CLEAN DEVELOPMENT MECHANISM

CDM-MP60-A03

Draft Methodological tool

Project emissions from cultivation of biomass

Version 01.0

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP), at its sixth session, endorsed the concept of standardized baselines and requested the Executive Board (hereinafter referred to as the Board) of the clean development mechanism (CDM) to develop standardized baselines, in particular, prioritizing methodologies that are applicable to least developed countries (LDCs), small island developing states (SIDS), Parties with 10 or fewer registered CDM project activities as of 31 December 2010 and underrepresented project activity types or regions.

2. CMP.7 requested the Board to conduct further work to develop simplified top-down baseline and monitoring methodologies, tools and standardized baselines, as appropriate, and in consultation with relevant designated national authorities, for the use in countries and for project activity types underrepresented in the CDM.

3. The draft tool “Project emissions from cultivation of biomass” is prepared in consultation with the A/R WG and other stakeholders.

2. Purpose

4. The purpose of the draft tool is to be used in conjunction with all biomass to energy methodologies to expand their applicability from the currently included biomass residue to cover also biomass from dedicated plantations.

3. Key issues and proposed solutions

5. The draft tool “Project emissions from cultivation of biomass” is prepared based on the need for a consistent and viable approach to estimate emissions from cultivation of biomass from dedicated plantations.

6. The draft tool does not allow shift of pre-project activities on the land used for biomass cultivation i.e. from being shifted outside the project boundary to avoid unaccountable leakage. The draft tool includes procedure for demonstrating no such shift occurs.

4. Impacts

7. Standardization of the procedure for accounting for biomass cultivation in various large-scale methodologies.

8. Potentially allowing biomass cultivation in other large-scale biomass methodologies.

5. Proposed work and timelines

9. Not applicable.

6. Budget and costs

10. Not applicable.

7. Recommendations to the Board

11. The Methodologies Panel recommends that the Board approve this draft tool.

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1. Introduction

1. This tool provides steps to determine the project emissions resulting from cultivation of biomass in a dedicated plantation.

Table 1. Parameters determined

Parameter	Unit	Description
$PE_{BC,y}$	t CO_2e	Project emissions resulting from cultivation of biomass in a dedicated plantation, in year *y*

2. Scope, applicability, and entry into force

2.1. Scope

2. This tool can be used for estimation of project emissions resulting from cultivation of biomass in a dedicated plantation of a CDM project activity that uses biomass as a source of energy.

2.2. Applicability

3. The land in which biomass is cultivated:

(a) Does not contain wetlands;

(b) Does not contain organic soils;

(c) Does not contain forests;

(d) Is not subjected to flood irrigation.

4. Pre-project activities are not shifted outside the project boundary, to avoid indirect land use changes as a result of the project activity. This condition is met if one of the following two conditions apply:

(a) The plantation area was abandoned land prior to the implementation of the project activity;

(b) The plantation area was used prior to the implementation of the project area but the pre-project land use of the plantation area will be accommodated for, providing at least the same level of service during the project activity, within the land area included in the project boundary. This could be achieved, inter alia, in the following ways:

(i) At least the same number of cattle as prior to the implementation of the project activity will continue being grazed during the project activity within the land area included in project boundary;

(ii) Due to more efficient farming practice, the pre-project crops can be grown on a smaller area, which is included in the land area included in the project boundary, to achieve the same level of annual production of crops, freeing land for the dedicated plantation;

(iii) Settlements are not removed from the land area included in the project boundary.

5. Desalination is not a substantial source of water in the host country.

2.3. Entry into force

6. Immediately upon adoption of the tool at the seventy-fifth meeting of the Board on 4 October 2013.

3. Normative references

7. This tool refers to the following documents:

(a) "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";

(b) "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";

(c) "Tool to calculate the emission factor for an electricity system";

4. Definitions

8. The definitions contained in the Glossary of CDM terms shall apply.

9. For the purpose of this tool, the following definitions apply:

(a) **Abandoned land** - land on which no land management (including crops, forestry, agroforestry and grazing) has been practiced for the longer period of:

(i) Three years;

(ii) The length of one crop rotation of the most recent crop grown on the plot;

(b) **Wetland**[1] - this category includes land that is covered or saturated by water for all or part of the year (e.g. peatland) and that does not fall into the forest land, cropland, grassland or settlements categories. This category can be subdivided into managed and unmanaged according to national definitions. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions;

(c) **Organic soil**[2] - soils are organic if they satisfy the requirements 1 and 2, or 1 and 3 below:

[1] As defined in "Annex A: Glossary" of the 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry.

[2] As defined in "Annex A: Glossary" of the 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry.

(i) Thickness of 10 cm or more. A horizon less than 20 cm thick must have 12 per cent or more organic carbon when mixed to a depth of 20 cm;

(ii) If the soil is never saturated with water for more than a few days, and contains more than 20 per cent (by weight) organic carbon (about 35 per cent organic matter);

(iii) If the soil is subject to water saturation episodes and has either:

a. At least 12 per cent (by weight) organic carbon (about 20 per cent organic matter) if it has no clay; or

b. At least 18 per cent (by weight) organic carbon (about 30 per cent organic matter) if it has 60 per cent or more clay; or

c. An intermediate, proportional amount of organic carbon for intermediate amounts of clay;

(d) **Forest**[3] - in the absence of national definition of forests, the following shall apply: Forest is a minimum area of land of 0.05–1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10–30 per cent with trees with the potential to reach a minimum height of 2–5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high portion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10–30 per cent or tree height of 2–5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest;

(e) **Indirect land use change** - is land-use change that may be induced on land areas not included in the project boundary as a result of shifting of pre-project activities;

(f) **Pre-project activities** - the land use prior to the implementation of the project activity, considering both land use practices and the primary and final products of the practices. This includes, for example, grazing, cultivation of crops, agroforestry, collection of biomass;

(g) **Stratum** - area of land with uniform properties.

5. Project emission

10. Project emissions resulting from cultivation of biomass in a dedicated plantation are estimated as follows:

$$PE_{BC,y} = PE_{SM,y} + PE_{EC,y} + PE_{BB,y}$$ Equation (1)

[3] As defined by the minimum values of tree crown cover, land area, and tree height selected by the host party for the purposes of the CDM (see paragraph 8, annex to decision 5/CMP.1).

Where:

$PE_{BC,y}$	=	Emissions resulting from cultivation of biomass in a dedicated plantation, in year *y*; t CO_2e
$PE_{SM,y}$	=	Emissions resulting from soil management, in year *y* (t CO_2e)
$PE_{EC,y}$	=	Emissions resulting from energy consumption, in year *y* (t CO_2e)
PE_{BBy}	=	Emissions resulting from burning of biomass, in year *y* (t CO_2e)

11. Biomass originating from land areas included in registered A/R project activities may be considered to have no project emissions, provided that the emission reductions from the A/R project activity have been verified and issued for the time period in which the biomass was harvested.

5.1. Emissions resulting from soil management

12. Emissions resulting from soil management are estimated as follows:

$$PE_{SM,y} = PE_{SOC,y} + PE_{SF,y} + PE_{SA,y}$$ Equation (2)

Where:

$PE_{SM,y}$	=	Emissions resulting from soil management, in year *y* (t CO_2e)
$PE_{SOC,y}$	=	Emissions resulting from loss of soil organic carbon, in year *y* (t CO_2e)
$PE_{SF,y}$	=	Emissions resulting from of soil fertilization and management, in year *y* (t CO_2e)
$PE_{SA,y}$	=	Emissions resulting from soil amendment (liming), in year *y* (t CO_2e)

5.1.1. Emissions resulting from loss of soil organic carbon

13. To estimate emissions resulting from loss of soil organic carbon, the areas of land are stratified according to:

(a) Climate region and soil types given in Table 2;

(b) Land-use and land management activities on croplands given in Tables 3 and 4; and

(c) Land-use and land management activities on grasslands given in Table 5. These apply also to abandoned land.

14. Emissions resulting from loss of soil organic carbon are estimated as follows:

$$PE_{SOC,y} = \max\left(\frac{44}{12} \times \frac{1.156}{T} \times \sum_{i} \Delta SOC_i \, , 0\right)$$ Equation (3)

Where:

$PE_{SOC,y}$	=	Emissions resulting from loss of soil organic carbon, in year *y* (t CO_2e)
T	=	Length of the first crediting period of the project in years (7 or 10)
ΔSOC_i	=	Loss of soil organic carbon in land stratum *i*, (t C)
$\frac{44}{12}$	=	Factor for converting units from t C to t CO_2e; dimensionless
1.156	=	Factor to account for soil N_2O emissions associated with loss of soil organic carbon,[4] dimensionless
i	=	Strata of areas of land

15. Loss of soil organic carbon in a stratum is estimated as follows:

$$\Delta SOC_i = 1.21 \times A_{SOC,i} \times SOC_{REF,i} \times (f_{LUB,i} \times f_{MGB,i} \times f_{INB,i} - f_{LUP,i} \times f_{MGP,i} \times f_{INP,i}) \quad \text{Equation (4)}$$

Where:

ΔSOC_i	=	Loss of soil organic carbon in land stratum *i*, (t C)
$A_{SOC,i}$	=	Area of land stratum *i*; (ha)
$SOC_{REF,i}$	=	Reference SOC stock applicable to land stratum *i*, (t C/ha)
$f_{LUB,i}$	=	Relative stock change factor for land-use in the baseline in stratum i
$f_{MGB,i}$	=	Relative stock change factor for land management in the in stratum i
$f_{INB,i}$	=	Relative stock change factor for input in the baseline in stratum i
$f_{LUP,i}$	=	Relative stock change factor for land-use in the project in stratum i
$f_{MGP,i}$	=	Relative stock change factor for land management in the project in stratum i
$f_{INP,i}$	=	Relative stock change factor for input in the project in stratum i
i	=	Strata of areas of land
1.21	=	Conservativeness factor accounting for the uncertainties in the values in Tables 3–5[5]

16. The values of relative stock change factors shall be determined according to Tables 3–5 of this tool.[6]

[4] Based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For details, see appendix 1.

[5] According to FCCC/SBSTA/2003/10/Add.2/6. For details, see appendix 1.

[6] Project proponents are encouraged to suggest revisions for this tool with alternative procedures (e.g. monitoring) to determine the relative stock change.

17. After the first crediting period of the project, the value of $PE_{SOC,y}$ shall be 0.

5.1.2. Emissions resulting from soil fertilization and management

18. Emissions resulting from soil fertilisation and management are estimated as follows:

$$PE_{SF,y} = q_{N,y} \times A_{FTM,y} \times EF_{FT}$$ Equation (5)

Where:

$PE_{SF,y}$	=	Emissions resulting from soil fertilization and management, in year *y* (t CO_2e)
$q_{N,y}$	=	Rate of nitrogen applied, in year *y* (t N/ha)
$A_{FTM,y}$	=	Area of land subjected to soil fertilization and management, in year *y* (ha)
EF_{FT}	=	Aggregate emission factor for N_2O and CO_2 emissions resulting from production and application of nitrogen (t CO_2e/(t N)). A default value of 13.3 t CO_2e/(t N)[7] shall be used

5.1.3. Emissions resulting from soil amendment

19. Emissions resulting from soil amendment (liming) are estimated as follows:

$$PE_{SA,y} = q_{LM,y} \times A_{LM,y} \times EF_{LM} + q_{DL,y} \times A_{DL,y} \times EF_{DL}$$ Equation (6)

Where:

$PE_{SA,y}$	=	Emissions resulting from soil amendment by liming, in year *y* (t CO_2e)
$q_{LM,y}$	=	Rate of application of limestone, in year *y* (t/ha)
$A_{LM,y}$	=	Area of land in which limestone is applied, in year *y* (ha)
EF_{LM}	=	Emission factor for CO_2 emissions from limestone application (t CO_2e/(t limestone)). A default value of 0.12 t CO_2e/(t limestone)[8] shall be used
$q_{DL,y}$	=	Rate of application of dolomite, in year *y* (t/ha)
$A_{DL,y}$	=	Area of land in which dolomite is applied, in year *y* (ha)
EF_{DL}	=	Emission factor for CO_2 emissions from dolomite application (t CO_2e (t dolomite). A default value of 0.13 t CO_2e /(t dolomite)[9] shall be used

[7] Based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For details, see appendix 1.

[8] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol 4, Ch 11, Eq 11.12.

[9] Ibid.

5.2. Emissions resulting from energy consumption

20. Emissions resulting from energy consumption are estimated by following the provisions in the methodological tools “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” and “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.

5.3. Emissions resulting from clearance or burning of biomass

21. Emissions resulting from clearance or burning of biomass are estimated as follows:

$$PE_{BB,y} = \frac{44}{12} \times 0.47 \times \sum_{i} A_{FR,i,z} \times b_i \times (1.07 + R_i) \qquad \text{Equation (7)}$$

Where:

$PE_{BB,y}$	=	Emissions resulting from burning of biomass, in year *y* (t CO_2e)
$\frac{44}{12}$	=	Factor for converting units from t C to t CO_2e; dimensionless
0.47	=	Default value of carbon fraction of biomass burnt;[10] dimensionless
1.07	=	Factor to account for non-CO_2 emissions from biomass burning;[11] dimensionless. If biomass is cleared without using open fire, then this factor is set equal to 1 (one)
$A_{FR,i,y}$	=	Area of stratum *i* of land subjected to fire in year *y* (ha)
b_i	=	Fuel biomass consumption per hectare in stratum *i* of land subjected to fire (t dry matter/ha)
R_i	=	Root-shoot ratio (i.e. ratio of below-ground biomass to above-ground biomass) for stratum *i* of land subjected to fire; dimensionless
i	=	Strata of areas of land

[10] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol 4, Ch 4 Table 4.3.

[11] Based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For details, see appendix 1.

Table 2. Default reference SOC stocks (SOCREF) for mineral soils (tC/ha in 0–30 cm depth)

Climate region	HAC soils[12]	LAC soils[13]	Sandy soils[14]	Spodic soils[15]	Volcanic soils[16]
Boreal	68	NA	10	117	20
Cold temperate, dry	50	33	34	NA	20
Cold temperate, moist	95	85	71	115	130
Warm temperate, dry	38	24	19	NA	70
Warm temperate, moist	88	63	34	NA	80
Tropical, dry	38	35	31	NA	50
Tropical, moist	65	47	39	NA	70
Tropical, wet	44	60	66	NA	130
Tropical montane	88	63	34	NA	80

[12] Soils with high activity clay (HAC) minerals are lightly to moderately weathered soils, which are dominated by 2:1 silicate clay minerals (in the World Reference Base for Soil Resources (WRB) classification these include Leptosols, Vertisols, Kastanozems, Chernozems, Phaeozems, Luvisols, Alisols, Albeluvisols, Solonetz, Calcisols, Gypsisols, Umbrisols, Cambisols, Regosols; in USDA classification includes Mollisols, Vertisols, high-base status Alfisols, Aridisols, Inceptisols).

[13] Soils with low activity clay (LAC) minerals are highly weathered soils, dominated by 1:1 clay minerals and amorphous iron and aluminium oxides (in WRB classification includes Acrisols, Lixisols, Nitisols, Ferralsols, Durisols; in USDA classification includes Ultisols, Oxisols, acidic Alfisols).

[14] Includes all soils (regardless of taxonomic classification) having >70 per cent sand and <8 per cent clay, based on standard textural analyses (in WRB classification includes Arenosols; in USDA classification includes Psamments).

[15] Soils exhibiting strong podzolization (in WRB classification includes Podzols; in USDA classification Spodosols).

[16] Soils derived from volcanic ash with allophanic mineralogy (in WRB classification Andosols; in USDA classification Andisols).

Table 3. Relative stock change factors for different management activities on cropland[17]

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
Land use (f_{LU})	Long-term cultivated	Temperate/ Boreal	Dry	0.80	Area has been continuously managed for crops for more than 20 years
			Moist	0.69	
		Tropical	Dry	0.58	
			Moist/Wet	0.48	
		Tropical montane	n/a	0.64	
Land use (f_{LU})	Short-term cultivated (<20 years) or set aside (<5 years)	Temperate/ Boreal and Tropical	Dry	0.93	Area has been managed for crops for less than 20 years and/or the area is cropland that has been in a fallow state for less than five years at any point during the last 20 years
			Moist/Wet	0.82	
		Tropical montane	n/a	0.88	
Manage-ment (f_{MG})	Full tillage	All	Dry and Moist/Wet	1.00	Substantial soil disturbance with full inversion and/or frequent (within year) tillage operations. At planting time, little (e.g. <30 per cent) of the surface is covered by residues
Manage-ment (f_{MG})	Reduced tillage	Temperate/ Boreal	Dry	1.02	Primary and/or secondary tillage but with reduced soil disturbance (usually shallow and without full soil inversion). Normally leaves surface with >30 per cent coverage by residues at planting
			Moist	1.08	
		Tropical	Dry	1.09	
			Moist/Wet	1.15	
		Tropical montane	n/a	1.09	
Manage-ment (f_{MG})	No-tillage	Temperate/ Boreal	Dry	1.10	Direct seeding without primary tillage, with only minimal soil disturbance in the seeding zone. Herbicides are typically used for weed control
			Moist	1.15	
		Tropical	Dry	1.17	
			Moist/Wet	1.22	
		Tropical montane	n/a	1.16	

[17] Adapted from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Table 5.5.

Table 4. Relative stock change factors for different levels of nutrient input on cropland[18]

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
Input (f_{IN})	Low	Temperate/ Boreal	Dry	0.95	There is removal of residues (via collection or burning), or frequent bare-fallowing, or production of crops yielding low residues (e.g. vegetables, tobacco, cotton), or no mineral fertilization or N-fixing crops
			Moist	0.92	
		Tropical	Dry	0.95	
			Moist/Wet	0.92	
		Tropical montane	n/a	0.94	
Input (f_{IN})	Medium	All	Dry and Moist/Wet	1.00	All crop residues are returned to the field. If residues are removed then supplemental organic matter (e.g. manure) is added. Additionally, mineral fertilization or N-fixing crop rotation is practised
Input (f_{IN})	High without manure	Temperate/ Boreal and Tropical	Dry	1.04	Represents significantly greater crop residue inputs over medium C input cropping systems due to additional practices, such as production of high residue yielding crops, use of green manures, cover crops, improved vegetated fallows, irrigation, frequent use of perennial grasses in annual crop rotations, but without manure applied
			Moist/Wet	1.11	
		Tropical Montane	n/a	1.08	
Input (f_{IN})	High with manure	Temperate/ Boreal and Tropical	Dry	1.37	Represents significantly higher C input over medium C input cropping systems due to an additional practice of regular addition of animal manure
		-	Moist/ Wet	1.44	
		Tropical Montane	n/a	1.41	

[18] Ibid.

Table 5. Relative stock change factors (*f_{LU}, f_{MG}, and f_{IN}*) for grassland management[19]

Factor type	Level	Climate regime	Factor value	Description
Land use (f_{LU})	All	All	1.00	All permanent grassland is assigned a land-use factor of 1
Management (f_{MG})	Non-degraded grassland	All	1.00	Non-degraded and sustainably managed grassland, but without significant management improvements
Management (f_{MG})	Moderately degraded grassland	Temperate/ Boreal	0.95	Overgrazed or moderately degraded grassland, with somewhat reduced productivity (relative to the native or nominally managed grassland) and receiving no management inputs
		Tropical	0.97	
		Tropical Montane	0.96	
Management (f_{MG})	Severely degraded	All	0.70	Implies major long-term loss of productivity and vegetation cover, due to severe mechanical damage to the vegetation and/or severe soil erosion
Management (f_{MG})	Improved grasslands	Temperate/ Boreal	1.14	Represents grassland which is sustainably managed with moderate grazing pressure and that receive at least one improvement (e.g. fertilization, species improvement, irrigation)
		Tropical	1.17	
		Tropical Montane	1.16	
Input (f_{IN}) (applied only to improved grassland)	Medium	All	1.00	All grassland without input of fertilizers is assigned an input factor of 1
	High	All	1.11	Grasslands with direct application of fertilizers (organic or inorganic) beyond what is required to be classified as improved grassland

6. Data and parameters

6.1. Data and parameters not monitored

22. Data and parameters not monitored have been provided along with the relevant equation in the preceding section of the tool.

Data / Parameter table 1.

Data / Parameter:	Pre-project land use
Data unit:	variable
Description:	Service level of the pre-project land use
Source of data:	Land management records, records of the relevant local authority, stakeholders interviews etc.

[19] Adapted from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Table 6.2.

Measurement procedures (if any):	-
Any comment:	-

6.2. Data and parameters monitored

23. Data and parameters are monitored as described in the following data description tables:

Data / Parameter table 2.

Data / Parameter:	$A_{SOC,i}$
Data unit:	ha
Description:	Area of land stratum *i*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party ~~country~~
Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party country are used
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	$q_{N,y}$
Data unit:	t N/ha
Description:	Rate of nitrogen applied, in year *y*
Source of data:	Land management records maintained by project participants and fertiliser composition information from supplier, study or independent laboratory. Alternatively, the default conservative value of 0.20 t N/ha per year may be used
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts and inventory
Any comment:	Nitrogen applied through the following methods shall be added up to arrive at this value: (i) synthetic fertilisers; (ii) organic manure; (iii) return of the residues or cover crops

Data / Parameter table 4.

Data / Parameter:	$A_{FTM,y}$
Data unit:	ha
Description:	Area of land subjected to soil fertilization and management, in year *y*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party ~~country~~

Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party ~~country~~ are used
Any comment:	Areas receiving one or more of the following inputs shall be added up to arrive at this value: (i) synthetic fertilisers; (ii) organic manure; (iii) return of the residues or cover crops

Data / Parameter table 5.

Data / Parameter:	$\mathbf{q_{LM,y}}$
Data unit:	t/ha
Description:	Rate of application of limestone, in year *y*
Source of data:	Land management records maintained by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts and inventory
Any comment:	-

Data / Parameter table 6.

Data / Parameter:	$\mathbf{A_{LM,y}}$
Data unit:	ha
Description:	Area of land in which limestone is applied, in year *y*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party
Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party are used
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	$\mathbf{q_{DL,y}}$
Data unit:	t/ha
Description:	Rate of application of dolomite, in year *y*
Source of data:	Land management records maintained by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts and inventory
Any comment:	-

Data / Parameter table 8.

Data / Parameter:	$\mathbf{A_{DL,y}}$
Data unit:	ha
Description:	Area of land in which dolomite is applied, in year *y*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party
Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party are used
Any comment:	-

Data / Parameter table 9.

Data / Parameter:	$\mathbf{Q_{FF,i,y}}$
Data unit:	t
Description:	Quantity of fossil fuel of type *i* consumed in year *y*
Source of data:	Land management records maintained by project participants. Alternatively, the default conservative value of 50 litre of diesel equivalent per hectare per year may be used
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	Fossil fuels used in the following activities shall be added up to arrive at this value: (i) use of farm machinery e.g. tractors, harvesters; (ii) treatment, pumping, and application of water for irrigation; (iii) use of machinery in transport and application of inorganic fertilisers, organic fertilisers, soil amending materials (e.g. limestone, dolomite)

Data / Parameter table 10.

Data / Parameter:	$\mathbf{Q_{EL,y}}$
Data unit:	MWh
Description:	Quantity of electricity consumed in year *y*
Source of data:	Land management records maintained by project participants or dedicated electricity meters
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	Electricity used in the following activities shall be added up to arrive at this value: (i) use of farm machinery run on electricity; (ii) treatment, pumping, and application of water for irrigation; (iii) transport and application of inorganic fertilisers, organic fertilisers, soil amending materials (e.g. limestone, dolomite)

Data / Parameter table 11.

Data / Parameter:	$\mathbf{A}_{FR,i,y}$
Data unit:	ha
Description:	Area of stratum *i* of land subjected to fire in year *y*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party
Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party are used
Any comment:	-

Data / Parameter table 12.

Data / Parameter:	$\mathbf{b}_i$
Data unit:	t dry matter/ha
Description:	Fuel biomass consumption per hectare in stratum *i* of land subjected to fire
Source of data:	Measurement by project participants. Alternatively, the default 'average above-ground biomass content in forest' values from Table 3A.1.4 of the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC-GPG-LULUCF 2003)
Measurement procedures (if any):	Measurement may be carried out through sample plots
Monitoring frequency:	Annual
QA/QC procedures:	If sample plots are used, the estimated mean value should not have an uncertainty of greater than 10% at 90% confidence level
Any comment:	-

Data / Parameter table 13.

Data / Parameter:	$\mathbf{R}_\mathbf{i}$
Data unit:	Dimensionless
Description:	Root-shoot ratio (i.e. ratio of below-ground biomass to above-ground biomass) for stratum *i* of land subjected to fire
Source of data:	Measurement by project participants. Alternatively, the default values from Table 4.4 of the 2006 IPCC Guidelines for National GHG Inventories may be used
Measurement procedures (if any):	Measurement may be carried out through sample plots
Monitoring frequency:	Annual
QA/QC procedures:	If sample plots are used, the estimated mean value should not have an uncertainty of greater than 10% at 90% confidence level
Any comment:	-

Data / Parameter table 14.

Data / Parameter:	**Land use**
Data unit:	variable
Description:	Service level of the project land use
Source of data:	-
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	The service level of the project land use shall at least provide the pre-project service level

Appendix 1. Explanation of factors used

1. In equation (3), the factor to account for soil N_2O emissions associated with loss of soil organic carbon is calculated following volume 4 chapters 3 and 11 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Loss of SOC leads to associated mineralisation of N in the soil, leading to N_2O emissions:

   (a) The mineralised *N* can be calculated using equation (11.1) and (11.10), with $EF_1=0.01$, $EF_5 = 0.0075$ *and* $Frac_{LEACH}$ = 0.3, results in total 0.01225 tN-N_2O/tN;

   (b) Using equation (11.8) of the IPCC guidelines, in which *R* is set to 10 tSOC/tN, results in 0.001225 tN-N_2O/tSOC;

   (c) Converting to t CO_2e/tSOC by multiplying with 298 (GWP_{N2O}) and dividing by 28/44 (Weight of *N* in N_2O) results in 0.574 t CO_2e/tSOC;

   (d) Dividing by 44/12 (mass ratio of CO_2 and C) to convert to t CO_2e/t CO_2 (dimensionless factor) results in 0.156 t CO_2e released in N_2O for each t CO_2 released from SOC.

2. In equation (4), the factor to account for the IPCC default factor was derived from evaluating worse-case scenario, i.e. worse uncertainties, in the used factors:

   (a) Reviewing the IPCC data, SOC_{REF} has error estimate of 90 per cent (IPCC table 2.3, table note), whereas the various *f* factors have error estimate of up to 50 per cent (IPCC tables 5.4 and 6.2). These are two sigma estimates, equivalent to 95 per cent confidence interval;

   (b) Converting them to 90 per cent confidence interval (equivalent to 1.282 sigma), which is deemed appropriate for the tool, by multiplying with 1.282/2, results in SOC_{REF} uncertainty of 58 per cent, and the various *f* factors in uncertainties of 32 per cent;

   (c) Adding the root-mean-square of these error estimates result in total 70 per cent error (Note the f uncertainties have each half the weight of the SOC_{REF} error estimate, due to the addition in the equation);

   (d) As SOC_{REF} always has error estimate of 58 per cent, total error estimate has range of 58-70 per cent;

   (e) The error estimates being in the uncertainty band of 50-100 per cent, result in a corrective factor of 1.21 according to FCCC/SBSTA/2003/10/Add.2/6.

3. In equation (5), The default value of the aggregate emission factor for N_2O and CO_2 emissions resulting from production and application of nitrogen, is calculated following volume 4 chapters 3 and 11 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories, as well as based on Wood and Cowie (2004) and Swaminathan (2004). The calculation is for ammonium nitrate, which is considered conservative:[20]

   (a) Direct and indirect N_2O emissions (emissions associated to the fertiliser application on the soil) calculated, using IPCC equations (11.1), (11.9) and (11.10), with $EF_1 = 0.01$, $EF_4 = 0.01$ $EF_5 = 0.0075$, $Frac_{GASF} = 0.1$ and $Frac_{LEACH}$ = 0.3, results in total 0.01325 tN-N_2O/tN. This is converted, by multiplying with 298 (GWP_{N2O}) dividing by 28/44 (Weight of *N* in N_2O), to 6.20 t CO_2e/tN;

   (b) Emissions from synthetic fertiliser production, including fuel, feedstocks and emissions during production, calculated based on Wood and Cowie (2004) and Swaminathan (2004), taken for ammonium nitrate, a conservative fertiliser, is 7.1 t CO_2e/tN;

   (c) Adding the above emissions results in 13.3 t CO_2e/tN.

4. In equation (8), the factor to account for non-CO_2 emissions from biomass burning was calculated using the values in table 2.5, volume 4 chapter 2 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories:

   (a) Taking the values for savannah and grassland, which are most conservative;

   (b) (1613 g CO_2 + 2.3 g CH_4 x 25 (GWP_{CH4}) + 0.21 g N_2O x 298 (GWP_{N2O}))/1613 g CO_2 = 1.07.

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[20] As a comparison, the calculation is repeated for organic fertiliser:

(a) Direct and indirect N_2O emissions calculated similarly to ammonium nitrate, but with $Frac_{GASM}$=0.2 resulting in 6.67 t CO_2e/tN;

(b) No emissions from fertiliser production are considered, resulting in total 6.67 t CO_2e/tN.

As an additional comparison, the calculation is also repeated for synthetic urea:

(a) Direct and indirect N_2O identical to ammonium nitrate equals 6.20 t CO_2e/tN;

(b) Emissions from urea production, from the same source as ammonium nitrate, is 1.70 t CO_2e/tN;

(c) Emissions from urea applications (carbon released from the urea decomposition) calculated as 0.429 tC/tN, which is the C/N mass ratio in urea. This is converted, by dividing by 12/44 (Weight of *C* in CO_2), to 1.57 t CO_2e/tN;

(d) Adding the above emissions results in 9.5 t CO_2e/tN.

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