**CDM-SSCWG45-A06**

# Draft Small-scale Methodology

# AMS-III.AU: Methane emission reduction by adjusted water management practice in rice cultivation

Version 04.0 – Draft

Sectoral scope(s): 15



United Nations
Framework Convention on
Climate Change

# COVER NOTE

## 1. Procedural background

1. The Executive Board of the clean development mechanism (CDM) (hereinafter referred to as the Board), at its eightieth meeting, took note of the recent submission from the designated national authority (DNA) of the Philippines on "Standardized Baseline for Methane Emissions from Rice Cultivation" and considered the issue that the approach taken for determining the baseline in the submission is built upon the methodological approach from the approved methodology "AMS-III.AU: Methane emission reduction by adjusted water management practice in rice cultivation", however it deviates from it in some aspects. The Board requested the secretariat to prepare and submit a draft top-down revision of AMS-III.AU incorporating the new approach based on the proposed standardized baseline and a draft recommendation on the proposed standardized baseline for consideration at the 45th meeting of the Small-Scale Working Group (SSC WG).

## 2. Purpose

2. The purpose of the draft revision of AMS-III.AU is to include a simplified new approach to calculate emission reductions using the IPCC tier 1 approach with measurement of baseline emission factors for continuously flooded fields.

## 3. Key issues and proposed solutions

3. The draft revision takes into account the approach proposed in the proposed standardized baseline submission from the DNA of the Philippines, "Standardized Baseline for Methane Emissions from Rice Cultivation", and it introduces a simplified option for emission reductions calculation, with the aim of reducing transaction costs especially for those in the regions which are underrepresented in the CDM.

## 4. Impacts

4. The revision, if approved, will provide a simplified approach to calculate emission reductions, and it will facilitate the implementation of CDM project activities and programme of activities in agricultural sector, which are relevant for the least developed countries and other regions that are underrepresented in the CDM.

## 5. Subsequent work and timelines

5. The SSC WG, at its 45th meeting, agreed to recommend the draft revised methodology for public comment. After receiving public inputs on the document, the SSC WG will continue working on the methodology, at its 46th meeting, with an aim to recommend to the Board for approval at a future meeting of the Board.

## 6. Recommendations to the Board

6. Not applicable (call for public input).

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# 1. Introduction

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

**Table 1. Methodology key elements**

| | |
|---|---|
| **Typical project(s)** | (a) Rice farms that change the water regime during the cultivation period from continuously to intermittent flooded conditions and/or a shortened period of flooded conditions;<br>(b) Alternate wetting and drying method and aerobic rice cultivation methods; and<br>(c) Rice farms that change their rice cultivation practice from transplanted to direct seeded rice (DSR) |
| **Type of GHG emissions mitigation action** | Greenhouse gas (GHG) emission avoidance:<br>Reduced anaerobic decomposition of organic matter in rice cropping soils |

# 2. Scope, applicability, and entry into force

## 2.1. Scope

2. The methodology comprises technology/measures that result in reduced anaerobic decomposition of organic matter in rice cropping soils and thus reduced generation of methane. The methodology includes projects such as:



(a) Rice farms that change the water regime during the cultivation period from continuously to intermittent flooded conditions and/or a shortened period of flooded conditions ~~are included.~~;

(b) Alternate wetting and drying method and aerobic rice cultivation methods ~~are covered~~ (see <http://www.knowledgebank.irri.org/watermanagement>);

(c) Rice farms that change their rice cultivation practice from transplanted to direct seeded rice ~~are included~~.[1]

## 2.2. Applicability

3. This methodology is applicable under the following conditions:

(a) Rice cultivation in the project area is predominantly characterized by irrigated, flooded fields for an extended period of time during the growing season, i.e. farms whose water regimes can be classified as *upland* or *rainfed and deep water* are not eligible to apply this methodology. This shall be shown from a representative survey conducted in the geographical region of the proposed project or by using national data. This project area characterization shall also include information on pre-season water regime and applied organic

[1] A switch from transplanted rice with continuously flooded fields to ~~direct seeded rice (~~DSR~~)~~ leads to a reduced flooding period since DSR requires non-flooded conditions after sowing until the seed has fully germinated and developed into a viable, young plantlet (at the “2 to 4 leaf stage”).

amendments, so that all dynamic parameters as shown in Table 2 are covered by the baseline study;

(b) The project rice fields are equipped with controlled irrigation and drainage facilities such that both during dry and wet season, appropriate dry/flooded conditions can be established on the fields;

(c) The project activity does not lead to a decrease in rice yield. Likewise, it does not require the farm to switch to a cultivar that has not been grown before;

(d) Training and technical support during the cropping season that delivers appropriate knowledge in field preparation, irrigation, drainage and use of fertilizer to the farmer is part of the project activity and is to be documented in a verifiable manner (e.g. protocol of trainings, documentation of on-site visits). In particular the project proponent is able to ensure that the farmer by himself or through experienced assistance is able to determine the crop's supplemental *N* fertilization need. The applied method shall assess the fertiliser needs using for example a leaf colour chart ~~(LCC)~~ or photo sensor or testing stripes. Alternatively a procedure to ensure efficient fertilization considering the specific cultivation conditions in the project area backed by scientific literature or official recommendations shall be used;

(e) Project proponents shall assure that the introduced cultivation practice, including the specific cultivation elements, technologies and use of crop protection products, is not subject to any local regulatory restrictions;

(f) Except~~ing~~ the case where the default value approach indicated in ~~paragraph 15~~ section 6.1.2 "Emission reductions using IPCC tier 1 approach or default values" is chosen for emission reductions calculations, project proponents have access to infrastructure to measure $CH_4$ emissions from reference fields using closed chamber method and laboratory analysis;

(g) Aggregated annual emission reductions of all fields included under one project activity shall be less than or equal to 60 kt $CO_2$ equivalent.

### 2.3. Entry into force

4. Not applicable (call for public input).

## 3. Normative references

5. Project participants shall apply the "General guidelines ~~to~~ for ~~small-scale (~~SSC~~)~~ ~~clean development mechanism (~~CDM~~)~~ methodologies, "Guidelines on the demonstration~~ng~~ of additionality of ~~SSC~~ small-scale project activities" and "General guidance on leakage in biomass project activities" (attachment C to appendix B) available at <http://cdm.unfccc.int/Reference/Guidclarif/index.html#meth> mutatis mutandis.

## 4. Definitions

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

7. For the purpose of this methodology the following definitions[2] apply:

(a) **Transplanted rice ~~(TPR)~~** - a system of planting rice where seeds are raised in a nursery bed for some 20 to 30 days. The young seedlings are then directly transplanted into the flooded rice field;

(b) **Direct seeded rice (DSR)** - a system of cultivating rice in which seeds, either pre-germinated or dry, are broadcast or sown directly in the field under dry- or wetland condition; no transplanting process is involved;

(c) **IPCC approach** - the most recent version of the applicable IPCC guidance on methane emission from rice cultivation. The applicable version at the time of approval of the methodology ~~submission, this~~ is chapter 5.5, volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;

(d) **Project cultivation practice** - a set of elements of a cultivation practice which is adopted under the CDM project activity. This mainly consists of the adjusted irrigation method. Field preparation, fertilization and weed and pest control may also be included;

(e) **Water regime** - a combination of rice ecosystem type (e.g. irrigated, rainfed and deep water) and flooding pattern (e.g. continuously flooded, intermittently flooded);

(f) **Upland** - a type of water regime in which fields are never flooded for a significant period of time;



(g) **Irrigated** - a type of water regime in which fields are flooded for a significant period of time and water regime is fully controlled;

(h) **Rainfed and deep water** - a type of water regime in which fields are flooded for a significant period of time and water regime depends solely on precipitation.

8. For the purpose of defining reference field conditions for baseline and project emission measurements and their comparison with project fields, classify each project field with its specific pattern of cultivation conditions, applying the following parameters under Table 2:

**Table 2. Parameters for the definition of cultivation patterns**

| Nr. | Parameter | Type[a] | Values/categories | Source/method[b] |
|---|---|---|---|---|
| 1 | Water regime – on-season[c] | Dynamic | Continuously flooded | Baseline: Farmer's information<br>Project: Monitoring |
| | | | Single Drainage | |
| | | | Multiple Drainage | |
| 2 | Water regime – pre-season | Dynamic | Flooded | Baseline: Farmer's information<br>Project: Monitoring |
| | | | Short drainage (<180d) | |
| | | | Long drainage (>180d) | |

[2] IPCC approach provides for the ~~following~~ definitions (e) to (h) (see volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for further details).

| Nr. | Parameter | Type[a] | Values/categories | Source/method[b] |
|---|---|---|---|---|
| 3 | Organic Amendment | Dynamic | Straw on-season[d] | Baseline: Farmer's information<br>Project: Monitoring |
| | | | Green manure | |
| | | | Straw off-season[d] | |
| | | | Farm yard manure | |
| | | | Compost | |
| | | | No organic amendment | |
| 4 | Soil pH | Static | < 4.5 | ISRIC-WISE soil property database[e] or national data |
| | | | 4.5 – 5.5 | |
| | | | > 5.5 | |
| 5 | Soil Organic Carbon | Static | < 1% | ISRIC-WISE soil property database[e] or national data |
| | | | 1 – 3 % | |
| | | | > 3% | |
| 6 | Climate | Static | [AEZ][f] | Rice Almanac, HarvestChoice[f] |

Comments:

(a) Dynamic conditions are those that are connected to the management practice of a field, thus can change over time (no matter whether intended by the project activity or due to other reasons) and shall be monitored in the project fields. Static conditions are site-specific parameters that characterize a soil and do not (relevantly) change over time and thus do in principle only have to be determined once for a project and the corresponding fields;

(b) Source/method of data acquisition to determine the applicable value for each parameter;



(c) The values ‚upland', regular rainfed', drought prone' and deep water', which are regularly used to differentiate the on-season water regime (see IPCC guidelines), are not mentioned here, because these categories are excluded from a project activity under this methodology (cf. applicability criteria);

(d) Straw on-season means straw applied just before rice season, and straw off-season means straw applied in the previous season. Rice straw that was left on the surface and incorporated into soil just before the rice season is classified as straw on-season;

(e) For these static parameters, refer to appropriate global or national data. The database from ISRIC provides soil data which can be used for this purpose;

(f) Climate zone: use agroecological zones as shown in the Rice Almanac or by HarvestChoice.

9. With the help of this field characterization, project fields can be grouped according to their cultivation pattern. All fields with the same cultivation pattern form one group.

# 5. Baseline methodology

## 5.1. Project boundary

10. The geographic boundary encompasses the rice fields where the cultivation method and water regime are changed. The spatial extent of the project boundary includes all fields that change the cultivation method in the context of the project activity.

## 5.2. Baseline ~~emissions~~

11. The baseline scenario is the continuation of the current practice e.g. transplanted and continuously flooded rice cultivation in the project fields.

#### 5.2.1. Baseline emissions

12. The baseline emissions shall be calculated on a seasonal basis using the following formula:

$$BE_y = \sum_s BE_s \quad \text{Equation (1)}$$

$$BE_s = \sum_{g=1}^{G} EF_{BL,s,g} \times A_{s,g} \times 10^{-3} \times GWP_{CH4} \quad \text{Equation (2)}$$

Where:

| | | |
|---|---|---|
| $BE_y$ | = | Baseline emissions in year *y* (t $CO_2$e) |
| $BE_s$ | = | Baseline emissions from project fields in season *s* (t $CO_2$e) |
| $EF_{BL,s,g}$ | = | Baseline emission factor of group *g* in season *s* (kg$CH_4$/ha per season) |
| $A_{s,g}$ | = | Area of project fields of group *g* in season *s* (ha) |
| $GWP_{CH4}$ | = | Global warming potential of $CH_4$ (t $CO_2$e/t $CH_4$~~, use value of 21~~) |
| *g* | = | Group *g*, covers all project fields with the same cultivation pattern as determined with the help of Table 2 (*G* = total number of groups) |



### 5.3. Determination of baseline emission factor on reference fields

13. Baseline reference fields shall be set up in a way that they are representative of baseline emissions in the project rice fields. For each group of fields with the same cultivation pattern, as defined with the help of Table 2, at least three reference fields with the same pattern shall be determined in the project area. On these fields, measurements using the closed chamber method shall be carried out, each resulting in an emission factor expressed as kg$CH_4$/ha per season. The seasonally integrated baseline emission factor $EF_{BL,s,g}$ shall be derived as average value from the three measurements for each group (see the appendix for guidelines on methane measurement).

### 5.4. Leakage

14. Any effects of the project activity on GHG emissions outside the project boundary are deemed to be negligible and do not have to be considered under this methodology.

### 5.5. Project emissions

15. Project emissions consist of the $CH_4$ emissions, which will still be emitted under the changed cultivation practice. Due to the optimized *N* fertilization practice (cf. applicability

criteria in paragraph 3 (d) ~~above~~, *N* fertilizer control), $N_2O$ emissions do not significantly deviate from the baseline emissions and hence are not considered.

16. $CH_4$ emissions from project fields are calculated on a seasonal basis as follows:

$$PE_y = \sum_s PE_s \qquad \text{Equation (3)}$$

$$PE_s = \sum_{g=1}^{G} EF_{P,s,g} \times A_{s,g} \times 10^{-3} \times GWP_{CH4} \qquad \text{Equation (4)}$$

Where:

| | | |
|---|---|---|
| $PE_y$ | = | Project emissions in year *y* (t $CO_2$e) |
| $PE_s$ | = | Project emissions from project fields in season *s* (t $CO_2$e) |
| $EF_{P,s,g}$ | = | Project emission factor of group *g* in season *s* (kg$CH_4$/ha per season) |

### 5.6. Determination of project emission factor on reference fields



17. The seasonally integrated project emission factor $EF_{P,s,g}$ shall be determined using measurements on at least three project reference fields that fulfil the same conditions as the baseline reference fields, with the difference that they are cultivated according to the defined project cultivation practice. Project reference fields shall be established close to the baseline reference fields and begin with the growing season at the same time. $EF_{P,s,g}$ is the average of the measurement results from the three reference fields.

## 6. Monitoring methodology

### 6.1. Emission reductions

18. The emission reductions achieved by the project activity shall be calculated as the difference between the baseline and the project emissions.

$$ER_s = BE_s - PE_s \qquad \text{Equation (5)}$$

Where:

| | | |
|---|---|---|
| $ER_s$ | = | Emission reductions in season s (t $CO_2$e) |

#### 6.1.1. Ex ante estimation of emission reductions

19. For the ex ante estimation of emission reductions within the project design document (PDD), project participants shall either refer to own field experiments or estimate

baseline and project emissions with the help of national data or IPCC tier 1 default values for emission and scaling factors. The approach shall be explained and justified in the PDD.

### 6.1.2. Emission reductions using IPCC tier 1 approach or default values

20. As an alternative to the reference field approach indicated in paragraphs 12, 13, 16 and 17, project participants may calculate emission reductions using one of the following two simplified approaches (i.e. **Option 1** or **Option 2** ):

21. **Option 1:** using the IPCC tier 1 approach with measurement of baseline emission factors for continuously flooded fields, as per the following formula:

$$ER_y = EF_{ER} \times A_y \times L_y \times 10^{-3} \times GWP_{CH4}$$ Equation (6)

$$EF_{ER} = EF_{BL} - EF_P$$ Equation (7)

$$EF_{BL} = EF_{BL,c} \ x \ SF_{BL,w} \ x \ SF_{BL,p} \ x \ SF_{BL,o}$$ Equation (8)

$$EF_P = EF_{BL,c} \ x \ SF_{P,w} \ x \ SF_{P,p} \ x \ SF_{P,o}$$ Equation (9)

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Where:

| | | |
|---|---|---|
| $ER_y$ | = | Emission reductions in year *y* (t $CO_2$e) |
| $EF_{ER}$ | = | Adjusted daily emission factor (kg$CH_4$/ha/day) |
| $A_y$ | = | Area of project fields in year *y* (ha) |
| $L_y$ | = | Cultivation period of rice in year *y* (days/year) |
| $GWP_{CH4}$ | = | Global warming potential of $CH_4$ (t $CO_2$e/t $CH_4$) |
| $EF_{BL}$ | = | Baseline emission factor (kg$CH_4$/ha/day) |
| $EF_P$ | = | Project emission factor (kg$CH_4$/ha/day) |
| $EF_{BL,c}$ | = | Baseline emission factor for continuously flooded fields without organic amendments (kg$CH_4$/ha/day) |
| $SF_{BL,w}$ or $SF_{P,w}$ | = | Baseline or project scaling factors[3] to account for the differences in water regime during the cultivation period |

[3] For all scaling factors used in the methodology, the average values in 2006 IPCC Guidelines for National Greenhouse Gas Inventories are chosen. Uncertainties related to scaling factors may be considered in the future revision of the methodology.

| | | |
|---|---|---|
| $SF_{BL,p}$ or $SF_{P,p}$ | = | Baseline or project scaling factors to account for the differences in water regime in the pre-season before the cultivation period |
| $SF_{BL,o}$ or $SF_{P,o}$ | = | Baseline or project scaling factors should vary for both type and amount of organic amendment applied |

22. The baseline emission factor for continuously flooded fields without organic amendments ($EF_{BL,c}$) shall be either determined ex ante prior to the start of the project activity (in this case, the ex ante value should be used to calculate emissions reduction during the crediting period) or monitored annually (in this case, the ex post values should be used to calculate emissions reduction during the crediting period). At least three reference fields shall be determined in the project area. On these fields, measurements shall be carried out using the closed chamber method in accordance with the guidance on methane measurement in the appendix.

23. Alternatively, the baseline emission factor for continuously flooded fields with organic amendments may be determined. In this case, scaling factors to account for organic amendments ($SF_{BL,o}$ or $SF_{P,o}$) shall not be applied in the equations (8) and (9) above.

24. IPCC default for $SF_{BL,w}$ or $SF_{P,w}$ is as follows:

**Table 3. IPCC default values for $SF_{BL,w}$ or $SF_{P,w}$**

| Water regime during the cultivation period | | $SF_{BL,w}$ or $SF_{P,w}$ |
|---|---|---|
| Irrigated | Continuously flooded | 1 |
| | Intermittently flooded - single aeration | 0.60 |
| | Intermittently flooded - multiple aeration | 0.52 |

[(a)] Source: IPCC 2006, volume 4, chapter 5.5, Table 5.12

1. Continuously flooded: Fields have standing water throughout the rice growing season and may only dry out for harvest (end-season drainage).
2. Intermittently flooded: fields have at least one aeration period of more than three days during the cropping season;
   (a) Single aeration: fields have a single aeration during the cropping season at any growth stage (except for end-season drainage);
   (b) Multiple aeration: fields have more than one aeration period during the cropping season (except for end-season drainage).

25. IPCC default for $SF_{BL,p}$ or $SF_{P,p}$ is provided in the following table. For regions/countries where it can be demonstrated by host country governments or peer-reviewed literatures that double cropping is practiced, a default value of 1.0 is used. Otherwise, 0.68 is used.

**Table 4. IPCC default values for** $SF_{BL,p}$ or $SF_{P,p}$

| **Water regime prior to rice cultivation** | $SF_{BL,p}$ or $SF_{P,p}$ |
|---|---|
| Non flooded pre-season < 180 days (indicating double cropping) | 1 |
| Non flooded pre-season > 180 days (indicating single cropping) | 0.68 |

[a] Source: IPCC 2006, volume 4, chapter 5.5, Table 5.13.

26. IPCC default for $SF_{BL,o}$ or $SF_{P,o}$ is calculated as follows:

$$SF_o = \left(1 + \sum_i ROA_i \; x \; CFOA_i\right)^{0.59}$$ Equation (10)

Where:

| | | |
|---|---|---|
| $ROA_i$ | = | Application rate of organic amendment type *i*, in dry weight for straw and fresh weight for others, tonne ha$^{-1}$.<br>5 tonne/ha of straw is assumed as the baseline quantity of organic amendment, because the value of leftover straw after harvest is in the range of 3 tonne/ha (when harvested manually to the ground level, leaving very little stubble and the root residues) to 7 tonne/ha (harvested mechanically leaving behind large amount of crop residues on the field) |
| $CFOA_i$ | = | Conversion factor for organic amendment type *i* (in terms of its relative effect with respect to straw applied shortly before cultivation.<br>0.29 is used for a single crop and 1.0 for a double crop.[4] |

27. Accordingly, default for $SF_{BL,o}$ or $SF_{P,o}$ is provided in the following table.

[4] For a single crop, where the rice straw is usually ploughed back to the soil after the harvest of the crop and as such rice straw is left for long time (i.e. rice straw is incorporated for a duration of > 30 days before cultivation), the straw is already mineralized being left in the dry field and the readily fermentable C component of the rice straw is less at flooding. This gives rise to lesser methane production when the soil is flooded for cultivation, therefore, 0.29 is used.

On the contrary, when rice straw is incorporated for a duration < 30 days before the cultivation (a double crop situation), the rice straw is still not mineralized and the readily fermentable C contents of the rice straw results in the formation of higher quantity of methane production, therefore, 1.0 is used. Moreover, the soil characteristics when a second crop follows an earlier one favour larger methane production.

**Table 5. IPCC default values for $SF_{BL,o}$ or $SF_{P,o}$**

| **Water regime prior to rice cultivation** | $SF_{BL,o}$ or $SF_{P,o}$ | |
|---|---|---|
| Non flooded pre-season < 180 days (indicating double cropping) | 2.88 | $SF_{BL,o}$ or $SF_{P,o}$ = $(1 + 5 \times 1)^{0.59}$ = 2.88 |
| Non flooded pre-season > 180 days (indicating single cropping) | 1.70 | $SF_{BL,o}$ or $SF_{P,o}$ = $(1 + 5 \times 0.29)^{0.59}$ = 1.70 |

[a] Source: calculated using equation (10) with default values from IPCC 2006, volume 4, chapter 5.5, Table 5.14.

28. The above table is for rice straw only. To include other organic amendments following IPCC 2006 Table 5.14, the data will be:

(a) For compost, the $SF_{BL,o}$ or $SF_{P,o}$ will be $(1 + C \times 0.05)^{0.59}$;

(b) For farm yard manure, the $SF_{BL,o}$ or $SF_{P,o}$ will be $(1 + YM \times 0.14)^{0.59}$;

(c) For green manure, the $SF_{BL,o}$ or $SF_{P,o}$ will be $(1 + GM \times 0.50)^{0.59}$.

(d) C, YM, GM are application rate (tonne ha-1) of compost, farm yard manure, and green manure, respectively.



29. The calculation of specific emission factor for the baseline ($EF_{BL}$) and for the project activity ($EF_P$) ($kgCH_4$/ha/day) is summarized in the table below.

**Table 6. Specific emission factors for baseline, project and emission reductions (kgCH$_4$/ha/day)**

| | $EF_{BL,c}$ | **Baseline** | | | | **Project scenarios** | **Project** | | | | **Emission reduction factor ($EF_{ER}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $SF_{BL,w}$ | $SF_{BL,p}$ | $SF_{BL,o}$ | **Emission factor** ($EF_{BL}$) | | $SF_{P,w}$ | $SF_{P,p}$ | $SF_{P,o}$ | **Emission factor** ($EF_P$) | |
| For regions/ countries where double cropping is practiced | $EF_{BL,c}$ | 1.00 | 1.00 | 2.88 | $EF_{BL,c}$ x 2.88 | **Scenario 1:** change the water regime from continuously to intermittent flooded conditions (single aeration) | 0.60 | 1.00 | 2.88 | $EF_{BL,c}$ x 1.73 | $EF_{BL,c}$ x 1.15 |
| | | | | | | **Scenario 2:** change the water regime from continuously to intermittent flooded conditions (multiple aeration) | 0.52 | 1.00 | 2.88 | $EF_{BL,c}$ x 1.50 | $EF_{BL,c}$ x 1.38 |
| For regions/ countries where single cropping is practiced | $EF_{BL,c}$ | 1.00 | 0.68 | 1.70 | $EF_{BL,c}$ x 1.16 | **Scenario 1:** change the water regime from continuously to intermittent flooded conditions (single aeration) | 0.60 | 0.68 | 1.70 | $EF_{BL,c}$ x 0.69 | $EF_{BL,c}$ x 0.46 |
| | | | | | | **Scenario 2:** change the water regime from continuously to intermittent flooded conditions (multiple aeration) | 0.52 | 0.68 | 1.70 | $EF_{BL,c}$ x 0.60 | $EF_{BL,c}$ x 0.55 |

30. **Option 2:** using global default values derived from IPCC tier 1 approach. ~~as per the following formula:~~

$$ER_y = EF_{ER} \times A_y \times L_y \times 10^{-3} \times GWP_{CH4}$$ ~~Equation (11)~~

~~Where:~~

| | | |
|---|---|---|
| $ER_y$ | = | ~~Emission reductions in year y ($tCO_2e$)~~ |
| $EF_{ER}$ | = | ~~Adjusted daily emission factor ($kgCH_4$/ha/day)~~ |
| $A_y$ | = | ~~Area of project fields in year y (ha)~~ |
| $L_y$ | = | ~~Cultivation period of rice in year y (days/year)~~ |
| $GWP_{CH4}$ | = | ~~Global warming potential of CH4 ($tCO_2e/tCH_4$, use value of 21)~~ |

31. Emission reductions shall be calculated, as per the equation (6), using default values of adjusted daily emission factor $EF_{ER}$ ($kgCH_4$/ha/day) ~~are~~ given below in different project scenarios:[5]

(a) For regions/countries where double cropping is practiced:

(i) Use 1.50 ($kgCH_4$/ha/day) for project activities that shift to intermittent flooding (single aeration);

(ii) Use 1.80 ($kgCH_4$/ha/day) for project activities that shift to intermittent flooding (multiple aeration);

(b) For regions/countries where single cropping is practiced:

(i) Use 0.60 ($kgCH_4$/ha/day) for project activities that shift to intermittent flooding (single aeration);

(ii) Use 0.72 ($kgCH_4$/ha/day) for project activities that shift to intermittent flooding (multiple aeration).

32. The default values above consider the rice straw on field as the only organic amendment inputs. Other organic amendments such as compost, farm yard manure and green manure, which have been used in the pre-project scenario, may continue to be applied at the same or a lower rate during the crediting period, but do not affect the emission reductions estimated using the default values.

### 6.1.3. Monitoring of baseline and project emissions

33. The following parameters shall be monitored as per the below. The applicable requirements specified in the "General guidelines ~~to~~ for SSC CDM methodologies" (e.g.

[5] Under this option, $EF_{BL,c}$ = 1.30 ($kgCH_4$/ha/day) from IPCC 2006, volume 4, chapter 5.5, Table 5.11. is used in Table 6 to derive at $EF_{ER}$ .

calibration requirements, sampling requirements) shall be taken into account by the project participants.

**Data / Parameter table 1.**

| **Data / Parameter:** | $EF_{BL,s,g}$ |
|---|---|
| Data unit: | $kgCH_4$/ha per season |
| Description: | Baseline emission factor |
| Source of data: | - |
| Measurement procedures (if any): | As per the instructions in the appendix (Guidelines for measuring methane emissions from rice fields) and IPCC 2006, volume 4, chapter 5.5. |
| Monitoring frequency: | Regular measurements as per closed chamber method guidance, seasonally integrated |
| QA/QC procedures: | - |
| Any comment: | - |

**Data / Parameter table 2.**

| **Data / Parameter:** | $EF_{BL,c}$ |
|---|---|
| Data unit: | $kgCH_4$/ha/day |
| Description: | Baseline emission factor for continuously flooded fields without organic amendments |
| Source of data: | - |
| Measurement procedures (if any): | As per the instructions in the appendix (Guidelines for measuring methane emissions from rice fields) and IPCC 2006, volume 4, chapter 5.5. |
| Monitoring frequency: | Determined ex ante prior to the start of the project activity (in this case, the ex ante value should be used to calculate emissions reduction during the crediting period) or monitored annually |
| QA/QC procedures: | - |
| Any comment: | - |



**Data / Parameter table 3.**

| **Data / Parameter:** | $EF_{P,s,g}$ |
|---|---|
| Data unit: | $kgCH_4$/ha per season |
| Description: | Project emission factor |
| Source of data: | - |
| Measurement procedures (if any): | As per the instructions in the appendix (Guidelines for measuring methane emissions from rice fields) and IPCC 2006, volume 4, chapter 5.5. |
| Monitoring frequency: | Regular measurements as per closed chamber method guidance, seasonally integrated |
| QA/QC procedures: | - |
| Any comment: | - |

**Data / Parameter table 4.**

| **Data / Parameter:** | **$A_{s,g}$** |
|---|---|
| Data unit: | ha |
| Description: | Aggregated project area in a given season *s*. Only compliant farms are considered (see paragraph 34) |
| Source of data: | - |
| Measurement procedures (if any): | To be determined by collecting the project field sizes in a project database. The size of project fields shall be determined by GPS or satellite data. Should such technologies not be available, established field size measurement approaches shall be used provided that uncertainties are taken into account in a conservative manner |
| Monitoring frequency: | Every season |
| QA/QC procedures: | - |
| Any comment: | - |

**Data / Parameter table 5.**

| **Data / Parameter:** | **$A_y$** |
|---|---|
| Data unit: | ha |
| Description: | Aggregated project area in year *y*. Only compliant farms are considered |
| Source of data: | - |
| Measurement procedures (if any): | This parameter is only required for ~~the default value~~ approaches in paragraph 21 and 31.<br>To be determined by collecting the project field sizes in a project database. The size of project fields shall be determined by GPS or satellite data. Should such technologies not be available, established field size measurement approaches shall be used provided that uncertainties are taken into account in a conservative manner |
| Monitoring frequency: | Every year |
| QA/QC procedures: | - |
| Any comment: | - |



**Data / Parameter table 6.**

| **Data / Parameter:** | **Ly** |
|---|---|
| Data unit: | days/year |
| Description: | Cultivation period of rice in year *y* |
| Source of data: | - |
| Measurement procedures (if any): | This parameter is only required for ~~the default value~~ approaches in paragraph 21 and 31.<br>To be determined using cultivation logbooks |
| Monitoring frequency: | Every year |
| QA/QC procedures: | - |
| Any comment: | - |

#### 6.1.4. Monitoring of farmers' compliance with project cultivation practice

34. In order to determine whether the project fields are cultivated according to the project cultivation practice as defined by the project activity, and thus assure that measurements on the reference fields are representative for the emissions from the project fields, a cultivation logbook shall be maintained for all project fields. With the help of the logbook, all parameters that are part of the project cultivation practice, and at least the following, shall be documented by the farmers:

(a) Sowing (date);

(b) Fertilizer, organic amendments, and crop protection application (date and amount);

(c) Water regime on the field (e.g. "dry/moist/flooded") and dates where the water regime is changed from one status to another;

(d) Yield.

35. In addition, farmers shall state whether they have followed fertilization recommendations provided with the introduction of the adjusted water management practice.

36. Project proponents shall assure that the project reference fields are cultivated in a way that they represent the ranges of cultivation practice elements on the project fields in a conservative manner with respect to methane emissions. Should farmers relevantly deviate from the defined project cultivation practice, so that their fields cannot be deemed to be represented by the reference fields any more, those fields shall not be taken into account for the determination of the aggregated project area $A_{s,g}$ of that season. This requirement shall assure that only those farms are considered for the calculation of emission reductions which do actually comply with the project cultivation practice.

37. Reporting and verification shall be done on the basis of samples of the log-books from the farmers, according to the latest version of the "Standard for sampling and surveys for CDM project activities and programme of activities".

38. Project proponents shall set up a database which holds data and information that allow an unambiguous identification of participating rice farms, including name and address of the rice farmer, size of the field and, if applicable, additional farm specific information as defined above.

### 6.2. Project activity under a programme of activities

39. The methodology is applicable to a programme of activities, no additional leakage estimations are necessary other than that indicated under leakage section above.

# Appendix. Guidelines for measuring methane emissions from rice fields

1. The implementation of methane measurement in rice fields requires the involvement of experts in this field or at least experienced staff trained by experts (i.e. from research institutions). These guidelines cannot replace expertise in setting up chamber measurements. They rather set minimum requirements that serve for standardizing the conditions under which methane emissions are measured for projects under this methodology.

2. Project proponents shall prepare a detailed plan for the seasonal methane measurements before the start of the season. The plan shall include the schedule for the field and laboratory measurements, the logistics that are necessary to get the gas samples to the laboratory and a cropping calendar. The plan shall also include all reference field specific information regarding location and climate, soil, water management, plant characteristics, fertilizer treatment and organic amendments.

3. The following guidance is structured according to the steps from field measurement to emission factor calculation. Project proponents shall make sure that the measurements on project and baseline reference fields are carried out in an equal manner and simultaneously.



**Table 1. On the field - technical options for the chamber design**

| Feature | Conditions | |
|---|---|---|
| Chamber material | Option 1: Non-transparent<br>• Commercially available PVC containers or manufactured chambers (e.g. using galvanized iron);<br>• Painted white or covered with reflective material (to prevent increasing inside temperature);<br>• Only suitable for short-term exposure (typically 30 min) followed by immediate removal from the field | Option 2: Transparent<br>• Manufactured chambers using acrylic glass;<br>• Advantage of transparent chambers: could be placed for longer time spans on the field if equipped with a lid that remains open between measurements and is only closed during measurements |
| Placement in soil | Option 1: Fixed base<br>• Base made of non-corrosive material and remains in the field for the whole season;<br>• Base should allow tight sealing of the chamber;<br>• Base should have bores in the submerged section to allow water exchange between inside and outside;<br>• Base should be installed at least 24 hours before the first sampling | Option 2: Without base<br>• Chamber have to be placed on the soil with open lid to allow escape of eventual ebullition |

<table>
<tr><th>Feature</th><th colspan="2">Conditions</th></tr>
<tr><td>Auxiliaries of chamber</td><td colspan="2">• Thermometer for measuring the temperature inside the chamber;<br>• Fan (battery operated) inside the chamber for mix the inside air during sampling;<br>• Sampling port (rubber stopper placed in a bore of the chamber)</td></tr>
<tr><td>Basal area</td><td colspan="2">Rectangular or rounded, but has to cover minimum of four rice hills (ca. 0.1 m² minimum)</td></tr>
<tr><td>Height</td><td>Option 1: Fixed height<br>Total height (protruding base + chamber) should exceed plant height</td><td>Option 2: Flexible height<br>• Adjustable to plant height;<br>• Chambers with different heights or modular design</td></tr>
</table>

**Table 2. On the field – air sampling**

| Feature | Conditions |
|---|---|
| Replicate chambers per plot | Minimum requirement: Three replicate chambers per plot |
| Number of air samples per exposure / data points per measurement | Minimum requirement: Three samples per exposure |
| Exposure time | 30 minutes |
| Daytime of measurement | Morning |
| Measurement interval | Minimum requirement: once per week |
| Syringe | Suitability test (leak proof) before measurement<br>Preferably equipped with a lock for ease of handling |
| Sample storage until analysis | • Storage < 24 h: air samples can remain in syringe;<br>• Storage > 24 h: transfer air samples into evacuated vial, store with slight overpressure |



**Table 3. Laboratory analysis**

| Feature | Conditions |
|---|---|
| Method | Gas Chromatograph with flame ionization detector (FID) |
| Injection | Direct injection or with multi-port valve and sample loop |
| Column | Packed (e.g. molecular sieve) or capillary column |
| Calibration | With certified standard gas each day of analysis before and after the analyses are done |

## 1. Calculation of the emission rate for a plot (reference field)

4. For each gas analysis, calculate the mass of $CH_4$ emissions with the help of the following formula:

$$m_{CH4,t} = c_{CH4,t} \times V_{Chamber} \times M_{CH4} \times \frac{1atm}{R \times T_t \times 1000}$$ Equation (1)

Where:

| | | |
|---|---|---|
| $m_{CH4,t}$ | = | Mass of $CH_4$ in chamber at time t (mg) |
| $t$ | = | Point of time of sample (e.g. 0, 15, 30 in case of three samples within 30 minutes) |
| $c_{CH4,t}$ | = | $CH_4$ concentration in chamber at time t, from gas analysis (ppm) |
| $V_{Chamber}$ | = | Chamber volume (L) |
| $M_{CH4}$ | = | Molar mass of $CH_4$: 16 g/mol |
| $1atm$ | = | Assume constant pressure of 1atm, unless pressure measurement is installed |
| $R$ | = | Universal gas constant: 0,08206 L atm K-1 mol-1 |
| $T_t$ | = | Temperature at time t (K) |

5. Determine the slope of the line of best fit for the values of over time with the help of software (e.g. Excel):

$$s = \frac{\Delta m_{CH4}}{\Delta t}$$ Equation (2)



Where:

| | | |
|---|---|---|
| $s$ | = | Slope of line of best fit (mg/min) |

6. Calculate the emission rate per hour for one chamber measurement:

$$RE_{ch} = s \times 60min / A_{Chamber}$$ Equation (3)

Where:

| | | |
|---|---|---|
| $RE_{ch}$ | = | Emission rate of chamber *ch* (mg/h × m²) |
| $ch$ | = | Index for replicate chamber on a plot |
| $A_{Chamber}$ | = | Chamber area (m²) |

7. Calculate the average emission rate of a chamber measurement per plot:

$$RE_{plot} = \frac{\sum_{ch=1}^{Ch} RE_{ch}}{Ch}$$ Equation (4)

Where:

| | | |
|---|---|---|
| $RE_{plot}$ | = | Average emission rate of a plot (mg/h $\times$ m²) |
| $Ch$ | = | Number of replicate chambers per plot |

8. Further procedure: from the average emission rates per plot of each chamber measurement, derive the seasonally integrated emission factor by integration of the measurement results over the season length. The simplest way of integration is multiplying the emission rate with the number of hours of the measurement interval (e.g. one week) and accumulating the results of every measurement interval over the season. Convert from mg/m² to kg/ha by multiplying with 0.01.

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## Document information

| Version | Date | Description |
|---|---|---|
| Draft 04.0 | 5 September 2014 | SSC WG 45, Annex 6<br>A call for public input will be issued on the draft revised methodology.<br>The revision takes into account the proposed standardized baseline “Standardized Baseline for Methane Emissions from Rice Cultivation”, and introduces a simplified option for emission reductions calculation, with the aim of reducing transaction costs especially for those in the regions which are underrepresented in the CDM. |
| 03.0 | 20 July 2012 | EB 68, Annex 24<br>The revision includes a simplified approach to calculate emission reductions using default values derived from IPCC tier 1 approach, as an alternative to the reference field approach. |
| 02.0 | 2 March 2012 | EB 66, Annex 59<br>The revision allows for an alternative procedure to ensure efficient fertilization. |
| 01.0 | 15 April 2011 | EB 60, Annex 16<br>Initial adoption. |

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