



**Indicative simplified baseline and monitoring methodologies  
for selected small-scale CDM project activity categories**

**TYPE III - OTHER PROJECT ACTIVITIES**

Project participants shall apply the general guidelines to small-scale (SSC) clean development mechanism (CDM) methodologies, Guidelines on the demonstrating of additionality of SSC 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*.

**III.AU Methane emission reduction by adjusted water management practice in rice cultivation**

**Technology/measure**

1. The methodology comprises technology/measures that result in reduced anaerobic decomposition of organic matter in rice cropping soils and thus reduced generation of methane. 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. Alternate wetting and drying method and aerobic rice cultivation methods are covered (see <<http://www.knowledgebank.irri.org/watermanagement>>). Rice farms that change their rice cultivation practice from transplanted to direct seeded rice are included.<sup>1</sup>

2. For the purpose of this methodology the following definitions 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. At the time of 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;

IPCC approach provides for the following definitions (see volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for further details):

<sup>1</sup> A switch from transplanted rice with continuously flooded fields to 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”).



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- (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:** Fields are never flooded for a significant period of time;
  - (g) **Irrigated:** Fields are flooded for a significant period of time and water regime is fully controlled;
  - (h) **Rainfed and deep water:** Fields are flooded for a significant period of time and water regime depends solely on precipitation.
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 amendments, so that all dynamic parameters as shown in Table 1 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) Excepting the case where the default value approach indicated in paragraph 15 is chosen for emission reductions calculations, project proponents have access to



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infrastructure to measure CH<sub>4</sub> 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<sub>2</sub> equivalent.

4. 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:

**Table 1: Parameters for the definition of cultivation patterns**

Nr.	Parameter	Type <sup>a</sup>	Values/Categories	Source/Method <sup>b</sup>
1	Water regime – on-season <sup>c</sup>	Dynamic	Continuously flooded	Baseline: Farmer's information Project: Monitoring
			Single Drainage	
			Multiple Drainage	
2	Water regime – pre-season	Dynamic	Flooded	Baseline: Farmer's information Project: Monitoring
			Short drainage (<180d)	
			Long drainage (>180d)	
3	Organic Amendment	Dynamic	Straw on-season <sup>d</sup>	Baseline: Farmer's information Project: Monitoring
			Green manure	
			Straw off-season <sup>d</sup>	
			Farm yard manure	
			Compost	
			No organic amendment	
4	Soil pH	Static	< 4.5	ISRIC-WISE soil property database <sup>e</sup> or national data
			4.5 – 5.5	
			> 5.5	
5	Soil Organic Carbon	Static	< 1%	ISRIC-WISE soil property database <sup>e</sup> or national data
			1 – 3 %	
			> 3%	
6	Climate	Static	[AEZ] <sup>f</sup>	Rice Almanac, HarvestChoice <sup>f</sup>

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);



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- (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

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.

### **Boundary**

5. 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.

### **Baseline**

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

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

$$BE_y = \sum_s BE_s \quad (1)$$

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

Where:

$BE_y$  Baseline emissions in year  $y$  (tCO<sub>2</sub>e)

$BE_s$  Baseline emissions from project fields in season  $s$  (tCO<sub>2</sub>e)

$EF_{BL,s,g}$  Baseline emission factor of group  $g$  in season  $s$  (kgCH<sub>4</sub>/ha per season)

$A_{s,g}$  Area of project fields of group  $g$  in season  $s$  (ha)

$GWP_{CH4}$  Global warming potential of CH<sub>4</sub> (tCO<sub>2</sub>e/tCH<sub>4</sub>, use value of 21)

$g$  Group  $g$ , covers all project fields with the same cultivation pattern as determined with the help of table 1 ( $G$  = total number of groups)



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#### **Determination of baseline emission factor on reference fields**

8. 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 1, 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 kgCH<sub>4</sub>/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 appendix I for guidelines on methane measurement).

#### **Leakage**

9. 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.

#### **Project emissions**

10. Project emissions consist of the CH<sub>4</sub> emissions, which will still be emitted under the changed cultivation practice. Due to the optimized N fertilization practice (cf. applicability criteria above, N fertilizer control), N<sub>2</sub>O emissions do not significantly deviate from the baseline emissions and hence are not considered.

11. CH<sub>4</sub> emissions from project fields are calculated on a seasonal basis as follows:

$$PE_y = \sum_s PE_s \quad (3)$$

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

Where:

$PE_y$  Project emissions in year  $y$  (tCO<sub>2</sub>e)

$PE_s$  Project emissions from project fields in season  $s$  (tCO<sub>2</sub>e)

$EF_{P,s,g}$  Project emission factor of group  $g$  in season  $s$  (kgCH<sub>4</sub>/ha per season)

#### **Determination of project emission factor on reference fields**

12. 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



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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.

#### **Monitoring**

##### **Emission reductions**

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

$$ER_s = BE_s - PE_s \quad (5)$$

Where:

$$ER_s \quad \text{Emission reductions in season } s \text{ (tCO}_2\text{e)}$$

##### **Ex ante estimation of emission reductions**

14. For the ex ante estimation of emission reductions within the 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.

##### **Emission reductions using default values**

15. As an alternative to the reference field approach indicated in paragraphs 7, 8, 11 and 12, project participants may calculate emission reductions using default values derived from IPCC tier 1 approach, as per the following formula:

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

Where:

$$ER_y \quad \text{Emission reductions in year } y \text{ (tCO}_2\text{e)}$$

$$EF_{ER} \quad \text{Adjusted daily emission factor (kgCH}_4\text{/ha/day)}$$

$$A_y \quad \text{Area of project fields in year } y \text{ (ha)}$$

$$L_y \quad \text{Cultivation period of rice in year } y \text{ (days/year)}$$

$$GWP_{CH4} \quad \text{Global warming potential of CH}_4 \text{ (tCO}_2\text{e/tCH}_4\text{, use value of 21)}$$

16. Default values of adjusted daily emission factor  $EF_{ER}$  (kgCH<sub>4</sub>/ha/day) are given below in different project scenarios:



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- (a) For regions/countries where double cropping is practiced:
  - (i) Use 1.50 (kgCH<sub>4</sub>/ha/day) for project activities that shift to intermittent flooding (single aeration);
  - (ii) Use 1.80 (kgCH<sub>4</sub>/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<sub>4</sub>/ha/day) for project activities that shift to intermittent flooding (single aeration);
  - (ii) Use 0.72 (kgCH<sub>4</sub>/ha/day) for project activities that shift to intermittent flooding (multiple aeration).

17. 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.

#### **Monitoring of baseline and project emissions**

18. The following parameters shall be monitored as per the Table 2 below. The applicable requirements specified in the “General Guidelines to SSC CDM methodologies” (e.g. calibration requirements, sampling requirements) shall be taken into account by the project participants.

**Table 2: Monitoring parameters**

No	Parameter	Description	Unit	Monitoring/ recording frequency	Measurement methods and procedures
1.	$EF_{BL, s, g}$	Baseline Emission Factor	kgCH <sub>4</sub> /ha per season	Regular measurements as per closed chamber method guidance, seasonally integrated	As per the instructions in appendix I (Guidelines for measuring methane emissions from rice fields) and chapter 5.5.5 of the IPCC guidelines
2.	$EF_{P, s, g}$	Project Emission Factor	kgCH <sub>4</sub> /ha per season	Regular measurements as per closed chamber method guidance, seasonally integrated	As per the instructions in appendix I (Guidelines for measuring methane emissions from rice fields) and chapter 5.5.5 of the IPCC guidelines
3.	$A_{s, g}$	Aggregated project area in a given season $s$ . Only compliant farms are	ha	Every season	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

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No	Parameter	Description	Unit	Monitoring/ recording frequency	Measurement methods and procedures
		considered (see paragraph 19)			technologies not be available, established field size measurement approaches shall be used provided that uncertainties are taken into account in a conservative manner
4.	$A_y$	Aggregated project area in year $y$ . Only compliant farms are considered	ha	Every year	This parameter is only required for the default value approach in paragraph 15. 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
5	$L_y$	Cultivation period of rice in year $y$	days/year	Every year	This parameter is only required for the default value approach in paragraph 15. To be determined using cultivation logbooks

**Monitoring of farmers' compliance with project cultivation practice**

19. 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);



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- (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.
20. In addition, farmers shall state whether they have followed fertilization recommendations provided with the introduction of the adjusted water management practice.
21. 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.
22. 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”.
23. 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.

### **Project activity under a programme of activities**

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



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## Appendix I

### **GUIDELINES FOR MEASURING METHANE EMISSIONS FROM RICE FIELDS**

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.

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.

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.

#### **On the field - technical options for the chamber design**

Feature	Conditions
Chamber material	<p>Option 1: Non-transparent</p> <ul style="list-style-type: none"><li>Commercially available PVC containers or manufactured chambers (e.g. using galvanized iron);</li><li>Painted white or covered with reflective material (to prevent increasing inside temperature);</li><li>Only suitable for short-term exposure (typically 30 min) followed by immediate removal from the field</li></ul> <p>Option 2: Transparent</p> <ul style="list-style-type: none"><li>Manufactured chambers using acrylic glass;</li><li>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</li></ul>



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Feature	Conditions
Placement in soil	Option 1: Fixed base <ul style="list-style-type: none"> <li>• Base made of non-corrosive material and remains in the field for the whole season;</li> <li>• Base should allow tight sealing of the chamber;</li> <li>• Base should have bores in the submerged section to allow water exchange between inside and outside;</li> <li>• Base should be installed at least 24 hours before the first sampling</li> </ul> Option 2: Without base <ul style="list-style-type: none"> <li>• Chamber have to be placed on the soil with open lid to allow escape of eventual ebullition</li> </ul>
Auxiliaries of chamber	<ul style="list-style-type: none"> <li>• Thermometer for measuring the temperature inside the chamber;</li> <li>• Fan (battery operated) inside the chamber for mix the inside air during sampling;</li> <li>• Sampling port (rubber stopper placed in a bore of the chamber)</li> </ul>
Basal area	Rectangular or rounded, but has to cover minimum of four rice hills (ca. 0.1 m <sup>2</sup> minimum)
Height	Option 1: Fixed height Total height (protruding base + chamber) should exceed plant height Option 2: Flexible height <ul style="list-style-type: none"> <li>• Adjustable to plant height;</li> <li>• Chambers with different heights or modular design</li> </ul>

**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 Preferably equipped with a lock for ease of handling
Sample storage until analysis	<ul style="list-style-type: none"> <li>• Storage &lt; 24 h: air samples can remain in syringe;</li> <li>• Storage &gt; 24 h: transfer air samples into evacuated vial, store with slight overpressure</li> </ul>



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**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

**Calculation of the emission rate for a plot (reference field)**

- For each gas analysis, calculate the mass of CH<sub>4</sub> emissions with the help of the following formula:

$$m_{CH_4,t} = c_{CH_4,t} * V_{Chamber} * M_{CH_4} * \frac{1atm}{R * T_t * 1000} \quad (1)$$

Where:

$m_{CH_4,t}$  Mass of CH<sub>4</sub> 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)

$c_{CH_4,t}$  CH<sub>4</sub> concentration in chamber at time  $t$ , from gas analysis (ppm)

$V_{Chamber}$  Chamber volume (L)

$M_{CH_4}$  Molar mass of CH<sub>4</sub>: 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)

- Determine the slope of the line of best fit for the values of  $M_{CH_4}$  over time with the help of software (e.g. Excel):

$$s = \frac{\Delta m_{CH_4}}{\Delta t} \quad (2)$$

Where:

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



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

$$RE_{ch} = s * 60\text{min} / A_{Chamber} \quad (3)$$

Where:

$RE_{ch}$  Emission rate of chamber  $ch$  (mg/h \* m<sup>2</sup>)

$ch$  Index for replicate chamber on a plot

$A_{Chamber}$  Chamber area (m<sup>2</sup>)

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

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

Where:

$RE_{plot}$  Average emission rate of a plot (mg/h \* m<sup>2</sup>)

$Ch$  Number of replicate chambers per plot

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/m<sup>2</sup> to kg/ha by multiplying with 0.01.

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**History of the document**

Version	Date	Nature of revision(s)
03.0	20 July 2012	EB 68, Annex 24 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	EB 66, Annex 59 2 March 2012	The revision allows for an alternative procedure to ensure efficient fertilization.
01	EB 60, Annex 16 15 April 2011	Initial adoption.

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