period and 1,233 cover crop planting events. The data collected from these

	events, based on management records and other sources, indicates the crop type planted. Some examples of the applied values for above-ground biomass t N/t dm are: Soybeans – 0.008 Vetch – 0.027 Clover – 0.027 Sugarbeans – 0.008 Some examples of the applied values for below-ground biomass t N/t dm are: Soybeans – 0.008 Vetch – 0.022 Clover – 0.022 Sugarbeans – 0.008
Comments	Values taken from Table 11.1a Volume 4 Chapter 11 IPCC (2019). See table 26 of QA3 Emission Calculations document for a comprehensive table of the default values used in the calculations.

<table>
<tr><td>Data / Parameter</td><td>g</td></tr>
<tr><td>Data unit</td><td>Dimensionless</td></tr>
<tr><td>Description</td><td>Type of N-fixing species</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th>Crop Name</th><th>N-fixing</th></tr>
<tr><td>Alfalfa</td><td>Yes</td></tr>
<tr><td>Soybeans</td><td>Yes</td></tr>
<tr><td>Sugarbeans</td><td>Yes</td></tr>
<tr><td>Yellow Field Peas</td><td>Yes</td></tr>
<tr><td>Birdsfoot Trefoil</td><td>Yes</td></tr>
<tr><td>Bitter Lupines</td><td>Yes</td></tr>
<tr><td>Common Vetch</td><td>Yes</td></tr>
<tr><td>Crimson Clover</td><td>Yes</td></tr>
<tr><td>Faba Beans</td><td>Yes</td></tr>
<tr><td>Forage Peas</td><td>Yes</td></tr>
<tr><td>Grain Peas</td><td>Yes</td></tr>
<tr><td>Hairy Vetch</td><td>Yes</td></tr>
<tr><td>Haymaker Vetch</td><td>Yes</td></tr>
<tr><td>Medics</td><td>Yes</td></tr>
<tr><td>Pinto Peanut</td><td>Yes</td></tr>
<tr><td>Red Clover</td><td>Yes</td></tr>
<tr><td>Sainfoin</td><td>Yes</td></tr>
<tr><td>Serradella</td><td>Yes</td></tr>
<tr><td>Sub Clover</td><td>Yes</td></tr>
<tr><td>Sunhemp</td><td>Yes</td></tr>
<tr><td>Sweet Clover</td><td>Yes</td></tr>
</table>
</td></tr>
</table>

Vetch	Yes
White Clover	Yes
White Cowpeas	Yes

Comments	The above crops represent our LookUp list and were not all present in the project. The most common legumes planted included Soybeans and Vetch.

Data / Parameter	$EF_{N2O,md,l,S}$
Data unit	kg N_2O-N/kg N input
Description	Emission factor for nitrous oxide from manure and urine deposited on soils by livestock type *l* and manure management system *S*
Equations	

Livestock Type	**Wet Climate** or Irrigation	**Dry Climate**
Cattle - Dairy	0.006	0.002
Cattle - Beef	0.006	0.002
Sheep	0.003	0.003
Goats	0.003	0.003
Horses	0.003	0.003
Pigs	0.006	0.002
Chicken - Broilers	0.006	0.002
Chicken - Laying	0.006	0.002

Comments	Table 11.1 Volume 4 Chapter 11 IPCC (2019)

Data / Parameter	$N_{exl,P}$
Data unit	kg N deposited/(head x year)
Description	Annual average nitrogen excretion per head of livestock type *l* in productivity system *P*
Value applied	Default values for nitrogen excretion rate (kg N (1000kg animal mass)$^{-1}$ day^{-1})

Livestock Type	High Production System	Low Production System	Mean
Cattle - Dairy	0.41	0.45	0.44
Cattle - Beef	0.42	0.45	0.44

Sheep	0.32	0.32	0.32
Goats	0.34	0.34	0.34
Horses	0.46	0.46	0.46
Pigs	0.49	0.33	0.44
Chicken - Broilers	1.34	1.58	1.4
Chicken - Laying	0.99	1.34	1.2

Comments	Table 10.19 Volume 4 Chapter 10 IPCC (2019). Important to note that these values are kg N/1000 kg animal mass/day and must be converted to kg N deposited/head/year. Important that one knows the livestock population and average weight.

Data / Parameter	EF_{Nvolat}
Data unit	t N_2O-N /(t NH_3-N + NO_x-N volatilized)
Description	Emission factor for nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces
Value applied	Aggregated value = 0.010 Wet climate = 0.014 Dry climate = 0.005
Comments	Table 11.3 Volume 4 Chapter 11 IPCC (2019)

Data / Parameter	$EF_{c,N20}$
Data unit	g N_2O/kg dry matter burnt
Description	Nitrous oxide emission factor for the burning of agricultural residue type *c*
Value applied	n/a
Comments	Values taken from Table 2.5, Chapter 2, Volume 4 in IPCC (2019). See QA3 Emission Calculation document Table 31 for a comprehensive list of values applied. The initial instances did not include any biomass burning.

Data / Parameter	*M_OAwp,I,t*
Data unit	Tonnes

Description	Mass of organic amendment applied as fertilizer on the project area in year t
Value applied	The table below provides an overview of the applied carbon during the first monitoring period. The 2017/2018 season is included for comparison to the baseline scenario. **Seasons** – **Organic Inputs (tonnes)** 2017/2018 – 132 2018/2019 – 127 2019/2020 – 2725 2020/2021 – 7778 2021/2022 – 14347
Comments	See section 1.19 for more details

Seasons	**Organic Inputs (tonnes)**
2017/2018	132
2018/2019	127
2019/2020	2725
2020/2021	7778
2021/2022	14347

Data / Parameter	*CCwp,l,t*
Data unit	t C/t manure
Description	Carbon content of manure from livestock type *l* applied as fertilizer on project area in year *t*
Value applied	Please note: The range of carbon content is due to the form of the manure (e.g. slurry, pelletized etc.) and factors such as moisture content.
Comments	See section 1.19 for more details

Organic Input Type	**Range of Carbon content (%)**
Compost	12.95 - 39
Cattle manure	5.73 – 15.50
Chicken manure	10.11 – 26.94
Pig manure	3.26 – 27.88

The 2017/2018 season is included for comparison to the baseline scenario.

Seasons	**Carbon component (tonnes)**
2017/2018	20
2018/2019	20
2019/2020	775
2020/2021	2298
2021/2022	3887

Data / Parameter	$P_{wp,p}$
Data unit	Output (e.g., kg) /ha

Description	Average productivity for product p during the project period
Value applied	Below are weighted average yields for the primary crop types occurring in the project. Results are in t/ha for the project period.
Comments	See Section 7.4.3 for values for the main cash crop yields across the provinces and years.

Major Cash Crop Type	Yield in the Project Scenario(t/ha)
Maize	7.81
Soybean	2.79
Sunflower	1.88
Wheat	4.62

Data / Parameter	P
Data unit	Categorical variable
Description	Crop/livestock product
Value applied	Primary cash crop types for which yield values are known: Maize Soybeans Sunflower Wheat
Comments	None

Data / Parameter	*RPwp,p*
Data unit	Output (e.g., kg)/ha
Description	Average regional productivity for product p during the same years as the project period
Value applied	Values were obtained per province, per crop type from the above source.

	Maize	Soybean	Sunflower	Wheat
Free State	4.966	1.920	1.462	3.798
Gauteng	5.878	2.190	1.177	6.273
Kwa-Zulu Natal	6.864	3.389	N/A	6.155
Mpumalanga	6.188	2.003	1.262	6.390

North West	4.129	2.190	1.343	6.060

	For application of these to the baseline (where farm records were not available), the provincial data was used. Where fields are irrigated, data from the Census of commercial agriculture 2017 (Financial and production statistics) report by the Department of Statistics and Department of Agriculture was used which results in higher yields than the above. For purposes of productivity comparisons for leakage considerations, the above values were weighted by the % of project area in each province to obtain comparable values to the project as a whole.
Comments	See Section 7.4.3 for values for the main cash crop yields across the provinces and years

Data / Parameter	$\overline{SOCbsl, \imath, t}$
Data unit	t CO_2e/ha
Description	Areal mean SOC stocks in the baseline scenario for sample unit *i* in year *t*
Value applied	54.83 tC = 201.04 tCO_2e The above represents a simple average, not a weighted average. Detailed calculations are provided in workbooks.
Comments	SOC stocks at time *t* = 0 are calculated based on directly measured SOC content and bulk density at *t* = 0 or (back-) modeled to *t* = 0 from measurements collected within ±5 years of *t* = 0. This initially measured SOC is the same in both the baseline and project scenarios at the outset of the project (i.e., SOC*wp,i,*0 = SOC*bsl,i,*0) in Quantification Approach 1.

Data / Parameter	$\overline{SOCbsl, \imath, t - 1}$
Data unit	t CO_2e/ha
Description	Areal mean SOC stocks in the baseline scenario for sample unit *i* in year *t* − 1
Value applied	56.49 tC = 207.13 tCO_2e The above represents a simple average, not a weighted average. Detailed calculations are provided in workbooks. t-1 in this case is the starting SOC
Comments	See parameter table for $\overline{SOCbsl, \imath, t}$

	See Section 8.2.1 for requirements for SOC content and bulk density measurements

Data / Parameter	$\overline{SOCwp, \imath, t}$
Data unit	t CO_2e/ha
Description	Areal mean SOC stocks in the project scenario for sample unit *i* in year *t*
Value applied	57.38 tC = 210.39 tCO_2e The above represents a simple average, not a weighted average. Detailed calculations are provided in workbooks.
Comments	Initially measured SOC stocks are the same in both the baseline and project scenarios at the outset of the project (i.e., *SOCwp,i,*0 = *SOCbsl,i,*0) under Quantification Approach 1. SOC stocks at time *t* = 0 are calculated based on directly measured SOC content and bulk density at *t* = 0 or (back-) modeled to *t* = 0 from measurements collected within ±5 years of *t* = 0. SOC stocks in the project scenario for sample unit *i* must be reported every five years or more frequently under Quantification Approaches 1 and 2.

Data / Parameter	$\overline{SOCwp, \imath, t - 1}$
Data unit	t CO_2e/ha
Description	Areal mean SOC stocks in the project scenario for sample unit *i* in year *t-1*
Value applied	56.49 tC = 207.13 tCO_2e The above represents a simple average, not a weighted average. Detailed calculations are provided in workbooks. t-1 in this case is the starting SOC
Comments	See parameter table for $\overline{SOCwp, \imath, t}$

Data / Parameter	•
Data unit	Dimensionless
Description	Gas or pool
Value applied	SOC

Comments	None

Data / Parameter	$\bar{\Delta}_{\bullet,t}$ and $\bar{\bullet}_t$
Data unit	t CO_2e/unit area
Description	Mean emission reductions from pool or source ●, or stock of pool ●, in year *t*
Value applied	18.35
Comments	None

Data / Parameter	*Buffer*,t
Data unit	tCO_2e
Description	Number of buffer credits to be contributed to the AFOLU pooled buffer account in year *t*
Value applied	20%
Comments	See *AFOLU Non-Permanence Risk Tool V4.2*

7.2 Baseline Emissions

7.2.1 Calculation of SOC Stocks

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

Parameter	Unit	Value	Source/Calculation method
$SOC_{bsl,1,t}$	tCO_2e/ha	190.93	Equation 6
$SOC_{bsl,1,t-1}$	tCO_2e/ha	207.13	Equation 6

The RothC model was used for the modelling component of this project to determine SOC stocks in the baseline and project scenarios. Due to the complexity of the model, it is not possible to provide a snapshot of values for the purposes of replicating a calculation. The model validation report provides a detailed description of the model, parameters used and the outputs.

All model input files, model parameters and outputs are made available for validation purposes.

Analysis was performed on any outliers in the SOC modelling on the project and baseline scenarios. This analysis is described in more detail in Section 7.5.6.

7.2.2 Carbon Dioxide Emissions from Fossil Fuel Combustion

Example Equation: Cash crop planting plus full fertilizer treatment (ID: 194 – Field L3 – 2017/2018)

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	79.7	Orizon Software field records
Fuel consumption	l/ha	3.21	DAFF, 2016, Orizon QA3 Emission calculation Document
liters	l	255.837	Calculated
$EF_{co2,j\ (diesel)}$	tCO$_2$e per liter	0.002886	Table 3.3.1 Chapter 3 Volume 2 in IPCC (2019)
$EFF_{bsl,j,i,t}$	tCO$_2$e	0.738345582	Equation 9 VM0042

Overall baseline emissions for the project area

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	Sum of all project fields per season using cumulative area of project fields.
$FFC_{bsl,j,i,t}$	tCO$_2$e	2018/19: 1,422 2019/20: 1,512 2020/21: 1,771 2021/22: 2,037	Equation 9 VM0042

$EFF_{bsl,j,i,t}$	tCO_2e/ha	2018/19: 0.130 2019/20: 0.130 2020/21: 0.126 2021/22: 0.131	Equation 8 VM0042

7.2.3 Carbon Dioxide Emissions from Liming

Example Equation: Calcitic Lime application (ID: 194 – Field L3 – 2016/2017 Baseline data)

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	79.7	Orizon Software field records
Application rate of Calcitic Lime	kg	3000	Orizon Software field records
$M_{Limestone,bsl,i}$	tonnes	239.1	Equation 10 VM0042
$EF_{limestone}$	T C per t of limestone	0.12	Section 11.3, Chapter 11, Volume 4 in IPCC (2019)
44/12		3.667	Not applicable
$EL_{bsl\ ,i,t}$	tCO_2e	105.204	Equation 10 VM0042

Overall baseline emissions for the project area

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
$EL_{bsl\ ,i,t}$	tCO_2e	2018/19: 5,221 2019/20: 3,451 2020/21: 3,748	Equation 10 VM0042

		2021/22: 6,411	
CO_2_lime$_{bsl,i,t}$	tCO_2e/ha	2018/19: 0.477 2019/20: 0.297 2020/21: 0.266 2021/22: 0.412	Equation 10 VM0042

7.2.4 Methane Emissions from Livestock Enteric Fermentation

Example Equation: Cattle- Beef (ID: 194 – Field L3 – 2016/2017 Baseline data) based on the Methodology Deviation including grazing days only.

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	79.7	Orizon Software field records
Livestock type	Cattle - Beef		Orizon Software field records
GWP_{CH4}	CO_2e/CH_4	28	IPCC 2019
EFent	Kg CH_4/head/year	52	Table 10.11 Volume 4 Chapter 10 IPCC (2019)
Population	Number of Mature animals	60	Orizon Software field records
Population	Number of young animals	21	Orizon Software field records
Effective Number of Animals		70.5	1 young animal = 0.5 mature animals
Average weight of mature animals	kg	550	Orizon Software field records
Average weight of young animals	kg	275	Orizon Software field records

			Assumed as 0.5 of mature animal weight
Days		138	Calculated based on dates provided in the field records from the farmer
Calendar year	Days	365	
Average weight	kg	550	
tCO_2e		38.80938	(GWP_{CH4} * Effective Population * Grazing Days *EF_{ent})/ (1000*365)

Overall baseline emissions for the project area for Enteric Fermentation

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
*(GWP_{CH4} * ∑Pop *EFent * Days)/(1000*365)*	tCO_2e	2018/19: 3,037 2019/20: 3,582 2020/21: 4,417 2021/22: 4,539	Equation 12 as per Methodology Deviation adjusted calculation
$CH4\_ent_{bsl,i,t}$	tCO_2e/ha	2018/19: 0.278 2019/20: 0.308 2020/21: 0.313 2021/22: 0.292	Equation 12 as per Methodology Deviation adjusted calculation

7.2.5 Methane Emissions from Manure Deposition

Example Equation: Cattle- Beef (ID: 194 – Field L3 – 2016/2017 Baseline data) based on the Methodology Deviation including grazing days only.

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	79.7	Orizon Software field records
Livestock type	Cattle - Beef		Orizon Software field records
GWP_{CH4}	CO_2e/CH_4	28	IPCC 2019
$EF_{CH4md,l,I,t,P}$	(g CH 4/ kg volatile solids)	0.6	Table 10.14 Volume 4 Chapter 10 IPCC (2019)
$AWMS_{l,I,t,P,S}$	unitless	1.0	All animals waste management systems are Pasture/Range/Paddock
$VSI_{,I,t,P}$	(kg volatile solids/(head × day)	6.6	VSrate * (Average weight/1000)
VSrate	kg volatile solids/(1000 kg animal mass * day)	12.0	Table 10.13a Volume 4 Chapter 10 IPCC (2019)
Population	Number of Mature animals	60	Orizon Software field records
Population	Number of young animals	21	Orizon Software field records
Effective Number of Animals		70.5	1 young animal = 0.5 mature animals
Average weight of mature animals	kg	550	Orizon Software field records
Average weight of young animals	kg	275	Orizon Software field records

			Assumed as 0.5 of mature animal weight
Average weight in the livestock population	kg	550	=((60*550)+(21*275))/81
Days		138	Calculated based on dates provided in the field records from the farmer
tCO_2e	tCO_2e	1.07875	(GWP_{CH4} * $VS_{l,I,t,P}$ * Population * Grazing Days *EF_{ch4md})/ (1000000)

Overall baseline CH_4 emissions for the project area for Manure Deposition

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
*(GWP_{CH4} * ∑Pop *$VS_{l,i,t,p}$* Days*$AWMS_{l,i,t,p}$ *$EF_{CH4md,l,p,s}$) / (1,000,000*365)*	tCO_2e	2018/19: 82 2019/20: 97 2020/21: 120 2021/22: 125	Equation 13 & 14 as per Methodology Deviation adjusted calculation
$CH4\_md_{bsl ,i,t}$	tCO_2e/ha	2018/19: 0.008 2019/20: 0.008 2020/21: 0.009 2021/22: 0.008	Equation 13 & 14 as per Methodology Deviation adjusted calculation

7.2.6 Nitrous Oxide Emissions from Nitrogen Fertilizers and Nitrogen-Fixing Species

Example Equation: Synthetic fertilizer combination mix (NPK) (ID: 194 – Field L3 – 2016/2017 Baseline data) – 5 January 2017

Parameter	Unit	Value	Source/Calculation method
Climate	Not applicable	Dry	SAPWAT data
Ai	Ha	79.7	Orizon Software field records
GWP_{N2O}	CO_2e/CH_4	265	IPCC 2019
Application Rate	Kg/ha	310	Orizon Software field records
$M_{bsl,SF,l,t}$	t fertilizer	24.707	Application rate * area / 1000
Nutrient Quantity	%	31	Orizon Software field records
N:P:K	Ratio	1:0:0	Orizon Software field records
N content	%	31	based on the ratio only containing N this means the full 31% Nutrient Quantity is N
Amount N (FSN)	t N	7.65917	Mass * N content
$EF_{ndirect}$	t N_2O-N/t N applied	0.005	Table 11.1 Volume 4 Chapter 11 IPCC (2019) Dry climate value applied
Direct emissions	tCO_2e	15.94749	FSN * $EF_{ndirect}$ * 44/28 * GWP N_2O
$EF_{N2Omd,l,l,t,P}$	kg N_2O-N/kg N input	0.002	Table 11.1 Volume 4 Chapter 11 IPCC (2019)
Direct emissions	tCO_2e	1.96089	($F_{bslmanure,l,l,t}$ * $EF_{N2Omd,l<S}$ * 44/28 * GWP_{N2O})/1000
$Frac_{GASF}$	Dimensionless	0.011	Table 11.3 Volume 4 Chapter 11 IPCC (2019)

			Used the aggregated value as it is a mixed synthetic fertilizer type
$Frac_{GASM}$	Dimensionless	0.21	Table 11.3 Volume 4 Chapter 11 IPCC (2019)
$Frac_{LEACH}$	Dimensionless	0	Table 11.3 Volume 4 Chapter 11 IPCC (2019) Value is 0 for dry climates
EF_{nvolat}	t N_2O-N /(t NH3-N + NOx-N volatilized)	0.005	Table 11.3 Volume 4 Chapter 11 IPCC (2019)
EF_{nleach}	t N_2O-N / t N leached and runoff	0.11	Table 11.3 Volume 4 Chapter 11 IPCC (2019)
Indirect Emissions	tCO_2e	1.75422	FSN * $Frac_{GASF}$ * EF_{nvolat} * 44/28 * $GWPN_2O$ No leaching calculation as it is a dry climate
Total Emissions	tCO_2e	17.70171	Direct + Indirect

Example Equation: Nitrogen-fixing cash crop - soybeans (NPK) (ID: 194 – Field L3 – 2017/2018 Baseline data)

Parameter	Unit	Value	Source/Calculation method
Climate	Not applicable	Dry	SAPWAT data
Ai	Ha	79.7	Orizon Software field records
GWP_{N2O}	CO_2e/CH_4	265	IPCC 2019
$EF_{ndirect}$	t N_2O-N/t N applied	0.005	Table 11.1 Volume 4 Chapter 11 IPCC (2019) Dry climate value applied

$N_{content,g}$	t N/t dm	Aboveground N: 0.008 Belowground N: 0.008	Table 11.1a Volume 4 Chapter 11 IPCC (2019)
Yield	T/ha	3.00	Orizon Software field records (for cover crop biomass, the Orizon tool was used in addition to field records and NDVI data)
Dry matter yield : Fresh yield ratio	Ratio	0.91	Table 11.1a Volume 4 Chapter 11 IPCC (2019)
Aboveground residues: dry yield ratio	Ratio	2.1	Table 11.1a Volume 4 Chapter 11 IPCC (2019)
Below-ground biomass : aboveground biomass ratio	Ratio	0.19	Table 11.1a Volume 4 Chapter 11 IPCC (2019)
Dry yield biomas	T/ha	2.73	Yield*(Dry matter yield: fresh yield ratio)
Above-ground residues	t/ha	5.733	(Dry matter yield : Fresh yield ratio) * (Dry yield biomass) This value excludes yield if harvested
Above-ground biomass returned to soil	t/ha	0	Harvested
Below-ground biomass	t/ha	1.61	(Dry yield biomass + above-ground residues)*(Below-ground biomass : aboveground biomass ratio)

Aboveground biomass average	t/ha	5.733	Above-ground residues + Above-ground biomass returned to soil
Total N aboveground	tN/ha	0.045864	Aboveground biomass average * Ncontent,g
Total N belowground	tN/ha	0.01288	Belowground biomass average * Ncontent,g
Total N	T N/ha	0.05874	Aboveground biomass average + Belowground biomass average
Emissions	tCO_2e	9.7477	TotalN * $Ef_{ndirect}$ * 44/28 * GWP_{N2O}

Important Note: *For nitrogen-fixing species calculations with cover crops one will need to refer to the Biomass Tool to do the calculation due to the lack of yield data for cover crops.*

Baseline emissions for fertilizer

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
Direct + Indirect Fertilizer Emissions	tCO_2e	2018/19: 2,738 2019/20: 3,230 2020/21: 3,549 2021/22: 3,437	Equation 19 - 24
$N2O\_fert_{bsl,i,t}$	tCO_2e/ha	2018/19: 0.250 2019/20: 0.278 2020/21: 0.252 2021/22: 0.221	Equation 19 - 24

Baseline emissions for N-fixing species

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
TotalN * Ef_ndirect * 44/28 * GWP_N2O	tCO_2e	2018/19: 545 2019/20: 511 2020/21: 724 2021:22: 739	Equation 25 & 26
$N2O\_Nfix_{bsl,i,t}$	tCO_2e/ha	2018/19: 0.050 2019/20: 0.044 2020/21: 0.051 2021/22: 0.048	Equation 25 & 26

7.2.7 Nitrous Oxide Emissions from Manure Deposition

Example Equation: Cattle- Beef (ID: 194 – Field L3 – 2016/2017 Baseline data) based on the Methodology Deviation including grazing days only.

Parameter	Unit	Value	Source/Calculation method
Climate	Not applicable	Dry	SAPWAT data
Ai	Ha	79.7	Orizon Software field records
Livestock type	Cattle - Beef		Orizon Software field records
GWP_{N2O}	CO_2e/CH_4	265	IPCC 2019

Population	Number of Mature animals	60	Orizon Software field records
Population	Number of young animals	21	Orizon Software field records
Effective Number of Animals		70.5	1 young animal = 0.5 mature animals
Average weight of mature animals	kg	550	Orizon Software field records
Average weight of young animals	kg	275	Orizon Software field records Assumed as 0.5 of mature animal weight
Average weight in the livestock population	kg	550	=((60*550)+(21*275))/70.5
Days		138	Calculated based on dates provided in the field records from the farmer
Number of 1000kg animal units	1000kg animal units	38.775	(Average population weight*population) /1000
N_{exl} *IPCC default value*	Kg N/ 1000kg animal mass / day	0.44	Table 10.19 Volume 4 Chapter 10 IPCC (2019)
$AWMS_{l,l,t,P,S}$	unitless	1.0	All animals waste management systems are Pasture/Range/Paddock
MSbsl,l,l,t	Fraction	0.3780821918	Number of grazing days / 365
$F_{bslmanure,l,l,t}$	Kg N in grazing period	2354.418	(Number of 1000kg animal units * $N_{exl,P}$) * ($AWMS_{l,l,t,P,S}$ * Days)

$EF_{N2Omd,l,l,t,P}$	kg N_2O-N/kg N input	0.002	Table 11.1 Volume 4 Chapter 11 IPCC (2019)
Direct emissions	tCO_2e	1.96089	$(F_{bslmanure,l,l,t} * EF_{N2Omd,l<S} * 44/28 * GWP_{N2O})/1000$
$Frac_{GASM}$	Dimensionless	0.21	Table 11.3 Volume 4 Chapter 11 IPCC (2019)
$Frac_{LEACH}$	Dimensionless	0	Table 11.3 Volume 4 Chapter 11 IPCC (2019) Value is 0 for dry climates
EF_{nvolat}	t N_2O-N /(t NH_3-N + NOx-N volatilized)	0.005	Table 11.3 Volume 4 Chapter 11 IPCC (2019)
EF_{nleach}	t N_2O-N / t N leached and runoff	0.011	Table 11.3 Volume 4 Chapter 11 IPCC (2019)
Indirect Emissions	tCO_2e	1.02947	$F_{bslmanure,l,l,t}*Frac_{GASM}*EF_{nvolat}*44/28*GWP_{N2O}/1000$ No leaching calculation as it is a dry climate
Total Emissions	tCO_2e	2.99	Direct + Indirect

Baseline emissions for N_2O manure deposition

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
$F_{bslmanure,l,l,t} * Frac_{GASM} * EF_{nvolat} * 44/28 * GWP_{N2O}/ 1000$	tCO_2e	2018/19: 379 2019/20: 344 2020/21: 475	Equation 27 - 32

		2021/22: 431	
$N2O\_md_{bsl,i,t}$	tCO_2e/ha	2018/19: 0.035 2019/20: 0.030 2020/21: 0.034 2021/22: 0.028	Equation 27 - 32

7.3 Project Emissions

The logic follows the procedures set out in section 7.2. All equations remain the same except that any field record data that differs from the baseline are adjusted accordingly and the emissions for each category are then calculated based on the same equations as in section 7.2. Therefore, no further examples are provided.

7.3.1 Calculation of SOC Stocks

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

Parameter	Unit	Value	Source/Calculation method
$SOC_{wp,1,t}$	tCO_2e/ha	206.40	Equation 6
$SOC_{wp1,t-1}$	tCO_2e/ha	207.13	Equation 6

The RothC model was used for the modelling component of this project to determine SOC stocks in the baseline and project scenarios. Due to the complexity of the model, it is not possible to provide a snapshot of values for the purposes of replicating a calculation. The model validation report provides a detailed description of the model, parameters used and the outputs.

In quantifying the SOC stock changes, the methodology-provided back-modelling approach was used as samples were taken subsequent to the project start date. All samples were taken within +-5 years after the project start date, and back-modelled to t=0 ensuring that both the baseline and project tSOC are equal at the project start date. All samples were taken during 2023.

The back-modelling was a two-step process. The first step entailed running the model to equilibrium, while the second step used the equilibrium carbon pool sizes to initialise the calibrated model with the aim of matching the observed/sampled tSOC of the field at the sampling date. Since the implemented model's parameters and variables were known, the resulted SOC dynamics could be modelled from the project start date. This allowed Orizon to iterate this two-step approach, whereby the equilibrium SOC stocks were adjusted, by amending the C-input value used in the spin-up period, until the modelled SOC stock matched the field SOC stock at the date of sampling for the recorded management conditions. The point at which the equilibrium run ended was the starting point for the project and baseline scenarios. These scenarios then diverged based on the model parameter values and variables of each scenario. Baseline and project values were consistent at t=0 before diverging subsequent to this based on implemented project activities.

Analysis was performed on any outliers in the SOC modelling on the project and baseline scenarios. This analysis is described in more detail in Section 7.5.6.

7.3.2 Carbon Dioxide Emissions from Fossil Fuel Combustion

Overall project emissions for the project area

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
$FFC_{wp,j,i,t}$	tCO_2e	2018/19: 1,318 2019/20: 1,193 2020/21: 1,501 2021/22: 1,730	Equation 9 VM0042
$EFF_{wp,j,i,t}$	tCO_2e/ha	2018/19: 0.120 2019/20: 0.103 2020/21: 0.106 2021/22: 0.111	Equation 8 VM0042

7.3.3 Carbon Dioxide Emissions from Liming

Overall project emissions for the project area

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110	

		2021/22: 15,547	
$EL_{wp,i,t}$	tCO_2e	2018/19: 4,486 2019/20: 3,265 2020/21: 4,137 2021/22: 5,032	Equation 10 VM0042
$CO_2\_lime_{wp,i,t}$	tCO_2e/ha	2018/19: 0.410 2019/20: 0.281 2020/21: 0.293 2021/22: 0.324	Equation 10 VM0042

7.3.4 Methane Emissions from Livestock Enteric Fermentation

Overall project emissions for the project area

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
$(GWP_{CH4} * \sum Pop *EFent * Days)/(1000*365)$	tCO_2e	2018/19: 3,472 2019/20: 3,577 2020/21: 4,288 2021/22: 5,368	Equation 12 as per Methodology Deviation adjusted calculation
$CH4\_ent_{wp,i,t}$	tCO_2e/ha	2018/19: 0.317 2019/20: 0.308 2020/21: 0.304 2021/22: 0.345	Equation 12 as per Methodology Deviation adjusted calculation

7.3.5 Methane Emissions from Manure Deposition

Overall project emissions for the project area

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
$(GWP_{CH4} * \sum Pop * VS_{l,i,t,p} * Days * AWMS_{l,i,t,p} * EF_{CH4md,l,p,s}) / (1{,}000{,}000*365)$	tCO_2e	2018/19: 93 2019/20: 98 2020/21: 117 2021/22: 147	Equation 13 & 14 as per Methodology Deviation adjusted calculation
$CH4\_md_{wp,i,t}$	tCO_2e/ha	2018/19: 0.008 2019/20: 0.008 2020/21: 0.008 2021/22: 0.009	Equation 13 & 14 as per Methodology Deviation adjusted calculation

7.3.6 Nitrous Oxide Emissions from Nitrogen Fertilizers and Nitrogen-Fixing Species

Overall project emissions for the project area for Fertilizer

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
Direct + Indirect Fertilizer Emissions	tCO_2e	2018/19: 3,419 2019/20: 3,206 2020/21: 3,709 2021/22: 4,541	Equation 19 - 24

$N20\_fert_{wp,i,t}$	tCO_2e/ha	2018/19: 0.313 2019/20: 0.276 2020/21: 0.263 2021/22: 0.292	Equation 19 - 24

Overall project emissions for the project area N-fixing species

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	
$TotalN * Ef_{ndirect} * 44/28 * GWP_{N20}$	tCO_2e	2018/19: 542 2019/20: 566 2020/21: 754 2021/22: 894	Equation 25 & 26
$N20\_Nfix_{wp,i,t}$	tCO_2e/ha	2018/19: 0.050 2019/20: 0.049 2020/21: 0.053 2021/22: 0.058	Equation 25 & 26

7.3.7 Nitrous Oxide Emissions from Manure Deposition

Overall project emissions for the project area N_2O manure deposition

Parameter	Unit	Value	Source/Calculation method
Ai	Ha	2018/19: 10,940 2019/20: 11,630 2020/21: 14,110 2021/22: 15,547	

$F_{wpmanure,l,l,t} * Frac_{GASM} * EF_{nvolat} * 44/28 * GWP_{N2O} / 1000$	tCO_2e	2018/19: 448 2019/20: 393 2020/21: 501 2021/22: 596	Equation 27 - 32
$N2O\_md_{wp,i,t}$	tCO_2e/ha	2018/19: 0.041 2019/20: 0.034 2020/21: 0.035 2021/22: 0.038	Equation 27 - 32

7.4 Leakage Emissions

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

See our Organic Inputs Leakage Assessment report as well as section 5.3 of this document for more details as to why the few cases of additional organic inputs within our project do not need to be adjusted for as a leakage deduction.

7.4.2 Accounting for Leakage from Livestock Displacement

Livestock grazing days and emissions from livestock increased in the project period by 16.25 days and 1,469 tCO_2e respectively, compared to the relative baseline. As a result, we conclude that no livestock displacement occurred on an aggregated grouped project level.

Additional details are included in section 5.3 within this document as well as the Collective Farmer Data workbook.

7.4.3 Accounting for Leakage from Productivity Declines

Section 8.4.3 of v2.0 of VM0042 requires an assessment of productivity every 10 years. Although this current monitoring period is only 4 years, we have provided information that supports the statement that the project activities have not caused any declines in productivity during this monitoring period.

The four main cash crops planted during this monitoring period were maize, soybeans, sunflower and wheat. The yield in t/ha for the project scenario was compared to the historical look-back period yield in t/ha for each cash crop. See the parameter $P_{bsl,p}$ in Section 6.1 and the parameter

$P_{wp,p}$ in Section 7.1 for the specific values for each cash crop type. Only wheat showed a small decline in yield and this decline was much less than 5% that would trigger further assessments as per Section 8.4.3 in v2.0 of VM0042. The weighted average net increase in yield was 9.9%. However, some of this effect was due to seasonality due to two above-average seasons in the monitoring period. When removing the effects of this seasonality, the net increase in the weighted average yield across the four main cash crops was 3.5% when comparing the average project yields to the average baseline yields. Refer to section 5.3.3 for more information.

7.5 GHG Emission Reductions and Carbon Dioxide Removals

For projects required to assess permanence risk:

State the non-permanence risk rating (%)	20
Has the non-permanence risk report been attached as either an appendix or a separate document?	☒ Yes
State, in tCO$_2$e, the expected total GHG benefit to date	160,159 VCU's excluding buffer 40,218 Buffer pool contributions
If a loss occurred (including a loss event or reversal), state the amount of tCO$_2$e lost:	Not applicable

Negative values refer to sequestrations or emission reductions*:*

Vintage period	Baseline emissions (tCO$_2$e)	Project emissions (tCO$_2$e)	Leakage emissions (tCO$_2$e)	Uncertainty deductions (tCO$_2$e)	Buffer pool allocation (tCO$_2$e)	Reduction VCUs (tCO$_2$e)	Removal VCUs – before buffer pool deduction (tCO$_2$e)	Total VCU issuance – after buffer pool allocations (tCO$_2$e)
01-Aug 2018 to 31-Dec-2018	5,593	(7,973)	0	2,204	2,302	148	(11,510)	9,061
01-Jan-2019 to 31-Dec-2019	13,134	(29,748)	0	6,895	7,203	28	(36,015)	28,784
01-Jan-2020 to 31-Dec-2020	13,593	(47,537)	0	9,796	10,234	(166)	(51,168)	41,100
01-Jan-2021 to 31-Dec-2021	16,019	(57,130)	0	11,812	12,340	363	(61,700)	48,998
01-Jan-2022 to 31-Jul-2022	10,337	(37,811)	0	7,791	8,140	342	(40,699)	32,216
Total	**58,676**	**(180,199)**	**0**	**38,497**	**40,218**	**715**	**(201,092)**	**160,159**

** In our emissions aggregation calculations, we calculated the net difference between the project and baseline SOC and carried these values through to aggregation. Therefore, the aggregated reductions/removals in the baseline and project periods are not known on an aggregated basis but only per farmer. Therefore, the baseline SOC flux for the purposes of this table were assumed to be 'nil' and the entire difference was allocated to the project column in order to arrive at the same net sequestration values.*

*** The season for each period runs from 1 August 20XX to 31 July 20XX+1. For example, the 2018/19 season starts on 1 August 2018 and runs up until 31 July 2019.*

**** This value matches the values in Table 5.4, with those in the referred table being split into calendar years.*

Differences exist between our original ex ante emission reduction / removal estimations and the actual final ERR's and are summarised below:

Vintage period	Ex-ante estimated reductions/ removals	Achieved reductions/ removals	Percent difference	Explanation for the difference
01-Aug-2018 to 31-Dec-2018	2,083	9,061	335%	*Since our pipeline submission, we have increased the number of hectares within our project and farmers have improved their cover cropping practices such that they are able to plant more hectares to winter cover crops than initially planned.*
01-Jan-2019 to 31-Dec-2019	6,042	28,784	376%	*Since our pipeline submission, we have increased the number of hectares within our project and farmers have improved their cover cropping practices such that they are able to plant more hectares to winter cover crops than initially planned.*
01-Jan-2020 to 31-Dec-2020	8,542	41,100	381%	*Since our pipeline submission, we have increased the number of hectares within our project and farmers have improved their cover cropping practices such that they are able to plant more hectares to winter cover crops than initially planned.*
01-Jan-2021 to 31-Dec-2021	12,083	48,998	306%	*Since our pipeline submission, we have increased the number of hectares within our project and farmers have improved their cover cropping practices such that they are able to plant more hectares to winter cover crops than initially planned.*
01-Jan-2022 to 31-Jul-2022	19,167	32,216	68%	*Since our pipeline submission, we have increased the number of hectares within our project and farmers have improved their cover cropping practices such that they are able to plant more hectares to winter cover crops than initially planned.*
Total	**47,917**	**160,159**	**234%**	*The initial estimates were purposefully conservative as we prefer to under-estimate rather than to over-promise results to our partnered growers.*

7.5.1 Net GHG Removals

Net GHG emissions removals are quantified as:

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

Where:

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

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

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

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

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

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

Refer to the Net Emission Reductions & Uncertainty Workings workbook for a detailed calculation of the net GHG Removals.

Season	$\Delta CO2\_soil_{i,t}$	$LE_{OA,t}$	$LE_{BR,t}$	$(1 - UNC_{t,CO2})$	$\Delta C_{TREE,t}$	$\Delta C_{SHRUB,t}$	Net GHG emission reductions or removals (tCO_2e)
2018/19	32,913	0	0	0.839320	0	0	27,625
2019/20	56,904	0	0	0.839320	0	0	47,761
2020/21	66,646	0	0	0.839320	0	0	55,937
2021/22	83,126	0	0	0.839320	0	0	69,769

7.5.2 Net GHG Reductions

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

7.5.3 Carbon Dioxide Emission Reductions and Removals

Change in SOC is shown in the Table below:

Parameter	Unit	Value	Source/Calculation method
$SOC_{wp,1,t}$	tCO_2e/ha*	206.40	Equation 6
$SOC_{wp1,t-1}$	tCO_2e/ha*	207.13	Equation 6
$SOC_{bsl,1,t}$	tCO_2e/ha*	190.93	Equation 6
$SOC_{bsl1,t-1}$	tCO_2e/ha*	207.13	Equation 6
Area	Hectares	15,547	
Formula	(($SOC_{wp,l,t}$ - $SOC_{wp,l,t}$) – ($SOC_{bsl,l,t}$ – $SOC_{bsl,l,t}$)) ~~x~~ ~~44/12~~*refer below x A_i	((206.40 – 207.13) – (190.93 – 207.13)) x 15,547***	Equation 40
$\Delta CO_2\_soil_{i,t}$	tCO_2e	240,512**	Equation 40

** Note that Equation 40 indicates that the $SOC_{wp/bsl,l,t}$ parameters are in tCO_2e/ha. However, the equation that uses these values multiplies these by 44/12 being the conversion from tC to tCO_2e. Therefore, either the unit values or the equation itself is incorrect. We have kept the units as tCO_2e and have removed the 44/12 factor from the equation. To convert our $SOC_{wp/bsl,l,t}$ parameters to tC, simply use the reverse factor, 12/44.*

*** Note that this simplified calculation arrives at a value of 240,512 tCO_2e, and not 239,589 tCO_2e. This is due to the simplicity of the calculation whereas the Net Emission reductions & Uncertainty Workings workbook lists all values in more detail, with weightings per field.*

****The average hectares across the monitoring period was used in this calculation as it is a simplified reasonability calculation. Note that the amounts are also not indicative of actual SOC removals vs reductions as farmers of lower average SOC were added in later years, decreasing the average SOC in those years (e.g. 2020/21 onwards) artificially. The correct figure of 239,589 tCO_2e has been computed by weighting each individual field and not by aggregating average values.*

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

$\overline{SOC_{wp,i,t}}$ = Areal mean carbon stocks in the SOC pool in the project scenario for sample unit *i* at the end of year *t* (t CO2e /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 CO2e/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 CO2e/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 CO2e/ha)

Carbon dioxide emission reductions from fossil fuel combustion are quantified as:

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

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 CO2e/ha)

Parameter	Unit	Value	Source/Calculation method
$CO_2\_ff_{wp,l,t}$	tCO2e	5,742	
$CO_2\_ff_{bsl,l,t}$	tCO2e	6,742	
$\Delta CO_2\_f\,ft$	tCO2e	(1,000) *Emission Reduction*	Equation 41

Carbon dioxide emission reductions from liming are quantified as:

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

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 CO2e/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 CO2e/ha)

Parameter	Unit	Value	Source/Calculation method
$CO_2\_lime_{wp,l,t}$	tCO_2e	16,920	
$CO_2\_lime_{bsl,l,t}$	tCO_2e	18,832	
$\Delta CO_2\_lime_t$	tCO_2e	(1,912) *Emission Reduction*	Equation 44

7.5.4 Methane Emission Reductions($\Delta CH4_t$)

Methane emission reductions from livestock enteric fermentation are quantified as:

$$\Delta CH4\_ent_t = \sum_{i=1}^{n} \left(\overline{CH4\_ent_{bsl,\imath,t}} - \overline{CH4\_ent_{wp,\imath,t}}\right) \times A_i \tag{46}$$

Parameter	Unit	Value	Source/Calculation method
$CH_4\_ent_{wp,l,t}$	tCO_2e	16,706	
$CH_4\_ent_{bsl,l,t}$	tCO_2e	15,575	
$\Delta CH_4\_ent_t$	tCO_2e	1,131 *Emission Increase*	Equation 46

$$\Delta CH4\_md_t = \sum_{i=1}^{n} \left(\overline{CH4\_md_{bsl,\imath,t}} - \overline{CH4\_md_{wp,\imath,t}}\right) \times A_i \tag{47}$$

Parameter	Unit	Value	Source/Calculation method
$CH_4\_md_{wp,l,t}$	tCO_2e	454	
$CH_4\_md_{bsl,l,t}$	tCO_2e	424	
$\Delta CH_4\_md_t$	tCO_2e	30	Equation 46

		Emission Increase	

7.5.5 Nitrous Oxide Emission Reductions($\Delta N2O_t$)

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

Parameter	Unit	Value	Source/Calculation method
$N_2O\_soil_{wp,I,t}$	tCO_2e	19,569	
$N_2O\_soil_{bsl,I,t}$	tCO_2e	17,103	
$\Delta N_2O\_soil_t$	tCO_2e	2,466 *Emission Increase*	Equation 46

7.5.6 Uncertainty

Orizon has used Quantification Approach 1 with the analytical calculation of error propagation found in section 8.6.1.1 in v2 of VM0042,

Model prediction error was determined by following Equation 51 and 52 as follows:

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

Where:

$s^2_{model,\Delta\bullet}$ = Variance of modeled estimates of emission reductions in gas or pool • (t CO_2e/ha)^2

$\widehat{\Delta\bullet}_{bsl}$ = Modeled estimate of change in emissions reductions in gas or pool • in the baseline scenario (t CO_2e)

$\widehat{\Delta\bullet}_{pr}$ = Modeled estimate of change in emissions reductions in gas or pool • in the project scenario (t CO_2e)

$s^2_{model,\bullet}$ = Estimated variance of errors made by model prediction of emissions in gas or pool • (estimated from measurements in fields that need not be side-by-side trials with baseline and project scenarios) (t CO_2e/ha)^2

By writing $cov(\widehat{\Delta \bullet}_{pr}, \widehat{\Delta \bullet}_{bsl})$ in terms of a correlation coefficient:

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

Then:

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

Where:

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

VM0042 Section 8.6.1 states “Model prediction error is calculated using independent validation datasets per the processes outlined in VMD0053,” In line with this requirement, the model prediction error was calculated based no independent validation studies. The studies used are representative of the range of project activities and context within the project, and therefore is appropriate to be applied to the project modelled results. The studies also contain a wide range of scenarios, ensuring that outlier scenarios (e.g. the high C-input trials based on varying levels of manure inputs, resulting in high tSOC stock changes ranging from 1.06tSOC/ha/year to 6.43tSOC/ha/year over 7 years, with some of the trial plots receiving >12t Carbon Inputs annually (Bierer, 2021). Including studies such as these ensures that extreme high or extreme low stock change scenarios are included in the model prediction error assessment and thereby impact the uncertainty applied to project results.

For Model Prediction Error, the resulting squared variance across all fields was calculated to be 12.86 t C/ ha, which is 47.17 tCO_2/ha. This is a squared value over the entire project period.

Sampling error, as per 8.6.1.1.3 in V2 of Vm0042, was determined by following Equation 53 and Equation 54:

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

and:

$s^2_{sampling,\Delta\bullet,t}$ = Variance of emission reductions in gas or pool • due to sampling error at time *t* across the entire project area (t CO2e)^2

$s^2_{sampling,\Delta\bullet,h,t}$ = Variance of emission reductions in gas or pool • within stratum *h* due to sampling error at time *t* (t CO2e)^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 CO2e/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 CO2e/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*

Where:

For sampling error, the resulting aggregated, squared variance across all strata was calculated to be: 8,384,594.84 variance^2. In other words $S^2_{sampling,\Delta\bullet,t}$ = 8,384,594.84

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

Where:

$s^2_{\Delta\bullet,t}$ = Variance of the estimate of mean emission reductions from gas or pool • at time *t* (t CO2e/ha)^2

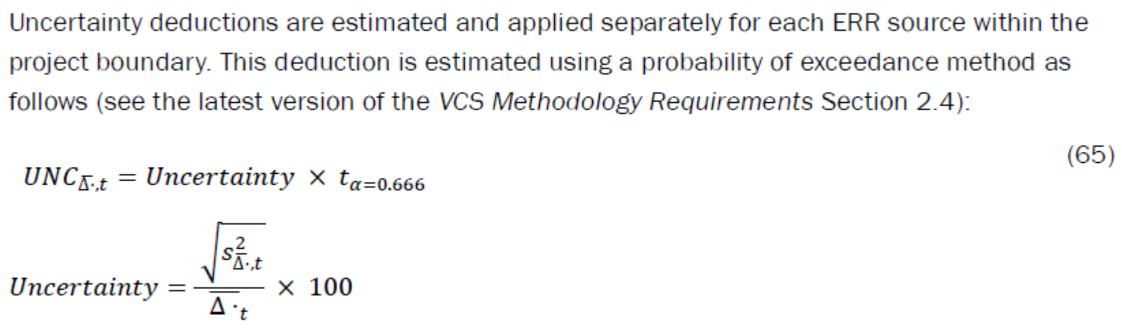
s^2_{model} = Variance of the estimate of emission reductions in gas or pool • due to model prediction error (t CO2e/ha)^2

A = Total project area

$$s^2_{model} = \sum_{h=1}^{H}\frac{A_h^2}{A^2}s^2_{model,h} \quad (55)$$

The below table outlines the project-wide values and calculation methods:

Parameter	Unit	Value	Source/Calculation method
s^2_{model}	$(tCO_2/ha)^2$	47.17	Equation 51 & 52. Using the mean variance calculated across all project fields.
$S^2_{sampling,\Delta\bullet,t}$	$(tCO_2e)^2$	8,384,594.84	Equation 53 & 54. The aggregated, squared variance across all strata.
A^2	$(ha)^2$	178,645,914.41	Total hectares within strata. See “Net Emission Reductions & Uncertainty Workings” workbook, sheet “Workings by Strata” for details.
$\frac{\mathbf{S2sampling,\Delta\bullet,t}}{\mathbf{A2}}$	tCO_2e / ha	0.05	The sampling variance was divided by the squared total area of the strata hectares:
$S\ ^{2}/_{\Delta\ \cdot t}$ Combined Model and sampling error	tCO_2/ha	47.21	Equation 53-55



Uncertainty deductions are estimated and applied separately for each ERR source within the project boundary. This deduction is estimated using a probability of exceedance method as follows (see the latest version of the *VCS Methodology Requirements* Section 2.4):

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

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

Uncertainty per gas or pool

Parameter	Unit	Value	Source/Calculation method
Δ-t	tCO_2e / ha	18.35	Total SOC-related emission reductions / removals divided by the total weighted average hectares across the period

$S^{2}/_{\Delta\text{-}t}$	tCO_2e / ha	47.21	Equation 54 & 55 Combined model prediction and sampling errors from the "Net Emission Reductions & Uncertainty Workings" workbook
$t_{\alpha=0.666}$	Unitless	0.4290902	Used value form student's t-distribution table for 650 observations less 1
$UNC_{t,CO2}$	%	16.068 %	Equation 65 See "Net Emission Reductions & Uncertainty Workings" workbook for a detailed calculation of uncertainty and a split between sampling and model prediction error

Various assessments were performed against the value of the uncertainty deduction, to ensure it is sufficient to cover various potential scenarios, mostly relating to outliers in the dataset. For example, it was assessed that the uncertainty deduction is sufficient to cover the ERR effect of any outliers in the modelled results. Outliers were identified within databases based on the rate of change in SOC in the project or baseline scenario, the relative rate of change in SOC in the project or baseline scenario or based on the net sequestration rate when comparing project and baseline stock changes.

As the uncertainty deduction is impacted by any potential outliers, the uncertainty was sufficient in all scenario analyses to cover any potential errors within outlier or extreme values. The outliers impact uncertainty in that the increased variance in modelled results within a strata increases error values.

Three different outlier methods were used to identify outliers (Inter-Quartile Range; Z-Score and Standard Deviation based methods). Where any of these methods found a point to be an outlier, the sample point was classified as an outlier. This conservative assessment of such outliers resulted in a maximum potential impact of 4.20% on ERR's. This figure does not represent a confirmed error, but rather the total maximum potential impact. The uncertainty deduction of 38,497tCO2e is sufficient to cover these outliers.

A further assessment was performed on a sample of these identified outliers where the SOC sequestration rate was compared to the known additional C-Inputs of that field, and the relationship of these compared to literature SOC sequestration/retention rates. It was found that the outliers have reasonable sequestration rates when compared to literature, in light of the C-Inputs of those sample units.

The above assessment is conservative in its identification of outliers as well as the fact that outliers are based on absolute stock changes of either the baseline or project scenarios (e.g. the project could have a rate change in SOC of 5tSOC/ha/year while the baseline's rate of change is 4.5tSOC/ha/year, resulting in a reasonable net stock change rate of 0.5tSOC/ha/year. While this is a reasonable net rate, the sample point would still be identified as an outlier due to the absolute rate changes of either scenario). Where the assessment is based on the net sequestration rate (i.e. difference in stock rate changes between the project and baseline), the total potential impact is reduced significantly.

The validation database also includes "outlier" studies with high sequestration rates which impact model error, in turn impacting uncertainty deductions. The validation studies used are representative of the range of project activities and context within the project and therefore is appropriate to be applied to the project modelled results.

The uncertainty deduction is likely also sufficient as the model uncertainty is based on modelling the published values used within validation, which generally have higher uncertainties due to limited data in some cases, as well as extreme scenarios (e.g. very high inputs of manure), which increase variance within the results, increasing the contribution of model error to the uncertainty deduction applied to the actual monitored results. The model error is also effectively based on the average study length of 6.1 years which is significantly longer than the verification period length of 4 years (i.e. the uncertainty of a longer average period from validation studies is applied to the results of a shorter period, likely over-estimating real uncertainty).

7.5.7 Calculation of Verified Carbon Units (VCUs)

The number of VCUs that may be issued in year *t* is calculated as:

$$VCU_t = E_{red,t} + (E_{rem,t} - Buffer_t) \tag{66}$$

Where:

VCU_t = Number of VCUs in year *t* (t CO_2e)

$Buffer_t$ = Number of buffer credits to be contributed to the AFOLU pooled buffer account in year *t* (t CO_2e)

Parameter	Unit	Value	Source/Calculation method
$E_{rem,t}$	tCO_2e	201,092	Equation 38

			"Net Emission Reductions & Uncertainty Workings" workbook After uncertainty, before buffer deduction/allocation
$E_{red,t}$	tCO_2e	(715)	Equation 37 "Net Emission Reductions & Uncertainty Workings" workbook
$Buffer_t$	tCO_2e	40,218	AFOLU Non-permanence Risk Tool V4.2
VCU_t	tCO_2e	160,159	Equation 66

8 APPENDICES

The following list of documents have been submitted as part of the audit pack or are available on request by Verra or the VVB.

8.1 Calculation Workbooks and Guidance for GHG Emission Reductions and Removals

- Farmer Emissions Summary 31 July 2022 (Farmer ID – Farmer Name) FINAL [22 Documents]
- Farmer ID - Final Output – Farmer Name [22 Documents]
- RothC Instance Folders [22 Folders containing the RothC input data as well as the output results for each sample unit]
- Orizon Sample List - 2023 (Final) [containing all sample results, Fulcrum data dump, strata & computations]
- Net Emission Reductions & Uncertainty Workings - July2022
- Collective Farmer Data (July 2022 Monitoring)

8.2 Guidance Materials

- Orizon CarbonCrop Programme - Methodology Deviation
- Orizon CarbonCrop Programme – Additionality
- Orizon CarbonCrop Programme – Land Conversion Assessment
- Orizon CarbonCrop Programme – Historic Land Use Assessment
- Orizon CarbonCrop Programme – Manure Leakage Assessment
- Orizon CarbonCrop Programme – RothC CSV Generation Rules
- Orizon CarbonCrop Programme – Cover Crop Biomass

8.3 Specialist Reports

- ModelValidationReport2023_Orizon_Project3368

8.4 Monitoring Plan Section Documents

- Orizon CarbonCrop Programme - Soil Sampling and Stratification
- Orizon CarbonCrop Programme - Farmer Process & Field Records
- Orizon CarbonCrop Programme - QA & QC
- Orizon CarbonCrop Programme – Calculations & Modelling Process Flow

8.5 Other Report / Workbooks / Documents

- Regional Baseline Development workbook
- Regional Baseline Development report
- Agronomist (Qualified local independent expert) Signed Attestations
- Farmer locations 2021-22 period end [PNG & XLSX]
- Orizon CarbonCrop Rewards Programme All Field Boundaries [KML of all project fields]
- Grower Attestations [22 Documents]
- Folder per Project Instance [22 Folders] containing:
    - Farmer ID – Farmer Name Farmer Summary [snapshot summary of the farmer's operations]
    - DocuSign Contract between Orizon & Farmer
    - Farmer ID – Farmer Name Biodiversity Report [study of endangered species of birds & mammals within the area]
    - Farmer ID – Farmer Name Wetland Report [desktop assessment of wetlands within and around the field boundaries]
    - Field Records Inputs (Farmer Name) [records and details of evidence for all field events; stratification process and results; sampling results]
    - Orizon fields (Farmer ID – Farmer Name) [KML of all included project fields relating to the farmer]
- Farm Ownership Assessment workbook [data of research of title ownership of all project farms & fields]
- Ownership Title Deeds [downloads of title deed summaries from winded per farm owned]

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