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 SSC CDM methodologies, information on additionality (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.*

## *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.[1]

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):

[1] 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”).

(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) 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.

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[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) | |
| 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 |

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:

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

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

Where:

| | |
|---|---|
| $BE_y$ | Baseline emissions in year *y* ($tCO_2e$) |
| $BE_s$ | Baseline emissions from project fields in season *s* ($tCO_2e$) |
| $EF_{BL,s,g}$ | Baseline emission factor of group *g* in season *s* ($kgCH_4$/ha per season) |
| $A_{s,g}$ | Area of project fields of group *g* in season *s* (ha) |
| $GWP_{CH4}$ | Global warming potential of $CH_4$ ($tCO_2e/tCH_4$, 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) |

**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 $kgCH_4$/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 annex for guidance 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 $CH_4$ 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), $N_2O$ emissions do not significantly deviate from the baseline emissions and hence are not considered.

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

$$PE_y = \sum_s PE_s \quad \textbf{(3)}$$

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

Where:

| | |
|---|---|
| $PE_y$ | Project emissions in year *y* ($tCO_2e$) |
| $PE_s$ | Project emissions from project fields in season *s* ($tCO_2e$) |
| $EF_{P,s,g}$ | Project emission factor of group *g* in season *s* ($kgCH_4$/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

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.

$$ER_s = BE_s - PE_s \tag{5}$$

Where:

| | |
|---|---|
| $ER_s$ | Emission reductions in season *s* ($tCO_2e$) |

***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.

**Monitoring of baseline and project emissions**

15. 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 | $kgCH_4$/ha per season | Regular measurements as per closed chamber method guidance, seasonally integrated | As per the instructions in the annex (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 | $kgCH_4$/ha per season | Regular measurements as per closed chamber method guidance, seasonally integrated | As per the instructions in the annex (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 considered (see paragraph 16) | 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 technologies not be available, established field size measurement approaches shall be used provided that uncertainties are taken into account in a conservative manner |

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

16. 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 and crop protection application (date and amount);

(c) Water regime on the field (e.g. "dry/moist/flooded");

(d) Yield.

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

18. 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.

19. 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 “General guidelines for sampling and surveys for SSC project activities”.

20. 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**

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

## Annex

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 | 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 |

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

| Feature | Conditions | |
|---|---|---|
| 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 |
| Auxiliaries of chamber | • 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) | |
| Basal area | Rectangular or rounded, but has to cover minimum of four rice hills (ca. 0.1 m² minimum) | |
| Height | Option 1: Fixed height<br>Total height (protruding base + chamber) should exceed plant height | Option 2: Flexible height<br>• Adjustable to plant height;<br>• Chambers with different heights or modular design |

**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 |

**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)**

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

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

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) |

2. Determine the slope of the line of best fit for the values of $M_{CH4}$ over time with the help of software (e.g. Excel):

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

Where:

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

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

$$RE_{ch} = s * 60min / A_{Chamber} \tag{3}$$

Where:

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

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

$$RE_{plot} = \frac{\sum_{ch=1}^{Ch} RE_{ch}}{Ch} \tag{4}$$

Where:

| | |
|---|---|
| $RE_{plot}$ | Average emission rate of a plot (mg/h * m²) |
| *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/m² to kg/ha by multiplying with 0.01.

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**History of the document**

| Version | Date | Nature of revision |
|---|---|---|
| 02.0 | EB 66, Annex 59<br>2 March 2012 | Revision to allow for an alternative procedure to ensure efficient fertilization. |
| 01 | EB 60, Annex 16<br>15 April 2011 | Initial adoption. |
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