



**GLOBAL
CARBON
COUNCIL**

Driving Climate Actions

**GCC AFOLU Tool for estimation of
GHG emissions from
fertilizer use in projects**

GCC TA003

V1.0 - 2024

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1. GCC AFOLU Methodologies and Tools

1. Global Carbon Council (GCC) is MENA region's first and only voluntary carbon offsetting and sustainable development program that contributes to a vision of sustainable and low carbon economy of the region and catalyses climate actions on the ground. Refer to www.globalcarboncouncil.com for details.
2. GCC AFOLU methodologies and tools allow for conservative estimation of GHG emission reductions and changes in carbon stocks resulting from the project activity.

2. Scope, Applicability, and Entry into force

2.1. Scope

3. This tool can be used for estimation of greenhouse gases emissions (expressed in carbon dioxide equivalents) due to the application of synthetic and organic fertilizers in a GCC AFOLU project activity. The tool is applicable for:
 - (a) Estimation of direct and indirect nitrous oxide (N₂O) emissions from the application of synthetic and organic fertilizers in the baseline;
 - (b) Estimation of carbon dioxide (CO₂) emissions from liming and urea application in the baseline.
 - (c) Ex-post estimation of direct and indirect nitrous oxide (N₂O) emissions from the application of synthetic and organic fertilizers, for monitoring of project activities.
 - (d) Ex-post estimation of carbon dioxide (CO₂) emissions from liming and urea application during monitoring of project activities.
4. This tool can be used for estimating changes in greenhouse gases emissions in AFOLU projects that implement forestation activities or a change in forest management practices or a switch from conventional agricultural practices to regenerative agriculture, natural and organic farming or agroforestry.
5. This tool does not provide an approach for the estimation of direct or indirect nitrous oxide (N₂O) emissions from urine or dung nitrogen deposited by grazing animals on pasture, range, or paddock (a separate tool to cover such emissions will be developed if the need arises).

2.2. Applicability Conditions

6. This tool has no applicability conditions.

2.3. Entry into force

7. The date of entry into force of this version of the methodology is **DD MM 2024**.

3. Definitions

8. The definitions contained in the following documents shall apply:¹
 - (a) “GCC definitions”;
 - (b) IPCC (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry;
 - (c) IPCC (2006). Guidelines for National Greenhouse Gas Inventories.
 - (d) IPCC (2019). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
9. For the purpose of this tool, the following definitions shall apply:
 - (a) **Fertilizer** – refers to any organic or inorganic material of natural or synthetic origin (other than liming materials) that contains one or more essential plant nutrient elements, which is added to the soil (or directly to plants) to provide additional nutrition to enhance plant growth.
 - (b) **Organic fertilizer** - refers to fertilizer that is derived from either plant or animal products containing a significant quantity of one or more of the primary nutrients necessary for plant growth: nitrogen, phosphorus, and potassium (e.g., animal manure, compost, sewage sludge, and bone meal). Most natural organic fertilizers also provide significant quantities of organic matter, so they can also be classified as soil amendments.
 - (c) **Synthetic fertilizer** - refers to chemically manufactured materials containing one or more of the primary nutrients necessary for plant growth: nitrogen, phosphorus, and potassium.

3.1. Parameters determined by the tool

10. This tool provides procedures to determine the parameters listed in Table 1.

Table 1. Parameters determined by the tool

Parameter	Unit	Description
$GHG_{Fert\ t}$	t CO ₂ e	GHG emissions from application of synthetic and organic fertilizers in a GCC AFOLU project activity, in year <i>t</i>

3.2. Stratification

11. If the application of fertilizers is not homogeneous within the project, stratification may be carried out to improve the precision of estimating the change in GHG emissions. Different stratifications may be used for the baseline and project scenarios to achieve enhanced precision in the estimation of net GHG emission reductions/removals. In particular:

¹ These documents are available online at the following URLs:

- (a) <<http://www.globalcarboncouncil.com/resource-centre/>>;
- (b) <<http://www.ipcc-nggip.iges.or.jp/public/gpplulucf/gpplulucf.html>>;
- (c) <<https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html>>;
- (d) <<https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol4.html>>.

- (a) For baseline GHG emissions and removals, it is usually sufficient to stratify the area according to major factors impacting fertilizer application before the project start date (e.g., management type, vegetation and land use types);
- (b) For net GHG emission reductions/removals the stratification for ex-ante estimations may be based on the project planting/management plan. The stratification for ex-post estimates should be based on the actual implementation of the project planting/management plan. If natural or anthropogenic impacts (e.g., local fires) or other factors (e.g., changes in management types) significantly alter the pattern of fertilizer use in the project area, then the ex-post stratification shall be revised accordingly and may differ among monitoring periods.

3.3. Calculation of Direct Nitrous Oxide (N₂O) Emissions

12. Nitrous oxide (N₂O) direct emissions, in year *t*, shall be calculated as follows:

$$N2O_{direct\ t} = \frac{44}{28} * GWP_{N2O} * (FSN_t + FON_t) * EF_{Ndirect} \quad \text{Equation (1)}$$

Where:

$N2O_{direct\ t}$	=	Nitrous oxide (N ₂ O) direct emissions, in year <i>t</i> ; t CO ₂ e
GWP_{N2O}	=	IPCC AR6-100, N ₂ O Global Warming Potential (=273); t CO ₂ e (t N ₂ O) ⁻¹
FSN_t	=	Total mass of nitrogen (N input) contained in all synthetic fertilizers applied within project boundary in year <i>t</i> ; t N
FON_t	=	Total mass of nitrogen (N input) contained in all organic fertilizers and other organic N additions applied within project boundary in year <i>t</i> ; t N
$EF_{Ndirect}$	=	Emission factor for N ₂ O-N emissions from N inputs (Table 11.1 in Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories); kg N ₂ O-N (kg N input) ⁻¹ = t N ₂ O-N (t N input) ⁻¹

13. Total mass of nitrogen input to the soil from the application of synthetic fertilizers shall be calculated using the following equation:

$$FSN_t = \sum_s MSF_{s,t} * NCSF_s \quad \text{Equation (2)}$$

Where:

FSN_t	=	Total mass of nitrogen (N input) contained in all synthetic fertilizers applied within project boundary in year <i>t</i> ; t N
$MSF_{s,t}$	=	Mass of N-containing synthetic fertilizer type <i>s</i> applied within project boundary in year <i>t</i> ; t fertilizer
$NCSF_s$	=	N content of synthetic fertilizer type <i>s</i> ; t N (t fertilizer) ⁻¹
<i>s</i>	=	Index for synthetic fertilizer type

14. Total mass of nitrogen input to the soil from the application of organic fertilizers and organic nitrogen additions shall be calculated using the following equation:

$$FON_t = \sum_o MOF_{o,t} * NCOF_o \quad \text{Equation (3)}$$

Where:

FON_t	=	Total mass of nitrogen (N input) contained in all organic fertilizers and other organic N additions applied within project boundary in year t ; t N
$MOF_{o,t}$	=	Mass of N-containing organic fertilizer type o (e.g., animal manure, compost, sewage sludge) applied within project boundary in year t ; t fertilizer
$NCOF_o$	=	N content of organic fertilizer type o ; t N (t fertilizer) ⁻¹
o	=	Index for organic fertilizer type

3.4. Calculation of indirect nitrous oxide (N₂O) emissions

15. Nitrous oxide (N₂O) indirect emissions, in year t , shall be calculated as follows:

$$N2O_{indirect\ t} = \frac{44}{28} * GWP_{N2O} * (FSN_t * FRSN + FON_t * FRON) * EF_{Nindirect} \quad \text{Equation (4)}$$

$EF_{Nindirect}$

Where:

$N2O_{indirect\ t}$	=	Nitrous oxide (N ₂ O) indirect emissions, in year t ; t CO ₂ e
GWP_{N2O}	=	IPCC AR6-100, N ₂ O Global Warming Potential (=273); t CO ₂ e (t N ₂ O) ⁻¹
FSN_t	=	Total mass of nitrogen (N input) contained in all synthetic fertilizers applied within project boundary in year t ; t N
$FRSN$	=	Fraction of nitrogen contained in synthetic fertiliser that volatilises as NH ₃ and NO _x (for default data see: Table 11.3 in Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories); kg N volatilized (kg N applied) ⁻¹ = t N volatilized (t N applied) ⁻¹
FON_t	=	Total mass of nitrogen (N input) contained in all organic fertilizers and other organic N additions applied within project boundary in year t ; t N
$FRON$	=	Fraction of nitrogen contained in organic fertilisers that volatilises as NH ₃ and NO _x , (for default data see: Table 11.3 in Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories); kg N volatilized (kg N applied) ⁻¹ = t N volatilized (t N applied) ⁻¹
$EF_{Nindirect}$	=	Emission factor for N ₂ O-N indirect emissions (for default data see: Table 11.3 in Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories); kg N ₂ O-N (kg NH ₃ -N and NO _x -N volatilised) ⁻¹ = t N ₂ O-N (t NH ₃ -N and NO _x -N volatilised) ⁻¹

3.5. Calculation of CO₂ emissions from urea fertilization and liming

16. Carbon dioxide (CO₂) emissions from urea fertilization, in year t , shall be calculated as follows:

$$CO2_{urea\ t} = \frac{44}{12} * MU_t * EFU \quad \text{Equation (5)}$$

Where:

$CO2_{urea\ t}$	=	CO ₂ emissions from urea application, in year t ; t CO ₂ e
MU_t	=	Total mass of urea applied within project boundary, in year t ; t urea

EFU = Emission factor for urea, default 0.20 (see: page 11.32 in Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories); t C (tonne of dolomite)⁻¹

17. Carbon dioxide (CO₂) emissions from liming, in year t , shall be calculated as follows:

$$CO2_{liming\ t} = \frac{44}{12} * (ML_t * EFL + MD_t * EFD) \quad \text{Equation (6)}$$

Where:

$CO2_{liming\ t}$ = CO₂ emissions from liming, in year t ; t CO₂e

ML_t = Total mass of calcic limestone (CaCO₃) applied within project boundary, in year t ; t limestone

EFL = Emission factor for calcic limestone, default 0.12 (see: page 11.27 in Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories); t C (tonne of limestone)⁻¹

MD_t = Total mass of dolomite (CaMg(CO₃)₂) applied within project boundary, in year t ; t dolomite

EFD = Emission factor for dolomite, default 0.13 (see: page 11.27 in Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories); t C (tonne of dolomite)⁻¹

3.6. Calculation of total GHG emissions from the application of synthetic and organic fertilizers in a GCC AFOLU project activity

18. Total GHG emissions from the application of synthetic and organic fertilizers in a GCC AFOLU project activity, in year t , shall be calculated as follows:

$$GHG_{Fert\ t} = N2O_{direct\ t} + N2O_{indirect\ t} + CO2_{urea\ t} + CO2_{liming\ t} \quad \text{Equation (7)}$$

Where:

$GHG_{Fert\ t}$ = GHG emissions from application of synthetic and organic fertilizers in a GCC AFOLU project activity, in year t ; t CO₂e

$N2O_{direct\ t}$ = Nitrous oxide (N₂O) direct emissions, in year t ; t CO₂e

$N2O_{indirect\ t}$ = Nitrous oxide (N₂O) indirect emissions, in year t ; t CO₂e

$CO2_{urea\ t}$ = CO₂ emissions from urea application, in year t ; t CO₂e

$CO2_{liming\ t}$ = CO₂ emissions from liming, in year t ; t CO₂e

19. To simplify notation, summation over all strata within the project boundary is omitted in the formulae applied in this tool however, if stratification is applied, Project Owners shall use data that are summed up over all strata identified within the project boundary.
20. For the ex-post estimation of GHG emissions from applied fertilizers, references to year t should be read as references to the period from the first day after the end of the previous monitoring period to the last day of the current monitoring period (i.e., including fractional years).

4. Data and parameters used in the tool

21. The following tables describe the data and parameters used in this tool. The guidelines contained in these tables regarding the selection of data sources, and the measurement procedures to be followed, should be treated as an integral part of this tool.

4.1. Data and parameters not measured

Data/Parameter Table 1.1.

Data / Parameter:	$NCSF_s$
Data unit:	t N (t fertilizer) ⁻¹
Used in equations:	2
Description:	N content of synthetic fertilizer type <i>s</i>
Measurement procedures:	Obtained from fertilizer manufacturer data
Monitoring frequency:	At each fertilizer application
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under National GHG Inventories are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied.

Data/Parameter Table 1.2.

Data / Parameter:	$NCOF_o$
Data unit:	t N (t fertilizer) ⁻¹
Used in equations:	3
Description:	N content of organic fertilizer type <i>o</i>
Measurement procedures:	Obtained from fertilizer manufacturer data
Monitoring frequency:	At each fertilizer application
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under National GHG Inventories are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied.

Data/Parameter Table 1.3.

Data / Parameter:	EFU
Data unit:	t C (tonne of dolomite) ⁻¹
Used in equations:	5
Description:	Emission factor for urea
Measurement procedures:	Default 0.20 (see: page 11.32 in Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories)
Monitoring frequency:	NA
QA/QC procedures:	NA

Data/Parameter Table 1.4.

Data / Parameter:	EFL
Data unit:	t C (tonne of limestone) ⁻¹
Used in equations:	6
Description:	Emission factor for calcic limestone

Measurement procedures:	Default 0.12 (see: page 11.27 in Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories)
Monitoring frequency:	NA
QA/QC procedures:	NA

Data/Parameter Table 1.5.

Data / Parameter:	<i>EFD</i>
Data unit:	t C (tonne of dolomite) ⁻¹
Used in equations:	6
Description:	Emission factor for dolomite
Measurement procedures:	Default 0.13 (see: page 11.27 in Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories);
Monitoring frequency:	NA
QA/QC procedures:	NA

4.2. Data and parameters measured

Data/Parameter Table 2.1.

Data / Parameter:	$MSF_{s,t}$
Data unit:	t fertilizer
Used in equations:	2
Description:	Mass of N-containing synthetic fertilizer type <i>s</i> applied within project boundary in year <i>t</i>
Measurement procedures:	Obtained directly as the total mass of fertilizer used in the project area or as the product of the area where fertilizer is applied and the fertilizer input per unit area
Monitoring frequency:	At each fertilizer application
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under National GHG Inventories are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied

Data/Parameter Table 2.2.

Data / Parameter:	$MOF_{o,t}$
Data unit:	t fertilizer
Used in equations:	3
Description:	Mass of N-containing organic fertilizer type <i>o</i> (e.g., animal manure, compost, sewage sludge) applied within project boundary in year <i>t</i>
Measurement procedures:	Obtained directly as the total mass of fertilizer used in the project area or as the product of the area where fertilizer is applied and the fertilizer input per unit area
Monitoring frequency:	At each fertilizer application

QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national GHG inventories are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied.
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Data/Parameter Table 2.3.

Data / Parameter:	MU_t
Data unit:	t urea
Used in equations:	5
Description:	Total mass of urea applied within the project boundary in year t
Measurement procedures:	Obtained directly as the total mass of urea used in the project area or as the product of the area where urea is applied and the urea input per unit area
Monitoring frequency:	At each urea application
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under National GHG Inventories are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied.

Data/Parameter Table 2.4.

Data / Parameter:	ML_t
Data unit:	t limestone
Used in equations:	6
Description:	Mass of limestone applied within project boundary in year t
Measurement procedures:	Obtained directly as the total mass of limestone used in the project area or as the product of the area where limestone is applied and the fertilizer input per unit area
Monitoring frequency:	At each limestone application
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under National GHG Inventories are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied.

Data/Parameter Table 2.5.

Data / Parameter:	MD_t
Data unit:	t dolomite
Used in equations:	6
Description:	Mass of dolomite applied within the project boundary in year t
Measurement procedures:	Obtained directly as the total mass of dolomite used in the project area or as the product of the area where dolomite is applied and the dolomite input per unit area
Monitoring frequency:	At each fertilizer application
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under National GHG Inventories are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied.

4.3. Monitoring of Tool Implementation

22. Information shall be provided in the project submission form (PSF), to establish that the commonly accepted principles and practices of the fertilizer inventory in the host country are implemented. If such principles and practices are not known or available, standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for inventory operations, including field data collection and data management, shall be identified, recorded, and applied. Use or adaptation of SOPs available from published relevant handbooks, or from the IPCC (2003) “Good Practice Guidance for Land Use, Land-Use Change and Forestry”, is recommended.

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DOCUMENT HISTORY		
Version	Date	Comment
V 1.0	DD/MM/2024	Initial adoption by GCC Regulatory Committee based on following: <ul style="list-style-type: none"> i. Consideration by individual Regulatory Committee member, followed by evaluation of entire Regulatory Committee. ii. XX days global stakeholder consultation taken place between DD/MM/2024 to DD/MM/2024

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