T-VER-P-METH-13-06

Enhanced Good Practices in Agricultural Land

Version 01

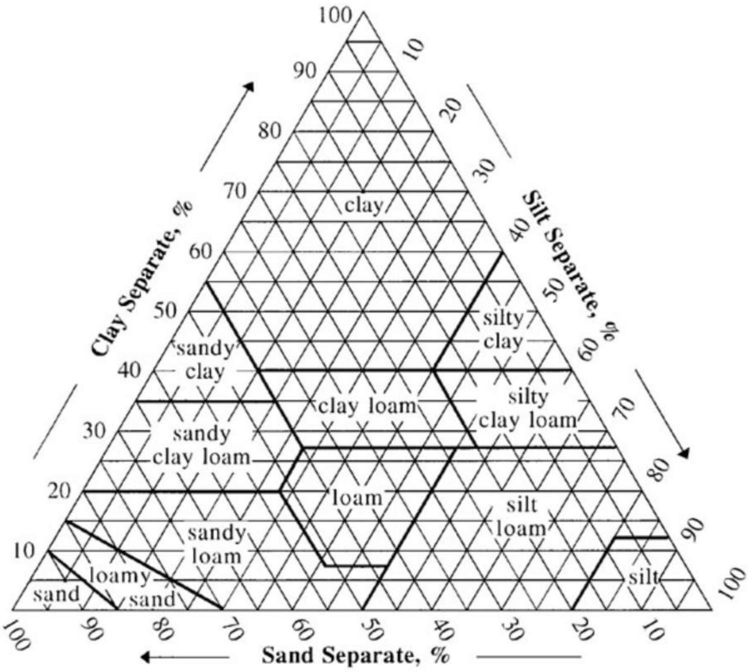
Sectoral Scope: 15 –Agriculture

Entry into force on 1 March 2023

1. Methodology Title	Enhanced Good Practices in Agricultural Land
2. Project Type	Reduction, absorption and removal of greenhouse gases from the forestry and agriculture sectors
3. Sector	15 - Agriculture
4. Project Outline	Greenhouse gas emission reduction and carbon sink from enhanced good practices in agricultural land
5. Applicability	1. Project area has land-use rights certificate as specified by law 2. Good management of agriculture land must contain one of the following criteria 2.1 The land must promote carbon sink such as use of organic matters, improvement of agricultural waste management, minimum soil tillage, using agroforestry system, crop rotation and growing covering plants. 2.2 The land must reduce the use of nitrogen fertilizers 2.3 The land must apply improved irrigation system
6. Project Conditions	1. Project area may compose of many areas together 2. Land used must be beneficial and suitable for the purpose 3. Not at risk of land slide 4. A good practice may be the implementation of one or more activities. It is the cessation or cessation of certain activities. This includes improvements or implementations in conjunction with pre-project guidelines. The improvements implemented must exceed 5% of the historical average. 5. In case there is no information on agricultural activities in item 4, references from government agencies can be used. Values from research or reference values that are acceptable and appropriate for the project area.
7. Project starting date	The date the project participant commences project activities on the project land or the start date of the planting year during which the project's activities begin.
8. Remarks	-

Definitions

Baseline	In business-as-usual greenhouse gas emission event
Leakage	The amount of greenhouse gas emissions arising from the project but occurs outside the scope of the project
Belowground carbon	Decomposition of organic matter accumulated in soil as organic carbon
Nitrogen fixing plant	All plants associated with nitrogen-fixing microorganisms commonly found in root nodules, such as legumes
Chemical fertilizer	Fertilizers derived from inorganic or synthetic organic compounds including single fertilizer, compound fertilizer, compound fertilizer and organic chemical fertilizers, which contain the main nutrient NPK by the initial process of ammonia gas (NH_3) obtained from the synthesis of oil and when combined with acid through chemical processes, the NPK element is obtained as the mother of various formulas
Organic fertilizer	Fertilizers obtained from living organisms, both plants and animals. which has undergone processing or have been piled up until it has completely rotted away and, in a condition, where plants can be used, such as rotted leaves, compost, manure, bone meal, bean waste, green manure and municipal manure
Soil texture or soil type classified by United State Department of Agriculture (USDA)	Soil is classified using "Soil Triangle" concept according to USDA consisting of 12 groups of soil texture as shown in the picture below (USDA-NRCS, 2022) Data Source: USDA-NRCS. 2022. Soil Texture Calculator. Available source: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167, June 27th, 2022.

	
Legal Land Use Rights Certificate	Documents demonstrating ownership of land, rights to use the land according to the law, such as a land title deed (Nor. Sor 4), a certificate of utilization (Nor Sor. 3), a document on land use rights in land reform area (Sor Por.), a request for public use, letter of permission to use in the self-establishing industrial estate (NorKhor.3) or land utilization certificate from the relevant government agency

In addition to the definitions contained in this document, Use definitions consistent with definitions in the T-VER, CDM and IPCC Guidelines.

T-VER Methodology for enhanced good practices in agricultural land

1. Scope of project

1.1 Operation Characteristics

Assessment methods to enhance good practices in agricultural land contains details in GHG emission reduction calculation and implementation, and promotion of carbon stock as a result of good agricultural land management activities, with emphasis on promotion of carbon sequestration in the form of soil organic carbon (SOC). This method calculates the net emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) from farmers' operations. The activities involved in project implementation are important to the project's carbon sequestration and greenhouse gas emission reduction capabilities as follows:

1) Project development must undertake at least one of the following:

- Conducting soil carbon sequestration activities such as adding organic matters, improving agricultural waste management, reduction of soil tillage, applying agroforestry system, crop rotation, cultivation of ground cover crops
- Reducing the use of nitrogen fertilizers such as proper fertilization, applying organic matters (such as manure, compost)
- Improving water management or irrigation, such as reducing water retention times. wet and dry rice cultivation, etc.

Best practices may involve more than one activity, either suspension or removal of certain activities and improvement or joint practices with activities set prior to the project initiation. Any improvements made must exceed 5% of the historical average such as a decrease in nitrogen fertilization rates of more than 5%.

2) The project area must not be modified from a natural ecosystem within the 10 years prior to the project start date.

3) Project activities must not reduce more than 5% of agricultural productivity as assessed by experts and/or information from publications conducted in the same or comparable region.

1.2 Scope of Work

The project developer must identify project location including geographic coordinate, location, and other details of such location as well as a legal land rights or land use certificate.

2. Selection of carbon pools and greenhouse gases for calculation

2.1 Source of carbon pools and greenhouse gases for calculation

Carbon pools	Selected	Explanation
Aboveground Woody Biomass	Yes / Optional	A carbon pool that calculated from tree biomass and sapling collected above the ground such as tree trunk, branches, and leaves. The assessment is conducted in case the project activity causes major loss of carbon pool comparing to baseline. Other cases are optional for aboveground biomass assessment.
Belowground Woody Biomass	Optional	An alternative assessment that calculates carbon stock from tree biomass and sapling collected below the ground such as root
Soil Organic Carbon	Yes	Main carbon stock in these pools may increase due to implementation of the project activity calculating from the belowground carbon stock in the project area

2.2 Emission source and GHG type selected for calculation

Sources	GHG Type	Selected	Explanation
Fossil Fuel Combustion	CO_2	conditional*	Fuel use for vehicles such as tractors, trucks and agricultural machinery in project activities must be taken to calculate the amount of greenhouse gas emissions
Soil Methanogenesis	CH_4	conditional*	Caused by the degradation of organic carbon in soil in anaerobic conditions
Use of Nitrogen Fertilizers	N_2O	Yes	Nitrogen fertilizers used in baseline scenario, or use of nitrogen fertilizers when the project value is higher than baseline scenario, the GHG emission must be assessed

Sources	GHG Type	Selected	Explanation
			from the use of nitrogen fertilizer in project activity.
Use of Nitrogen Fixing Species	N_2O	Yes	When using nitrogen fixing species in the project, it is necessary to assess the GHG emission from such activity.
Biomass Burning	CH_4	conditional*	Non-CO_2 emission from biomass burning
	N_2O	conditional*	

Remarks * Conditional assessment is an assessment when project activities cause significant increases or decreases in greenhouse gas emissions comparing to baseline. The project developer may apply *T-VER-P-Tool-01-09 Tool for Testing Significance of GHG emissions in Project Activities.*

3. Baseline scenario

Baseline calculation of carbon sink and reduction of greenhouse gas emissions is an assessment based on the activities carried out before project initiation or the continuation of greenhouse gas reduction activities. This calculation must consider project activity details occurred in a year or one crop cycle of a crop rotation or alternating crops. Baseline greenhouse gas emissions or carbon changes are assessed by direct measurements or simulations made in controlled areas. However, in the case of project extension, if the baseline has changed from previous calculation, agricultural plants and activities will be re-assessed and improved to reflect current agricultural productivity in that area.

The project developer must develop a baseline activity for each sampling unit by assessing from cultivation history of not less than 3 years. In the case of crop rotation, it must cover at least one crop rotation cycle. The information of agricultural activities must be reported as shown in Table 1.

Table 1 Agricultural activities for baseline

Activity	Description
Planting and harvesting	• Plant species • Planting date (if any) • Date of harvest or end of planting (if any)
Nitrogen fertilization	• Chemical fertilizer (add/not apply) with type and rate of application (if any). • Organic matters (add/not apply) with type and rate of application (if any).

Activity	Description
Tilling and/or handling of agricultural waste	• Tillage (yes/no) with details such as depth, Monitoring Frequency and proportion of tilled area (if applicable). • Removing agricultural waste from the area. with the type and proportion to be removed (if any)
Irrigation	• Irrigation system including water supply system (yes/no) and water supply rate (if any) • Water logging system (yes/no)

At the end of each credit cycle, an extended project can continue operate the same agricultural activities described in baseline but they must be reviewed according to TGO requirement (if any), if presenting evidences demonstrated activities' continuous operations. Otherwise, the project developer must conduct a new baseline assessment using historical data of less than 5 years counting from the previous project baseline's expiry date stated in publications released in the project's area or region related to the project. The project developer must also develop a new agricultural activity schedule as recommended by agricultural experts who has no conflict of interest towards the project or those government agricultural officials . The new activity schedule must contain at minimum a list of activity details and the principle for baseline data selection such as lowest greenhouse gas emission values or highest carbon sink values as required in conservative approach. However, if the values recommended are not field specific, the project developer is required to select a value from referenced data set suitable for the project area.

4. Additionality

Additionality is a result derived from previous guidelines on good agricultural land management. Counting from the project initiation date, the project developer must present additionality as follow.

- Step 1 Identify obstacles that will hinder implementing changes in pre-existing agricultural practices

  The project developer must identify barriers to prevent changes in GHG emission reduction activities, which may be one or a combination of these barriers: attitudinal, cultural, and social barriers, regulatory and legal barriers, marketing and technological barriers.
- Step 2 Prove the common practices of these agricultural activities proposed

  The project developer must demonstrate that greenhouse gas reduction agricultural activities are not common practice in the project area or region where the project is located. Common practice means agricultural activities implemented in more than 20% of total area (adoption rate). Therefore, the project developer must prove that their project is not common practice in the area.

When there are many good practices in agricultural land management, the project developer must select main GHG emission reduction activities, calculate an average value from at least 3 main activities (or more), and calculate a weighted average value (more than 20% of total area, which may include a proportion of an activity that exceeds 20% of total area). Therefore, the project developer must present a calculation of the average value in each region of the project for consideration.

The project developer must provide credible published evidence for consideration such as agricultural data of government agencies, academic publications, research data from organizations or experts, and documents compiled by industry associations or confederations.

Documents should be specific to the terrain specified in the project area. Especially provincial or regional data, but if not available, national or regional data may be used. or may use the discretion of qualified persons such as agricultural extension officers and accredited agricultural scholars to determine the proportional operations or to certify common practice of the project activity in the area. The project developer must present the paper with certified signature and the date of certification.

After completing step 1 and 2 and the assessment results show that the project is consistent with additionality condition, the project developer can present this proof of additionality.

5. Quantification of GHG emission reductions and removals

A quantitative assessment of GHG emission reductions and carbon sequestration from good practices in agricultural land management calculates the rate of greenhouse gas emissions namely CH_4, N_2O and CO_2 gases in tons of carbon dioxide equivalent per area in the follow-up period. The quantitative assessment has 3 methods as follows:

- **Assessment method 1: Modelling method**

  This modeling method uses acceptable scientific model in assessing GHG emission rate and/or change in soil organic carbon. The project developer must conduct the assessment according to appropriate standards and principles, starting from model calibration and validation, details presentation or assessment procedures in various steps with reference to internationally acceptable assessment guidelines.

For baseline, the modelling method conducted for each sample unit may use referred performance values in forecasting changes or emissions from agricultural activities. Inputs include soil characteristics such as quantity of soil organic carbon, and total soil density; climate factors such as rainfall and temperature; and project implementation activities such as monitoring input data consulted and certified by farmers and owners of the sampling data. Quantitative data must be supported by evidences from the sampling area such as activity records, receipt or quotation of agricultural tools, list of agricultural tools, unit of the reported data as per the model's requirements.

- Assessment method 2: Direct measurement

  Direct measurement is to collect samples in the project area and analyze the samples. In this regard, the project developer shall detail the principles or methods of assessment at various stages by referring to the internationally acceptable assessment guidelines.

- Assessment method 3: Default

  The default method defines an equation for calculating greenhouse gas emissions and sequestration based on internationally acceptable assessment guidelines, in particular, a manual on the preparation of a national greenhouse gas account.

Agricultural activities within the scope of the Good Practices for Agricultural Land Management must follow the assessment guidelines shown in Table 2.

Table 2 Summary of actionable quantitative assessment approaches

GHGs/Carbon Source	Activity	Assessment Method 1: Modelling *	Assessment Method 2: Direct measurement	Assessment Method 3: Default
CO_2	Soil Organic Carbon	√	√	√
	Fossil Fuel			√
	Woody Biomass**			
CH_4	Soil Methanogenesis	√		√
	Biomass Burning			√
N_2O	Use of Nitrogen Fertilizers	√		√

GHGs/Carbon Source	Activity	Assessment Method 1: Modelling *	Assessment Method 2: Direct measurement	Assessment Method 3: Default
	Use of Nitrogen Fixing Species	√		√
	Biomass Burning			√

Remarks:

* Assessment method 1 can be used when a suitable model is available. A detailed model suitability assessment can be found in the Model Calibration and Validation Manual or other suitable sources.

** Assessment of wood biomass Refer to the tool-based assessment method *T-VER-P-TOOL-01-02 Calculation for carbon stocks and changes in carbon stocks of trees in forest project activities)*

5.1 Baseline emissions

5.1.1 Soil Organic Carbon stocks

Assessment Method 1

$$SOC_{BSL,t} = f(SOC_{BSL,t-1})$$

Where:

$SOC_{BSL,t}$	Soil organic carbon stock in the baseline scenario at the end of year t (tCO2eq / rai)
$f(SOC_{BSL,t-1})$	Soil organic carbon stock in the baseline scenario at the end of the year t-1 was estimated using a model. (Tonnes of carbon dioxide equivalent per rai)

Assessment Method 2

For the baseline, monitoring of changes in soil organic carbon must be conducted in the control area. Soil samples must be collected at a depth of at least 30 cm, and soil organic carbon accumulation must be reported for the baseline scenario control area and for each terrain layer within the project site using *T-VER-P-TOOL-01-12 Calculation for change in soil organic carbon stocks in agricultural project activities*

The project developer must manage a control area as per baseline requirement for sampling units or areas with similar characteristics such as geographical region, soil content, agricultural activities, plant type, planting cycle, cover crop, soil improvement materials, irrigation system/ hydrological management and/or tillage.

The area must be large enough to be a suitable representation of the measured value. and reduce edge effect. If the area is too small, it may be affected by the surrounding area and thus not be used as an appropriate representative value. A control area can be set outside the project area. One control area may cover multiple areas, if possessing similar characteristics, but must cover at least 2 areas. More areas reduce uncertainty.

The project developer may refer to other internationally acceptable assessment methods such as calculating changes in soil organic carbon accumulation using the equivalent soil mass (ESM) principle, according to Ellert and Bettany (1995), Wendt and Hauser (2013) and Von Haden, Yang and DeLucia (2020)

$$SOC_{BSL,t} = SOC_{BSL,m,t=0}$$

Where:

$SOC_{BSL,t}$	Soil organic carbon stock in the baseline scenario at the end of year t (tCO_2eq / rai).
$SOC_{BSL,m,t=0}$	Soil organic carbon stock in the baseline scenario at the end of the year t=0 was assessed by measurements. (tCO_2eq / rai)

Assessment Method 3

Changes in soil organic carbon calculated through default assessment method is the calculation of change in soil organic carbon accumulation according to the IPCC Manual called *T-VER-P-TOOL-01-12 Calculation for change in soil organic carbon stocks in agricultural project activities.*

$$SOC_{BSL,t} = SOC_{BSL,t=0}$$

Where:

$SOC_{BSL,t}$	Soil organic carbon stock in the baseline scenario at the end of year t (tCO_2eq / rai).
$SOC_{BSL,t=0}$	Soil organic carbon stock in the baseline scenario at the end of the year t=0 was estimated from the recommended values. (tCO_2eq / rai)

5.1.2 Change in carbon stocks in aboveground and belowground woody biomass

If the project requires an assessment of carbon stored in the woody, it is necessary to assess the change in the carbon accumulation of trees and young trees for each sampling unit in a given year and express it as a quantity per unit area using the calculation tool *T-VER-P-TOOL-01-02 Calculation for carbon stocks and changes in carbon stocks of trees in forest project activities*

5.1.3 Carbon dioxide emissions from fossil fuel combustion

If the project requires an assessment of the CO_2 emissions from fuel combustion It is necessary to evaluate with the third evaluation method, computation with the recommended value (Default) with the following equation.

Assessment Method 3

$$CO_{2\,FUEL,BSL,i,t} = \left(\sum \left(FC_{BSL,a,i} \times (NCV_a \times 10^{-6}) \times EF_{CO2,a}\right) \times 10^{-3}\right)/A_i$$

Where:

$CO_{2\,FUEL,BSL,t}$	Greenhouse gas emissions from the use of fossil fuels from project activities in the baseline scenario of the sample unit i in year t (tonnes of carbon dioxide equivalent per rai)
$FC_{BSL,a,i}$	Quantity of fuel type *a of sample unit i for baseline scenario (unit)*
NCV_a	Net Calorific Value of type a fuel (MJ/unit)
$EF_{CO2,a}$	GHG emissions from the burning of fossil fuel type a (Kg CO_2 / TJ)
A_i	Area of sample unit i (rai)
a	fossil fuel type
i	sample unit

5.1.4 Methane emissions from the soil organic carbon pool

Methane released is caused by the decomposition of organic matter accumulating by soil microorganisms of the methanogen group such as anaerobic conditions in rice fields. If the project has activities to reduce methane emissions from the soil namely water management in rice fields, it is necessary to apply the Assessment Method 1 Modelling or Assessment Method 3 Default as shown below.

Assessment Method 1

$$CH_{4\,SOIL,BSL,t} = GWP_{CH4}\ x\ fCH_{4\,SOIL,BSL,t}$$

Where:

$CH_{4_{SOIL,BSL,t}}$	Baseline methane emissions from soil carbon sources in year t (tCO_2eq/rai).
$fCH_{4_{SOIL,BSL,t}}$	Methane emissions from soil carbon sources modeled in the baseline scenario in years t (t CH_4/rai).
GWP_{CH4}	The global warming potential of methane (tCO_2eq/ t CH_4)

Assessment Method 3

Methane Emissions from Soil Carbon Sources Based on Recommended Assessment Method It is the calculation of methane emissions from rice planting areas according to the IPCC manual and expressed as quantity per unit area using *T-VER-P-TOOL-01-13 Calculation for methane emission reduction by adjusted water management practice in rice cultivation*

5.1.5 Methane emissions from biomass burning

If the project requires an assessment of methane emissions from biomass burning It is necessary to evaluate with the third assessment method, which is calculated by default (default) with the following equation.

Assessment Method 3

$$CH_{4_{BURNING,BSL,i,t}} = \frac{(GWP_{CH4}\ x \sum MB_{BSL,b,i,t}\ x\ CF_b\ x\ EF_{CH4,b})}{10^6\ x\ A_i}$$

Where:

$CH_{4_{BURNING,BSL,i,t}}$	Methane emissions from biomass burning in the baseline scenario of sample unit i in year t (tCO_2eq/rai)
$MB_{BSL,b,i,t}$	Mass of type b agricultural waste incinerated in the baseline scenario of the sample unit i in year t (kg)
CF_b	Emission coefficient of type b agricultural waste (proportion of biomass as fuel before combustion)
$EF_{CH4,b}$	Methane emission factor from incineration of agricultural waste type b (grams of methane per kg of dry burned biomass)
GWP_{CH4}	The global warming potential of methane (tCO_2eq/ t CH_4)
A_i	Area of sample unit i (rai)

b types of agricultural waste

10^6 conversion unit (grams per ton)

5.1.6 Nitrous oxide emissions from nitrogen fertilizers and nitrogen-fixing species

Nitrous oxide emissions from nitrification and denitrification processes consists of direct and indirect emissions from nitrogen fertilization and direct emissions for nitrogen-fixing plants. If the project requires an assessment of the amount of nitrous oxide emissions from nitrogen fertilization and nitrogen fixation plants, the project can apply Assessment Method 1 Modelling or Assessment Method 3 Default as shown in equation below.

Assessment Method 1

$$N_2O_{SOIL,BSL,i,t} = GWP_{N2O}\ x\ fN_2O_{SOIL,BSL,i,t}$$

Where:

$N_2O_{SOIL,BSL,i,t}$ Direct and indirect nitrous oxide emissions from soil nitrogen application in the baseline scenario of sample unit i in year t (tCO_2eq/rai)

$fN_2O_{SOIL,BSL,i,t}$ Nitrous oxide emissions from the soil modeled in the baseline scenario. of sample unit i in year t (tN_2O/rai)

GWP_{N2O} The global warming potential of nitrous oxide (tCO_2eq/ tN_2O)

Assessment Method 3

$$N_2O_{Soil,BSL,i,t} = N_2O_{Direct,BSL,i,t} + N_2O_{Indirect,BSL,i,t}$$

(1) Direct measurement

$$N_2O_{Direct,BSL,i,t} = ((F_{SN,BSL,i,t} + F_{ON,BSL,i,t} + F_{Nfix,BSL,i,t})\ x\ EF_{N2ODirect}\ x\frac{44}{28}x\ GWP_{N2O})/A_i$$

$$F_{SN,BSL,i,t} = \sum M_{SN,BSL,i,t}\ x\ N_{SN}$$

$$F_{ON,BSL,i,t} = \sum M_{ON,BSL,i,t}\ x\ N_{ON}$$

$$F_{Nfix,BSL,i,t} = \sum M_{c,BSL,i,t}\ x\ N_c$$

(2) Indirect measurement

$$N_2O_{Indirect,BSL,i,t} = (N_2O_{ATD,BSL,i,t} + N_2O_{L,BSL,i,t})/A_i$$

$$N_2O_{ATD,BSL,i,t} = \left((F_{SN,BSL,i,t}\ x\ Frac_{GASF}) + (F_{ON,BSL,i,t}\ x\ Frac_{GASM})\right)\ x\ EF_{ATD}\ x\frac{44}{28}x\ GWP_{N2O}$$

$$N_2O_{L,BSL,i,t} = \left(F_{SN,BSL,i,t} + F_{ON,BSL,i,t}\right) x\ Frac_{LEACH}\ x\ EF_{LEACH}\ x \frac{44}{28} x\ GWP_{N2O}$$

Where:

$N_2O_{SOIL,BSL,i,t}$	Nitrous oxide emissions from nitrogen application in the soil baseline scenario of sample unit i in year t (tCO_2eq/rai)
$N_2O_{Direct,BSL,i,t}$	Direct nitrous oxide emissions from soil nitrogen application in the baseline scenario of sample i in year t (tCO_2eq/rai)
$N_2O_{Indirect,BSL,i,t}$	Amount of indirect nitrous oxide emissions from soil nitrogen application in baseline scenario of sample unit i in year t (tCO_2eq/rai)
$EF_{N2ODirect}$	Emission factor of nitrous oxide from nitrogen application from chemical fertilizers, organic fertilizers, organic materials for soil improvement. and agricultural waste (tN_2O/ton of nitrogen)
$F_{SN,BSL,i,t}$	Nitrogen content of chemical fertilizers added to the soil in the baseline scenario of the sample unit i in year t (tonnes of nitrogen)
$F_{ON,BSL,i,t}$	Nitrogen content of organic fertilizers added to the soil in the baseline scenario of sample unit i in year t (tons of nitrogen)
$F_{Nfix,BSL,i,t}$	Nitrogen content of nitrogen-fixing plants in the aboveground and underground parts) added to the soil in the basal case. of the sample unit i in year t (tonnes of nitrogen)
$M_{SN,BSL,i,t}$	The amount of chemical fertilizer application in the baseline scenario of the sample unit i in year t (tons of fertilizer)
N_{SN}	Nitrogen content in chemical fertilizers (tonnes of nitrogen per ton of fertilizer)
$M_{ON,BSL,i,t}$	The amount of organic fertilizer application in the baseline scenario of sample units i in year t (tons of fertilizer)
N_{ON}	Nitrogen content in organic fertilizers (tonnes of nitrogen per ton of fertilizer)
$M_{c,BSL,i,t}$	Dry weight of aboveground biomass and underground parts of c-type nitrogen-fixing plants added to soil in basal cases. of the sample unit i in year t (ton dry weight)
N_c	Nitrogen content in c-type nitrogen-fixing plants (tonnes of nitrogen per ton dry weight)

$N_2O_{ATD,BSL,i,t}$	Indirect nitrous oxide emissions from volatile nitrogen deposition from baseline scenario nitrogenization of the sample unit i in year t (tCO_2eq/rai)
$N_2O_{L,BSL,i,t}$	Indirect nitrous oxide emissions from nitrogen leaching and runoff in the baseline scenario of the sample unit i in year t (tCO_2eq/rai)
$Frac_{GASF}$	The proportion of nitrogen fertilizer added to soil and evaporation in the form of ammonia and nitrogen oxides
$Frac_{GASM}$	The proportion of nitrogen organic fertilizer added to soil and evaporation in the form of ammonia and nitrogen oxides
$Frac_{LEACH}$	The proportion of nitrogen fertilizers added to the soil (chemical and organic fertilizers) and lost through leaching and runoff.
EF_{ATD}	Coefficient of nitrous oxide emission from nitrogen deposition from the atmosphere to the soil and water surface (tN_2O-N / (t NH_3-N + NO_X-N))
EF_{LEACH}	The emission coefficient of nitrous oxide from leaching and runoff (tonnes N_2O-N per ton of nitrogen leaching and runoff)
SN	type of chemical fertilizer
ON	type of organic fertilizer
c	Types of nitrogen-fixing plants
A_i	Area of sample unit i (rai)
GWP_{N2O}	The global warming potential of nitrous oxide (tCO_2eq/t N_2O)
$\frac{44}{28}$	The molecular weight ratio of nitrous oxide to nitrogen

5.1.7 Nitrous oxide emissions from biomass burning

If the project requires an assessment of nitrous oxide emissions from biomass burning It is necessary to evaluate with the third assessment method, which is calculated by default (default) using the following equation.

Assessment Method 3

$$N_2O_{BURNING,BSL,i,t} = \frac{(GWP_{N2O}\ x \sum MB_{BSL,b,i,t}\ x\ CF_b\ x\ EF_{N2O,b})}{10^6\ x\ A_i}$$

Where:

$N_2O_{BURNING,BSL,i,t}$	Nitrous oxide emissions from biomass burning in the baseline scenario of the sample unit i in year t (tCO_2eq/rai)
$MB_{BSL,b,i,t}$	Mass of type b agricultural waste incinerated in the baseline scenario of the sample unit i in year t (kg)
CF_b	The incineration coefficient of type b agricultural waste (proportion of biomass as fuel before combustion)
$EF_{N2O,b}$	The emission coefficient of nitrous oxide from incineration of agricultural waste type b (grams of nitrous oxide per kg dry of burned biomass)
GWP_{N2O}	The global warming potential of nitrous oxide (tCO_2eq/t N_2O)
A_i	Area of sample unit i (rai)
b	types of agricultural waste
10^6	conversion unit (grams per ton)

5.2 Project emissions

Evaluation of the amount of greenhouse gas emissions or sequestrations for the project Use the assessment methods and equations as given in the baseline scenario by adjusting the symbol from BSL to PROJ.

6. Leakage

Assessment of the amount of leakage caused by the implementation of the project There is an issue to consider, namely the acquisition of organic materials to improve soil used in the project area and the effect on agricultural products from the project implementation.

6.1 Leakage from organic amendments from the outside

When soil organic matters used in the project such as manure, compost or sludge is a new source or additionality, it will cause leakage in project activities but not include activities using soil organic content in the following situations:

1) Soil organic matters are produced within the project site.

2) The manure used is from the anaerobic fermentation process without the utilization of the methane gas generated.

3) The soil organic matters used has never been used before in the project area.

When a leakage occurs, it is necessary to assess the amount of this leakage subtracting from the project's greenhouse gas reduction (calculated for soil organic carbon accumulation) giving the carbon leakage value equivalent to 12% of total soil organic carbon content added from baseline or determined from reliable data source. The project developer must present the detailed principles or assessment method used in reference to appropriate internationally acceptable standards.

6.2 Leakage from productivity

GHG emission reduction activities in agricultural area must not lead to productivity reduction due to leakage. Therefore, the assessment of such activities must be conducted in periodic basis or every credit cycle to create non-leakage confidence. Leakage from agricultural productivity reduction must meet the following requirements.

Project activities must not face a reduction in agricultural productivity of more than 5% compared to the baseline scenario. This means that an assessment of agricultural productivity calculated between baseline and project implementation excludes years of extreme weather events, and performs by using project field data and baseline, or comparing regional agricultural productivity data (baseline and project implementation) with reference to available data from government agencies, academic or research institutes, and studies published domestically and internationally such as FAO publication.

In the event that agricultural productivity may decrease due to the change in agricultural activities during the start-up period agricultural productivity assessments can be calculated excluding data for the first 3 years of project implementation. However, stratification that causes a decrease in agricultural productivity caused by one or more agricultural activities or factors, including: plant type, soil type, weather conditions If the project can determine which activities accomplished and caused agricultural productivity reduction, the project cannot use these activities in future credit assessment. If the project cannot determine specific agricultural activities, all agricultural productivity cannot be used for future credit assessment.

In the event that agricultural productivity is reduced by more than 5% but not more than 15%, the project developer can provide additional evidence to prevent leakage calculation of agricultural products from weather variations occurred in tropical countries and variation of agricultural productivity in Thailand (reference to Agricultural Product Production Data, Office of Agricultural Economics). These data are very sensitive to climate fluctuation and may mislead that project implementation affects agricultural productivity.

The project developer must describe in detail the principles or methods of assessment at these stages that reference internationally compliant assessment guidelines.

The amount of leakage from the project implementation It is calculated as follow.

$$LE_t = LE_{OM\ OUTSIDE}$$

Where:

LE_t	Leakage from project implementation in year t (tCO_2eq)
$LE_{OM\ OUTSIDE}$	Organic matters leakage from soil improvement from sources outside the project area in years t (tCO_2eq)

7. Net GHG emission reductions and removals

$$\Delta C_{ACTUAL,t} = (\Delta C_{P,t} + GHG_t - LE_t)\ x\ UF_t\ x\ A_0$$

$$\Delta C_{P,t} = \Delta SOC_t + \Delta C_{TREE,t} + \Delta C_{SAB,t}$$

$$GHG_t = \Delta CO_{2\,FUEL,t} + \Delta CH_{4\,SOIL,t} + \Delta CH_{4\,BURNING,t} + \Delta N_2O_{SOIL,t} + \Delta N_2O_{BURNING,t}$$

Where:

$\Delta C_{ACTUAL,t}$	Emission reductions and greenhouse gas removal in years t (tCO_2eq)
$\Delta C_{P,t}$	Greenhouse gas removal in year t (tCO_2eq/rai)
GHG_t	Greenhouse gas emission reductions in year t (tCO_2eq/rai)
LE_t	Spill volume in year t (tCO_2eq/rai)
UF_t	Proportion of devaluation from uncertainty in year t
A_0	Project area (rai)
ΔSOC_t	Change in soil organic carbon stock in years t (tCO_2eq / rai)
$\Delta C_{TREE,t}$	Change in carbon stock in trees in year t (tCO_2eq/rai)
$\Delta C_{SAB,t}$	Change in carbon stock in sapling in year t (tCO_2eq/rai)
$\Delta CO_{2\,FUEL,t}$	Change in CO_2 emission reduction from fossil fuel burning in years t (tCO_2eq/rai)
$\Delta CH_{4\,SOIL,t}$	Change in in methane emissions reduction from soil carbon sources in years t (tCO_2eq/rai)
$\Delta CH_{4\,BURNING,t}$	Change in methane emissions from biomass burning in years t (tCO_2eq/rai)
$\Delta N_2O_{SOIL,t}$	Change in nitrous oxide emissions reduction from nitrogen fertilization and nitrogen fixing plants in year t (tCO_2eq / rai)

$\Delta N_2O_{BURNING,t}$ Change in nitrous oxide emission reduction from biomass burning in year t (tCO_2eq / rai)

Soil Organic Carbon

The CO_2 emissions reductions resulting from the promotion of soil organic carbon stock at year t were estimated using Method 1 as follows:

Assessment Method 1

$$\Delta SOC_{i,t} = (SOC_{PROJ,i,t} - SOC_{PROJ,i,t-1}) - (SOC_{BSL,i,t} - SOC_{BSL,i,t-1})$$

Where:

$\Delta SOC_{i,t}$	Change in soil organic carbon stock of the i sample unit in year t (tCO_2eq / rai)
$SOC_{PROJ,i,t}$	Soil organic carbon stock in case of project implementation of sample i at the end of year t (tCO_2eq / rai)
$SOC_{PROJ,i,t-1}$	Amount of organic carbon accumulation in soil in case of project implementation of sample i at the end of year t-1 (tCO_2eq / rai)
$SOC_{BSL,i,t}$	Soil organic carbon stock in the baseline scenario of sample i at the end of year t (tCO_2eq / rai)
$SOC_{BSL,i,t-1}$	Soil organic carbon stock in the baseline scenario of sample i at the end of year t-1 (tCO_2eq / rai)

Soil organic carbon at baseline scenario or project implementation are the same, which can be described as $SOC_{PROJ,0}$ = $SOC_{BSL,0}$ Therefore, the baseline scenario calculation appears as $SOC_{PROJ,t} - SOC_{BSL,t}$

Assessment Method 2

The reductions in carbon dioxide emissions resulting from the promotion of soil organic carbon stock in year t were compared with base-case accumulation changes and equal to the standard performance value (if any) or is an estimation of the change in the control plot in the baseline scenario according to method 2 as follows:

$$\Delta SOC_{i,t} = (SOC_{PROJ,i,t} - SOC_{PROJ,i,t\_prev}) - (SOC_{BSL,i,t} - SOC_{BSL,i,t\_prev})$$

Where:

$\Delta SOC_{i,t}$ Change in soil organic carbon stock of the i sample unit in year t (tonnes of carbon dioxide equivalent per rai)

$SOC_{PROJ,i,t}$	Soil organic carbon stock in case of project implementation of sample i at the end of year t (tCO_2eq / rai)
SOC_{PROJ,i,t_prev}	Soil organic carbon stock in case of project implementation of the sample i at the year of the previous measurement (tCO_2eq / rai)
$SOC_{BSL,i,t}$	Soil organic carbon stock in the baseline scenario of sample i at the end of year t (tCO_2eq / rai)
SOC_{BSL,i,t_prev}	Soil organic carbon stock in the baseline scenario of the sample i at the year of the previous measurement (tCO_2eq / rai)

When the period between times t and t_prev is a period of several calendar years, project proponents may use pro-rate allocations based on the number of days in the follow-up period, and the assessment of changes in soil organic carbon stock requires appropriate international guidance.

Assessment Method 3

Changes in organic carbon in soil with a guideline estimate. It calculates the change in soil organic carbon accumulation according to the IPCC using *T-VER-P-TOOL-01-12 Calculation for change in soil organic carbon stocks in agricultural project activities)*

<u>Carbon sequestration of budding trees and trees</u>

The CO2 sequestration resulting from the carbon sequestration of trees and young trees in year t is estimated as follows:

$$\Delta C_{TREE,i,t} = \Delta C_{TREE,PROJ,i,t} - \Delta C_{TREE,BSL,i,t}$$

$$\Delta C_{SAB,i,t} = \Delta C_{SAB,PROJ,i,t} - \Delta C_{SAB,BSL,i,t}$$

Where:

$\Delta C_{TREE,i,t}$	Change in carbon stock in trees of the i sample unit in year t (tCO_2eq / rai)
$\Delta C_{TREE,PROJ,i,t}$	Change in carbon stock in trees In the case of a project of sample i in year t (tCO_2eq / rai)
$\Delta C_{TREE,BSL,i,t}$	Change in carbon stock in trees in the baseline scenario of the i sample unit in year t (tCO_2eq/rai)
$\Delta C_{SAB,i,t}$	Change in carbon stock in trees of the i sample unit in year t (tCO_2eq/rai)
$\Delta C_{SAB,PROJ,i,t}$	Change in carbon stock in trees of sapling in the project of the i sample unit in year t (tCO_2eq / rai)

$\Delta C_{SAB,BSL,i,t}$ Change in carbon stock in trees of sapling in baseline scenario of sample i in year t (tCO_2eq/rai)

Refer to the calculation tool *T-VER-P-TOOL-01-02 Calculation for carbon stocks and changes in carbon stocks of trees in forest project activities*

Fossil Fuel Combustion

The CO2 emissions reductions resulting from the burning of fossil fuels in year t are estimated as follows:

$$\Delta CO_{2FUEL,i,t} = CO_{2FUEL,BSL,i,t} - CO_{2FUEL,PROJ,i,t}$$

Where:

$\Delta CO_{2FUEL,i,t}$ Carbon dioxide emission reduction caused by the burning of fossil fuels in of the i sample unit, year t (tCO_2eq / rai)

$CO_{2FUEL,BSL,i,t}$ Carbon dioxide emissions generated by the burning of fossil fuels in the baseline scenario of the i sample unit in year t (tCO_2eq / rai)

$CO_{2FUEL,PROJ,i,t}$ Carbon dioxide emissions generated by the burning of fossil fuels in the case of project implementation of the i sample unit in year t (tCO_2eq / rai)

Methane from belowground carbon

$$\Delta CH_{4SOIL,i,t} = CH_{4SOIL,BSL,i,t} - CH_{4SOIL,PROJ,i,t}$$

Where:

$\Delta CH_{4SOIL,i,t}$ Methane emissions reduction from soil organic carbon stock of the i sample unit in year t (tCO_2eq / rai)

$CH_{4SOIL,BSL,i,t}$ Methane emissions from soil organic carbon stock in the baseline scenario of the i sample unit in year t (tCO_2eq / rai)

$CH_{4SOIL,PROJ,i,t}$ Methane emissions from soil organic carbon stock in case of project implementation of the i sample unit in year t (tCO_2eq / rai)

Biomass Combustion

The reductions in methane and nitrous oxide emissions from biomass combustion in year t were estimated as follows:

$$\Delta CH_{4BURNING,i,t} = CH_{4BURNING,BSL,i,t} - CH_{4BURNING,PROJ,i,t}$$

Where:

$\Delta CH_{4BURNING,i,t}$	Methane emission reduction from biomass burning of the i sample unit in year t (tCO_2eq / rai)
$CH_{4BURNING,BSL,i,t}$	Methane emissions from biomass burning in the baseline scenario of the i sample unit in year t (tCO_2eq / rai)
$CH_{4BURNING,PROJ,i,t}$	Methane emissions from biomass burning in case of project implementation of the i sample unit in year t (tCO_2eq / rai)

$$\Delta N_2O_{BURNING,i,t} = N_2O_{BURNING,BSL,i,t} - N_2O_{BURNING,PROJ,i,t}$$

Where:

$\Delta N_2O_{BURNING,i,t}$	Nitrous oxide emission reduction from biomass burning of the i sample unit in year t (tCO_2eq / rai)
$N_2O_{BURNING,BSL,i,t}$	Nitrous oxide emission reduction from biomass burning in the baseline scenario of the i sample unit in year t (tCO_2eq / rai)
$N_2O_{BURNING,PROJ,i,t}$	Nitrous emission reduction from biomass burning in case of project implementation of the i-sample unit in year t (tCO_2eq / rai)

Nitrogen fertilization and nitrogen fixing plants

$$\Delta N_2O_{SOIL,i,t} = N_2O_{SOIL,BSL,i,t} - N_2O_{SOIL,PROJ,i,t}$$

Where:

$\Delta N_2O_{SOIL,i,t}$	Nitrous oxide emissions reduction from nitrogen fertilization and nitrogen fixation plants of the i sample unit in year t (tCO_2eq / rai)
$N_2O_{SOIL,BSL,i,t}$	Nitrous oxide emission reduction from soil nitrogen application in the baseline scenario of the i sample unit in year t (tCO_2eq / rai)
$N_2O_{SOIL,PROJ,i,t}$	Nitrous oxide emission reduction from soil nitrogen application in the case of project implementation of the i sample unit in year t (tCO_2eq / rai)

8. Uncertainty

The project developer must assess the uncertainty of greenhouse gas emission reduction from project activities using Assessment Method 1 Modelling, Method 2 Direct Measurement and Method 3 Default. If the project requires an assessment, the project developer must consider an assessment method assessing uncertainty according to appropriate internationally acceptable principles with reference to the assessment guidelines used in accordance with conservative principles. In cases where the cumulative uncertainty for the project is greater than the reference guidelines stipulated, the resulting value must be deducted from the amount of carbon change in the reservoir both from the baseline scenario and from the project implementation.

9. Monitoring Procedure

9.1 Monitoring Plan

Monitoring plan shall provide for collection of all relevant data necessary for verification of changes in carbon stocks in the pools selected, GHG emission and leakage emission.

9.2 Monitoring of project implementation

Information for project implementation monitoring is provided in the project design document (PDD) that includes monitoring parameters, QA/QC methodology, Monitoring Frequency of QA/QC as per TGO requirements.

10. Relevant parameters

10.1 Parameters not require monitoring

Parameter	$FC_{BSL,a,t}$
Unit	Fuel unit
Definition	Consumption of fossil fuel type a in the baseline scenario in year t
Data Source	measurement report or a reference note
Remarks	-

Parameter	NCV_a
Unit	MJ/Unit
Definition	Net Calorific Value of fossil fuel type *a*
Data Source	Option 1 Net calorific value of fossil fuel specified in invoice from fuel supplier Option 2 from monitoring Option 3 Thailand energy statistics report, Department of Alternative Energy Development and Efficiency, Ministry of Energy

Remarks	

Parameter	$EF_{CO_2,a}$
Unit	kg CO_2/TJ
Definition	GHG emission factor from fossil fuel burning type *a*
Data Source	Table 1.4 2006 IPCC Guidelines for National GHG Inventories
Remarks	-

Parameter	CF_b
Unit	-
Definition	The incineration emission factor of type b agricultural waste (proportion of biomass as fuel before combustion)
Data Source	IPCC (IPCC, 2019) No 4 Chapter 2 Table 2.6
Remarks	-

Parameter	$EF_{CH4,b}$
Unit	grams of methane per kilogram of dry burned biomass
Definition	Methane emission factor from the burning of agricultural waste materials type *b*
Data Source	IPCC (IPCC, 2019) No 4 Chapter 2 Table 2.5
Remarks	-

Parameter	$EF_{N2O,Direct}$
Unit	tons of nitrous oxide per ton of nitrogen to be used
Definition	The emission factor of nitrous oxide from nitrogen application of chemical fertilizers, organic fertilizers, organic soil improvement materials and agricultural waste
Data Source	*Option 1* Use recommended value from IPCC (IPCC, 2019) No 4 Chapter 11 Table 11.1 - Application of chemical fertilizers and compound fertilizers between chemical fertilizers and organic fertilizers in wet climates set value equal to 0.016 - Application of organic materials, manure, compost, agricultural waste and nitrogen degradation of soil organic carbon for wet climates. set value equal to 0.006 - Nitrogen feeding from various sources in dry climates set value equal to 0.005

	- Nitrogen application from various sources in rice planting area The value was 0.004 and was 0.006 for waterlogging throughout the growing season and 0.005 for one or more drainages. - Cow and buffalo, poultry and swine manure application values were 0.004 and were 0.006 and 0.002 for wet and dry climates, respectively, for sheep and other animal manures. set to be equal to 0.003 *Option 2* Using an area or country specific value - If there is reliable and verifiable information, selectable values can be adjusted. In particular, the classification of values according to soil characteristics such as organic carbon content in soil, soil texture, soil drainage. soil pH and nitrogen application in soil (type, form and amount of fertilizer or organic material used)
Remarks	- Wet climate determines temperate and cold regions with a precipitation to transpiration ratio greater than 1 and tropical regions with a precipitation greater than 1000 ml.

Parameter	$Frac_{GASF}$
Unit	-
Definition	The proportion of nitrogen fertilizer added to soil and evaporation in the form of ammonia and nitrogen oxides
Data Source	IPCC (IPCC, 2019) No 4 Chapter 11 Table 11.3 (value equivalent to 0.11)
Remarks	-

Parameter	$Frac_{GASM}$
Unit	-
Definition	The proportion of nitrogen organic fertilizer added to soil and evaporation in the form of ammonia and nitrogen oxides
Data Source	IPCC (IPCC, 2019) No 4 Chapter 11 Table 11.3 (value equivalent to 0.21)
Remarks	-

Parameter	EF_{ATD}
Unit	ton N_2O-N /ton NH_3-N + ton NO_X-N
Definition	Emission factor of nitrous oxide from nitrogen deposition from the atmosphere to the soil and water surface.
Data Source	IPCC (IPCC, 2019) No 4 Chapter 11 Table 11.3 (value equivalent to 0.01)
Remarks	-

Parameter	$Frac_{LEACH}$
Unit	-
Definition	The proportion of nitrogen in the soil (chemical and organic fertilizers) and lost through leaching and runoff
Data Source	IPCC (IPCC, 2019) No 4 Chapter 11 Table 11.3 - If the climate is dry or wet and the area is watered (excluding drip water system) set at 0.24 - In the case of dry climate, set the value at 0
Remarks	-

Parameter	EF_{LEACH}
Unit	N_2O-N ton per tons of nitrogen leaching and runoff
Definition	Emission factor of nitrous oxide from leaching and runoff
Data Source	IPCC (IPCC, 2019) No 4 Chapter 11 Table 11.3 (value equivalent to 0.011)
Remarks	-

Parameter	N_b
Unit	tons of nitrogen per ton of dry weight
Definition	Nitrogen ratio in *b*-type nitrogen-fixing plants added to soil
Data Source	IPCC (IPCC, 2019) No 4 Chapter 11 Table 11.2
Remarks	-

Parameter	$EF_{N2O,b}$
Unit	grams of nitrous oxide per kilogram of dry burnt biomass.
Definition	Emission factor of nitrous oxide from incineration of agricultural waste type *b*
Data Source	IPCC (IPCC, 2019) No 4 Chapter 2 Table 2.5
Remarks	-

Parameter	$MB_{b,BSL,t}$
Unit	kilogram
Definition	Mass of type b agricultural waste incinerated in the baseline scenario in year t
Data Source	Values obtained from research published in academic papers that are recognized and can be identified as appropriate for the project area. It

	is the amount of biomass above the ground before it is burned. (Required to burn at 100% for base and project cases)
Remarks	The burnt biomass must be consistent with the aboveground biomass, removed part and the unburned part

Parameter	$M_{SN,BSL,t}$
Unit	tons of fertilizer
Definition	The amount of nitrogen fertilizer application in the baseline scenario in year t
Data Source	measurement report
Remarks	-

Parameter	$N_{SN,BSL,t}$
Unit	tons of nitrogen per ton of fertilizer
Definition	Nitrogen content in soil chemical fertilizers
Data Source	Measurement report or from a fertilizer manufacturer or distributor
Remarks	-

Parameter	$M_{ON,BSL,t}$
Unit	ton of fertilizer
Definition	The amount of nitrogen organic fertilizer application in the basal case in year t
Data Source	measurement report
Remarks	-

Parameter	$N_{ON,BSL,t}$
Unit	tons of nitrogen per ton of fertilizer
Definition	Nitrogen ratio in soil organic fertilizers
Data Source	measurement report or values derived from research published in academic papers that are recognized and can be identified as suitable for the project area
Remarks	-

Parameter	$M_{c,BSL,t}$
Unit	dry weight ton
Definition	Dry weights of aboveground biomass and underground parts of c-type nitrogen-fixing plants added to soil in the basal case in year t.

Data Source	measurement report
Remarks	-

Other parameter not requiring monitoring appears in relevant calculation tool.

9.4 Parameter require monitoring

Parameter	A_i
Unit	rai
Definition	Area of the sample unit i
Data Source	Project site measurements, such as local surveys Using satellite/aerial imagery
Monitoring method	Documented evidence by the farmer or landowner
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	a
Unit	-
Definition	Types of fossil fuels burned
Data Source	measurement report
Monitoring method	Documented evidence by the farmer or landowner
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	b
Unit	-
Definition	Types of burned agricultural waste
Data Source	measurement report
Monitoring method	Documented evidence by the farmer or landowner
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	c
Unit	-
Definition	Types of nitrogen-fixing plants
Data Source	measurement report
Monitoring method	Documented evidence by the farmer or landowner
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	SN
Unit	-
Definition	Types of nitrogen fertilizers
Data Source	measurement report
Monitoring method	Documented evidence by the farmer or landowner
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	ON
Unit	-
Definition	Types of Nitrogen Organic Fertilizers
Data Source	measurement report
Monitoring method	Documented evidence by the farmer or landowner
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$f(SOC_{BSL,t-1})$
Unit	tons of carbon dioxide equivalent per rai
Definition	Soil organic carbon accumulation from the base-case model at the end of year t.
Data Source	measurement report

Monitoring method	Details according to the selected assessment method including collecting samples and data using reference or recommendation values from data trusted source and calculating values from appropriate equations
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$SOC_{BSL,t}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Soil organic carbon stock from base-case estimates at the end of year t.
Data Source	measurement report with values from the model or actual measurements in the area
Monitoring method	- Details according to the selected assessment method including collecting samples and data using reference or recommendation values from data trusted source and calculating values from appropriate equations - Local sampling and laboratory analysis by removing organic waste from the soil surface Then, soil samples were collected at the specified soil depth. by not less than 30 centimeters. If collecting multiple samples from a local sample plot, mix all the soil samples together and keep them in a cool place before sending for assessment within 5 days to analyze soil organic carbon content and soil density at the time of project start. The monitoring must be conducted every 5 years or less. The assessment method specifies dry combustion as prominent method, but also allow other methods if necessary. - Soil sampling must be covered by the representative area of the project and reference is carried out in accordance with appropriate sampling principles.
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	Direct measurements with laboratory analysis at the start time (t=0) or the model may be adjusted. If data is collected within 5 years, before or after the start time, or using new assessment technologies such as INS, LIBS, MIR and Vis-NIR with known uncertainty values.

Parameter	$SOC_{BSL,t-1}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Soil organic carbon stock from base-case estimates at the end of the year t-1.
Data Source	measurement report with values from the model or actual measurements in the area
Monitoring method	Details according to the selected assessment method including collecting samples and data using reference or recommendation values from data trusted source and calculating values from appropriate equations
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$SOC_{PROJ,t}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Soil organic carbon stock from project implementation estimates at the end of year t.
Data Source	measurement report
Monitoring method	- Details according to the selected assessment method including collecting samples and data using reference or recommendation values from data trusted source and calculating values from appropriate equations - Local sampling and laboratory analysis by removing organic waste from the soil surface Then, soil samples were collected at the specified soil depth. by not less than 30 centimeters. If collecting multiple samples from a local sample plot Mix the soil samples together. The soil samples were kept in a cool place. and sent for analysis within 5 days to analyze soil organic carbon content and soil density at the time of project start. Monitoring must be conducted every 5 years or less. Dry combustion is predominantly used and other methods may be used if necessary. - Soil sampling must be covered by the representative area of the project and reference is carried out in accordance with appropriate sampling principles.
Monitoring Frequency	Following a cycle of follow-up assessments for certification

Remarks	Direct measurements with laboratory analysis at the start time (t=0) or the model may be adjusted. If data is collected within 5 years, before or after the start time, or using new assessment technologies such as INS, LIBS, MIR and Vis-NIR with known uncertainty values.

Parameter	$SOC_{PROJ,t-1}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Soil organic carbon stock from project implementation estimates at the end of year t-1.
Data Source	Measurement report with values from the model or actual area
Monitoring method	Details according to the selected assessment method including collecting samples and data Using reference or recommendation values from Data Trusted Source and calculating values from appropriate equations
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$SOC_{BSL,m,t=0}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Soil organic carbon stock in the baseline scenario at the end of the year t=0 was assessed by measurements.
Data Source	measurement report
Monitoring method	Details according to the selected assessment method including collecting samples and data using reference or recommendation values from data trusted source and calculating values from appropriate equations
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$fCH_{4SOIL,BSL,t}$
Unit	tons of methane per rai
Definition	Methane emissions from soil modeled in the baseline scenario in year t.
Data Source	measurement report

Monitoring method	Details according to the selected assessment method including collecting samples and data using reference or recommendation values from data trusted source and calculating values from appropriate equations
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$fN_2O_{SOIL,BSL,t}$
Unit	tons of nitrous oxide per rai
Definition	The amount of nitrous oxide emissions from the soil modeled in the baseline scenario in year t
Data Source	measurement report
Monitoring method	Details according to the selected assessment method including collecting samples and data using reference or recommendation values from Data Trusted Source and calculating values from appropriate equations
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$\Delta C_{TREE\_BSL,t}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Change in carbon stock in trees of the baseline scenario in year t
Data Source	measurement report
Monitoring method	*T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities*
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$\Delta C_{SAP\_BSL,t}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Change in carbon stock in sapling in the baseline scenario model in year t
Data Source	measurement report

Monitoring method	*T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities*
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$\Delta C_{TREE\_P,t}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Change in carbon stock in trees in the project boundary in year t
Data Source	measurement report
Monitoring method	*T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities*
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$\Delta C_{SAP\_P,t}$
Unit	tons of carbon dioxide equivalent per rai
Definition	Change in carbon stock in sapling in the project boundary in year t
Data Source	measurement report
Monitoring method	*T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities*
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$FC_{a,PROJ,t}$
Unit	Fuel unit
Definition	Consumption of fossil fuel type a in case of project implementation in year t
Data Source	measurement report
Monitoring method	Measuring or calculating the fuel efficiency of machinery or vehicles
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$MB_{b,PROJ,t}$
Unit	kilogram
Definition	Mass of agricultural waste type b incinerated in case of project implementation in year t
Data Source	measurement report
Monitoring method	Collecting samples of biomass above ground in the area before incineration and sample size at 1 x 1 meter, at least 3 repetitions
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	Set the burnt biomass as the above-ground biomass.

Parameter	$M_{SN,PROJ,t}$
Unit	ton of fertilizer
Definition	The amount of nitrogen SN fertilizer application in the soil in case of project implementation in year t
Data Source	measurement report
Monitoring method	Data and evidence collection of farmers
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$M_{ON,PROJ,t}$
Unit	ton of fertilizer
Definition	Amount of organic nitrogen fertilizer ON type in soil in case of project implementation in year t
Data Source	measurement report
Monitoring method	Data collection and evidence from farmers
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	$M_{c,PROJ,t}$
Unit	Ton of dry weight

Definition	Dry weight of aboveground biomass and underground part of the soil c-type nitrogen-fixing plant in the case of project implementation in year t.
Data Source	measurement report
Monitoring method	Aboveground and belowground biomass of nitrogen-fixing plants collected from the soil samples or using reference or recommended values from Data Trusted Source
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	LE_t
Unit	tons of carbon dioxide equivalent
Definition	Leakage amount in year t
Data Source	measurement report
Monitoring method	Details according to the method in the topic "Additionality "
Monitoring Frequency	Following a cycle of follow-up assessments for certification
Remarks	-

Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Definition	The global warming potential of methane
Data Source	Use data from the Climate Change Situation Assessment Report released by the Intergovernmental Panel on Climate Change. (Intergovernmental Panel on Climate Change or IPCC) announced by TGO
Monitoring method	<u>For the preparation of project proposal documents</u> - Use the latest GWP_{CH4} value announced by TGO <u>For monitoring the results of reducing greenhouse gas emissions</u> – Use the value of $GWPN_{2O}$ as announced by TGO for evaluating the amount of greenhouse gases during the crediting period for which the amount of greenhouse gas certification is requested.

Parameter	GWP_{N2O}
Unit	tCO_2e/tN_2O

Definition	The global warming potential of nitrous oxide
Data Source	se data from the Climate Change Situation Assessment Report released by the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change or IPCC) announced by TGO
Monitoring method	For the preparation of project proposal documents - Use the latest GWP_{CH4} value announced by TGO For monitoring the results of reducing greenhouse gas emissions –Use the value of $GWPN_{2O}$ as announced by TGO for evaluating the amount of greenhouse gases during the crediting period for which the amount of greenhouse gas certification is requested.

Other parameters required monitoring shall appear in relevant calculation tool.

10. References

1) AMS-III.BF.: Reduction of N_2O emissions from use of Nitrogen Use Efficient (NUE) seeds that require less fertilizer application --- Version 2.0
2) AMS-III.AU.: Methane emission reduction by adjusted water management practice in rice cultivation --- Version 4.0
3) Methodology for improved agricultural land management (VM0042 Version 2.0), VCS
4) T-VER-METH-AGR-01 การใช้ปุ๋ยอย่างถูกวิธีในพื้นที่การเกษตร (Good Fertilization Practice in Agricultural Land) Version 03
5) 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Document information

Version	Amendment	Entry into force	Description
01	--	1 March 2023	-