

**AMS-III.BE**

## Small-scale Methodology

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### Avoidance of methane and nitrous oxide emissions from sugarcane pre-harvest open burning through mulching

Version 01.0

Sectoral scope(s): 13



**United Nations**  
Framework Convention on  
Climate Change

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## 1. Introduction

1. The following table describes the key elements of the methodology:

**Table 1. Methodology key elements**

<b>Typical project(s)</b>	Methane and nitrous oxide emissions avoidance by replacing pre-harvest open burning of sugarcane biomass with mulching of sugarcane biomass.
<b>Type of GHG emissions mitigation action</b>	GHGs avoidance

## 2. Scope, applicability, and entry into force

### 2.1. Scope

2. This methodology comprises measures to avoid methane and nitrous oxide emissions to the atmosphere from pre-harvest burning of sugarcane biomass that would have otherwise been burnt openly. In the project activity, aerobic treatment of biomass by mulching is introduced.

### 2.2. Applicability

3. This methodology is applicable to the mulching of biomass from sugarcane harvesting, which would have been openly burned in the absence of the project activity. In addition, it shall be established ex ante at the beginning of the project activity that open burning is not legally prohibited in the project region.
4. The source of the biomass, that in the absence of the project activity would have been burned, and the characteristics of such biomass shall be known in order to: (a) allow the estimation of its methane and nitrous oxide emissions; and (b) avoid double counting, for example by similar projects in the same region claiming the emissions reductions.
5. It shall be established ex ante before the starting date of the project activity that on field open burning of sugarcane biomass before sugarcane harvesting is the common practice in the applicable geographical area<sup>1</sup> (e.g. at least 80 per cent of the cultivated area). This shall be established by on-site inspection in the project region on a sample basis.
6. This methodology is only applicable when it can be demonstrated that the participating farms have been cultivating only sugarcane or, have been cultivating sugarcane as well as other crops on the same land (i.e. crop rotation on the same land) in the immediate three years prior to the starting date of the project activity.

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<sup>1</sup> It should be the entire host country. If project participants opt to limit the applicable geographical area to a smaller geographical area (such as a province or region, etc.) within the host country, then they shall provide justification on the essential distinction between the identified specific geographical area and rest of the host country.

7. If sugarcane biomass is collected and stored before the mulching process, the storage time shall be less than seven days. Otherwise, it shall be justified that no anaerobic decay of the stored biomass will occur for the duration of the project activity.
8. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO<sub>2</sub> equivalent annually.

### **2.3. Entry into force**

9. The date of entry into force is the date of the publication of the EB 70 meeting report on the 23 November 2012.

## **3. Normative references**

10. Project participants shall apply the “General guidelines for SSC CDM methodologies”, “Guidelines on the demonstration of additionality of small-scale project activities” (Attachment A to Appendix B) and “General guidance on leakage in biomass project activities” (Attachment C to Appendix B) provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> mutatis mutandis.

## **4. Definitions**

11. The definitions contained in the “Glossary of CDM terms” shall apply.
12. For the purpose of this methodology, the following definitions also apply:
  - (a) Open burning is the combustion of unwanted combustible materials in open-air, where smoke and other emissions are released directly into the air without passing through a chimney or a stack.<sup>2</sup> In the case of sugarcane, open burning is the practice of setting fire to the mature plants in the field before harvesting. It does not include cases where biomass is burned and the generated heat is utilized (e.g. for cooking);
  - (b) Mulching is the establishment of a protective covering on agricultural soil, usually of organic matter such as leaves, straw, or peat, placed around plants to prevent the evaporation of moisture, the freezing of roots, and the growth of weeds.<sup>3</sup>

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<sup>2</sup> In accordance with the “2006 IPCC Guidelines for National Inventories, Volume 5, chapter 5”.

<sup>3</sup> In accordance with the FAO Glossary on Organic Agriculture, <http://termportal.fao.org/faooa/oa/pages/pdfFiles/OA-en-ar.pdf>.

## 5. Baseline methodology

### 5.1. Project boundary

13. The project boundary is the physical, geographical site:
- (a) Where the sugarcane biomass would have been burnt openly and the methane and nitrous oxide emissions would have occurred in absence of the proposed project activity;
  - (b) Where the sugarcane biomass for mulching is treated (if applicable, e.g. chopping of coarse material) and submitted to soil application.

### 5.2. Baseline emissions

14. The baseline scenario is the situation where, in the absence of the project activity, biomass is burned openly within the project boundary. The baseline emissions are the amount of methane and nitrous oxide emitted during the process of open burning:

$$BE_y = Q_y \times (EF_{burning,CH_4} \times GWP_{CH_4} + EF_{burning,N_2O} \times GWP_{N_2O}) \quad \text{Equation (1)}$$

Where:

$BE_y$	=	Baseline emissions from open burning in the year $y$ (t CO <sub>2</sub> e)
$Q_y$	=	Quantity of sugarcane biomass that would have been burned openly in year $y$ (tonnes, dry basis)
$EF_{burning,CH_4}$	=	Methane emission factor for open burning of sugarcane biomass (t CH <sub>4</sub> /tonne biomass burned). The IPCC default value of 2.7 g CH <sub>4</sub> /kg for agricultural residues (based on dry matter burned) may be used <sup>4</sup> . Alternatively, country-specific or peer reviewed local default values or crop-specific local measurements may also be used, if available
$GWP_{CH_4}$	=	Global warming potential of methane applicable to the crediting period (t CO <sub>2</sub> e/tCH <sub>4</sub> )
$EF_{burning,N_2O}$	=	Nitrous oxide emission factor for open burning of sugarcane biomass (t N <sub>2</sub> O/tonne biomass burned). The IPCC default value of 0.07 g N <sub>2</sub> O/kg for agricultural residues (based on dry matter burned) may be used <sup>5</sup> . Alternatively, country-specific or peer reviewed local default values or crop-specific local measurements may also be used, if available
$GWP_{N_2O}$	=	Global warming potential of nitrous oxide applicable to the crediting period (t CO <sub>2</sub> e/tN <sub>2</sub> O)

<sup>4</sup> Table 2.5, chapter 2, Volume 4, 2006 IPCC Guidelines for National Greenhouse Gas Inventories

<sup>5</sup> Table 2.5, chapter 2, Volume 4, 2006 IPCC Guidelines for National Greenhouse Gas Inventories

<[http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4\\_Volume4/V4\\_02\\_Ch2\\_Generic.pdf](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_02_Ch2_Generic.pdf)>

15. Amount of biomass ( $Q_y$ ) is determined based on sugarcane biomass quantity per area that would have been burned openly, according to the following equation:

$$Q_y = A_y \times q_y \times C_f \quad \text{Equation (2)}$$

Where:

- $A_y$  = Area from which the sugarcane plants would have been openly burned in year  $y$  (ha)
- $q_y$  = Specific quantity of sugarcane biomass that would have been openly burned in year  $y$ , per hectare (tonnes dry matter per ha)
- $C_f$  = Combustion factor (proportion of pre-fire biomass consumed in the fire) (dimensionless). The IPCC default value of 0.8 for agricultural residues (based on dry matter burned) may be used<sup>6</sup>. Alternatively, peer reviewed local default values or direct measurements of the combustion factor may also be used, if available

16. Specific quantity of sugarcane biomass ( $q_y$ ) is determined based on ratio of the combustible sugarcane biomass to sugarcane yield ( $R_{ResiduesYield}$ ), according to the following equation:

$$q_y = Q_{SugarcaneYield,y} \times R_{ResiduesYield} \quad \text{Equation (3)}$$

Where:

- $Q_{SugarcaneYield,y}$  = Sugarcane yield (stalks only, without tops and leaves) from participating farms in year  $y$  per hectare (tonnes wet matter per ha)
- $R_{ResiduesYield}$  = Ratio of biomass that would be openly burned to sugarcane yield, i.e. mass fraction of combustible dry matter (tops and leaves) as a share of sugarcane yield (stalks only, in wet matter). A default value of 15% may be used. Peer reviewed local default values or direct measurements may also be used, if available

17. Sugarcane yield ( $Q_{SugarcaneYield,y}$ ) is measured directly. Alternatively, if the farm produces raw sugar in-house, it may be derived from raw sugar yields according to the following equation:

$$Q_{SugarcaneYield,y} = \frac{Q_{Sugar,y}}{Ext_{Sugar}} \quad \text{Equation (4)}$$

<sup>6</sup> Table 2.6, chapter 2, Volume 4, 2006 IPCC Guidelines for National Greenhouse Gas Inventories  
<[http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4\\_Volume4/V4\\_02\\_Ch2\\_Generic.pdf](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_02_Ch2_Generic.pdf)>

Where:

$Q_{sugar,y}$  = Quantity of raw sugar produced by the individual farm in year  $y$  (t/ha), obtained from the sugarcane harvested at the individual farm/field

$Ext_{sugar}$  = Sugar extraction rate from the sugarcane (%; quantity of raw sugar as a share of total sugarcane biomass (stalks only) on wet matter basis). A default value of 15% may be used. Alternatively, peer-reviewed local default values or direct measurements of the extraction rate may be used, if available

### 5.3. Leakage

18. No leakage calculation is necessary.

### 5.4. Project activity emissions

19. Project activity emissions consist of:

- (a) CO<sub>2</sub> emissions from incremental electricity and/or fossil fuel consumption of the project activity facilities (e.g. for collecting and chopping the coarse mulching material, transportation of biomass from the field to the processing facility and backwards, or due to changes in harvesting or irrigation practices); and
- (b) Nitrous oxide emissions from the mulching layer on the soil.

$$PE_y = PE_{y,power} + PE_{y,mulch} \quad \text{Equation (5)}$$

Where:

$PE_y$  = Project activity emissions in the year  $y$  (t CO<sub>2</sub>e)

$PE_{y,power}$  = Emissions from incremental electricity and/or fossil fuel consumption in year  $y$  (t CO<sub>2</sub>e)

$PE_{y,mulch}$  = Emissions from the mulching layer in year  $y$  (t CO<sub>2</sub>e)

20. For the calculation of project emissions from electricity and/or fossil fuel consumption of the project activity facilities ( $PE_{y,power}$ ), the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and/or the "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion" shall be followed. Energy consumption of all equipment/devices installed or used in the project activity shall be included. Alternatively, a default value of 18 litre diesel per hectare may be used.
21. In order to avoid anaerobic conditions in the mulching layer, sugarcane biomass shall be spread in a loose layer during the mulching process. The conditions for proper soil application to ensure aerobic conditions shall be established by field inspections by an expert taking into account the soil conditions, crop types grown and weather conditions.
22. Nitrous oxide emissions from the mulching layer ( $PE_{y,mulch}$ ) are determined based on the  $N$  content of the applied sugarcane biomass, according to the following equation:

$$PE_{y,mulch} = A_y \times q_y \times Conc_N \times EF_{mulch} \times 44/28 \times GWP_{N_2O} \quad \text{Equation (6)}$$

Where:

- $Conc_N$  = Nitrogen concentration of the sugarcane biomass applied for mulching (%). A default value of 0.7% may be used. Peer-reviewed local default values or direct measurements of the  $N$  concentration may alternatively be used, if available
- $EF_{mulch}$  = Emission factor for  $N_2O$  from the mulching material. A default value of 0.005 kg  $N_2O$ -N/kg  $N$  applied may be used. Peer-reviewed local default values or direct measurements of the emission factor may also be used, if available
- 44/28 = Conversion factor from  $N_2O$ -N to  $N_2O$

## 5.5. Emission reductions

23. The emission reductions from the project activity are determined as the difference between the baseline emissions and the project emissions.

$$ER_y = BE_y - PE_y \quad \text{Equation (7)}$$

Where:

- $ER_y$  = Emission reductions in the year  $y$  (t  $CO_2e$ )

## 6. Monitoring methodology

24. Relevant parameters shall be monitored as indicated in section 6.1 below. The applicable requirements specified in the "General guidelines for SSC CDM methodologies" (e.g. calibration requirements, sampling requirements) are also an integral part of the monitoring guidelines specified below and therefore shall be followed by the project participants.

### 6.1. Data and parameters monitored

Data / Parameter table 1.

Data / Parameter:	Presence of open burning in the baseline
Data unit:	-
Description:	-
Source of data:	-



Measurement procedures (if any):	Presence of open burning in the baseline shall be established through field inspection by a third party (e.g. based on evidence such as the presence of burned residues). If a sampling method is used, the sampling shall be done with single fields as observational units and the "Standard for sampling and surveys for CDM project activities and programme of activities" shall be followed
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

**Data / Parameter table 2.**

<b>Data / Parameter:</b>	<b>Absence of open burning in the project activity</b>
Data unit:	-
Description:	-
Source of data:	-
Measurement procedures (if any):	Absence of open burning in the project activity shall be established through field inspection by a third party right after the end of the harvest (e.g. based on evidence such as the absence of ash residues) and/or via analysis of satellite images of the relevant area, if available in adequate temporal and spatial resolution for the burning season. If sampling is used, the sampling shall be done using single fields as observational units and the "Standard for sampling and surveys for CDM project activities and programme of activities" shall be followed
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

**Data / Parameter table 3.**

<b>Data / Parameter:</b>	$A_y$
Data unit:	ha
Description:	Area from which the sugarcane plants would have been openly burned in year $y$
Source of data:	-
Measurement procedures (if any):	At the same frequency as the open burning occurred in the baseline (e.g. annually)

Monitoring frequency:	Monitored based on farm site measurements or farm plot area records and shall correspond with the results from the site inspection for open burning and mulching, that is only those areas for which it is demonstrated that there was a switch from open burning to mulching will be counted
QA/QC procedures:	-
Any comment:	-

**Data / Parameter table 4.**

<b>Data / Parameter:</b>	$Q_{\text{SugarcaneYield},y}$
Data unit:	t wet matter ha <sup>-1</sup>
Description:	Sugarcane yield (stalks only, without tops and leaves) from participating farms in year $y$ per hectare
Source of data:	-
Measurement procedures (if any):	Monitored by directly weighing the sugarcane yield, and cross-checked with the production data and/or the sales record provided by the farms, and divided by the cultivated area. If sampling is used, the sampling is done with single fields as observational units and the "Standard for sampling and surveys for CDM project activities and programme of activities" shall be followed
Monitoring frequency:	At the same frequency as harvesting and sugar production (e.g. annually)
QA/QC procedures:	-
Any comment:	-

**Data / Parameter table 5.**

<b>Data / Parameter:</b>	$Q_{\text{Sugar},y}$
Data unit:	t ha <sup>-1</sup>
Description:	Quantity of raw sugar produced by the individual farm in year $y$
Source of data:	-
Measurement procedures (if any):	Monitored by directly weighing the raw sugar produced by the individual farms and cross checked with the production data and/or the sales records provided by the farms
Monitoring frequency:	At the same frequency as harvesting and sugar production (e.g. annually)
QA/QC procedures:	-
Any comment:	-

**Data / Parameter table 6.**

<b>Data / Parameter:</b>	<b>Presence of mulching in the project activity</b>
Data unit:	-
Description:	-
Source of data:	-
Measurement procedures (if any):	Established via field inspection by a third party after the end of the burning season (based on evidence such as the presence of an adequate mulching layer). If sampling is used, the sampling is done with single fields as observational units and the "Standard for sampling and surveys for CDM project activities and programme of activities" shall be followed
Monitoring frequency:	-
QA/QC procedures:	
Any comment:	

**Data / Parameter table 7.**

<b>Data / Parameter:</b>	<b>Absence of anaerobic conditions in the mulching layer</b>
Data unit:	-
Description:	-
Source of data:	-
Measurement procedures (if any):	Established via field inspection by a third party after the end of the burning season. The conditions for proper soil application ensuring aerobic conditions should be established by an expert taking into account the soil conditions, crop types grown and weather conditions(e.g. it may be observed that the mulching layer is of a loose, not dense structure and soil incorporation is without dense wet bunches of mulching material). If sampling is used, the sampling is done with single fields as observational units and the "Standard for sampling and surveys for CDM project activities and programme of activities" shall be followed
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

**Data / Parameter table 8.**

<b>Data / Parameter:</b>	<b>Parameters related to emissions from electricity and/or fuel consumption, if applicable</b>
Data unit:	-
Description:	
Source of data:	-

Measurement procedures (if any):	As per the procedure in the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” and/or the “Tool to calculate project or leakage CO <sub>2</sub> emissions from fossil fuel combustion”
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

## 6.2. Project activity under a programme of activities

25. No special measures are necessary for applying this methodology in a project activity under a programme of activities.

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### Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
01.0	23 November 2012	EB 70, Annex 25. Initial adoption.
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