Joint Crediting Mechanism Proposed Methodology PH_PM0XX

"Methane Emission Reduction by Water Management in Rice Paddy Fields"

A. Title of the methodology

Methane Emission Reduction by Water Management in Rice Paddy Fields

B. Terms and definition

Terms	Definitions
Drainage	A drainage*[1,2] is considered fully completed when the water level is observed to reach 15 cm below the soil surface. **1: The above requirements do not apply to the end-of-season drainage.* **2: In case the water level does not reach 15cm below the soil surface, a drainage may be deemed fully completed under the following condition, however, such drainage is only perceived as a single drainage even if the conditions are met multiple times in one cropping season.* *The water level is below the soil surface between 0 cm and −15 cm for a total of 10 days consisting of at least 3 consecutive days. This condition is demonstrated by observation on the first and last days of consecutive days when the water level is observed to be below the soil surface, and either 1) observation on every 3 days when the water level stays below the soil surface or 2) precipitation data which indicates there is no precipitation during those consecutive days.*
Single Drainage	Fields have a single drainage event and period of time without flooded conditions during the cropping season at any growth stage, in addition to the end-of-season drainage.
Multiple Drainage	Fields have more than one drainage event and period of time without flooded conditions during the cropping season, in addition to the end-of-season drainage, including alternate wetting and drying (AWD).

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	CH_4 emission reductions achieved through change of water management scheme of rice paddy field, while increases/decreases of N_2O and CO_2 emissions are also considered. Uncertainty concerning both reference and project emissions are conservatively addressed through Uncertainty deduction (Ud) values.
Calculation of reference emissions	Reference emissions are calculated based on CH_4 and N_2O emissions in reference fields in the same cultivation and environmental conditions including pre-season water regime, soil type, and type and amount of organic amendment of project rice paddy field. Direct measurement is used to estimate reference CH_4 and N_2O emissions. Country specific values for calculating CH_4 emissions can also be used subject to cross-checking of the values obtained from direct measurement. N_2O emissions can also be calculated from the amount of fertilizer applied. CO_2 emissions from the use of irrigation and drainage pumps are optional for counting and calculated based on fuel consumption of the pumps.
Calculation of project emissions	Project emissions are calculated based on CH_4 and N_2O emissions in project fields. Direct measurement is used to estimate project CH_4 and N_2O emissions. Country specific values for calculating CH_4 emissions can also be used subject to cross-checking of the values obtained from direct measurement. N_2O emissions can also be calculated from the amount of fertilizer applied. CO_2 emissions from the use of drainage pumps for draining water from rice paddy fields are counted while those from the use of irrigation pumps are optional for counting. CO_2 emissions are calculated based on fuel consumption of the pumps.
Monitoring parameters	● CH_4 and N_2O emissions from rice paddy fields from both reference and project water regimes. ● Areas of project fields of each stratum. ● Days of a cropping season, when applicable ● Application rate of nitrogen fertilizer, when applicable

	● Fuel consumption of drainage pumps (Fuel consumption of irrigation pumps are optional).

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	The project field is rice paddy field that changes water regime[1] during cultivation period from continuously flooded to single or multiple drainage, or from single to multiple drainage. For the former, farmers have not conducted single or multiple drainage, as defined in Section B above, in the past 2 years prior to the start of the project, and for the latter, project participants have not conducted multiple drainage in the past 2 years prior to the start of the project* **If a pilot study is carried out on the same field as the project field, project participants have not conducted single and/or multiple drainage in the past 2 years prior to the start of the pilot study.* *See Appendix C for the method to demonstrate water management in the past 2 years prior to the start of the project.*
Criterion 2	A drainage*[1,2] is considered fully completed when the water level is observed to reach 15 cm below the soil surface. To maintain yield, an irrigation is carried out within 2 days after the completion of the drainage. If the irrigation, to be conducted within 2 days after the completion of drainage, fails, project participants demonstrate that yield reduction*3 has not resulted in significant difference between the reference and project field or has resulted from causes beyond the reasonable control of the project participants. Any evidence of the drainage not causing yield reduction[*3] is to be submitted . **1: The above requirements do not apply to the end of season drainage.* **2: In case the water level does not reach 15cm below the soil surface, a drainage may be deemed fully completed under the following condition, however, such drainage is only perceived as a single drainage even if the conditions are met multiple times in one cropping season.:* *The water level is below the soil surface between 0 cm and −15 cm for a total of 10 days consisting of at least 3 consecutive days. This condition is demonstrated by observation on the first and last days of consecutive days when the water*

[1] For supplemental information on water management of rice paddy fields in this methodology, refer to Appendix B

	level is observed to be below the soil surface, and either 1) observation on every 3 days when the water level stays below the soil surface or 2) precipitation data which indicates there is no precipitation during those consecutive days. *Methods to demonstrate conditions for water level of 15 cm below the soil surface or periods in which the water level stays below the soil surface are detailed in Appendix C.* *Methods other than those mentioned above may be applied subject to prior expert review as described in the Appendix C.* **3: See Appendix C for the method to demonstrate no significant rice yield reduction. A proposed project may be considered eligible if yield reduction arises from causes beyond the reasonable control of the project participants.*
Criterion 3	Single or multiple drainage is not required by the local or national legislation at the project field.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
CH_4 generated from rice paddy field due to activity of microorganism under anaerobic soil condition.	CH_4
N_2O emissions from fertilizer application.	N_2O
CO_2 emissions due to the utilization of drainage pumps used to drain water from rice paddy fields are optional.	CO_2
CO_2 emission due to utilization of irrigation pumps are optional.	CO_2
Project emissions	
Emission sources	GHG types
CH_4 generated from rice paddy field due to activity of microorganism under anerobic condition.	CH_4
N_2O emissions from fertilizer application.	N_2O
CO_2 emissions due to the utilization of drainage pumps used to drain water from rice paddy fields.	CO_2
CO_2 emission due to utilization of irrigation pumps are optional.	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated based on CH_4 and N_2O emissions in reference fields in the same conditions including pre-season water regime, soil type, and type and amount of organic amendment of project rice paddy field. Direct measurement is used to estimate reference CH_4 and N_2O emissions. Country specific values for calculating CH_4 emissions can also be used subject to cross-checking of the values obtained from direct measurement.

In the Philippines, continuous flooding, or single drainage in some limited regions, for rice cultivation is commonly practiced as the multiple drainage method for rice cultivation requires additional project site preparation. In addition, there are farmers who perceive the drainage of water from rice paddies could potentially reduce yields. As a result, water management schemes which involve drainage have not been practiced in many parts of the country.

Business as usual (BaU) practice, which is continuous flooding, or single drainage in some limited regions, results in CH_4 emissions due to anaerobic decomposition of organic matter from flooded rice paddies and N_2O emissions from fertilizer application.

CO_2 emissions from drainage pumps and irrigation pumps are optional for counting, as emissions from the use of irrigation pumps tend to decrease when drainage is conducted. CO_2 emissions from the utilization of mechanical devices and farm equipment are not counted as such emissions occur both in reference and project cases.

To assure conservativeness of the methodology, an uncertainty deduction factor is applied to emission reductions.

F.2. Calculation of reference emissions

$$RE_p = RE_{CH4,p} + RE_{N2O,p} + RE_{CO2,p}$$

Where:

RE_p = Reference emissions during the period p (tCO_2e/p)

$RE_{CH4,p}$ = Reference emissions of CH_4 during the period p (tCO_2e/period)

$RE_{N2O,p}$ = Reference emissions of N_2O during the period p (tCO_2e/period)

$RE_{CO2,p}$ = Reference emission of CO_2 during the period p (tCO_2/period)

1. CH_4 emissions

Regarding CH_4 emissions, project participants may choose one option from 1) or 2) below. Frequency and interval of measurements for both 1) and 2) are explained in 3) below.

1) Direct Measurement

Reference emissions are calculated based on the monitored CH_4 emissions measured at reference field in the same condition (stratum) of pre-season water regime, soil type, and type and amount of organic amendment of project site. Reference emissions are calculated separately for the dry and wet seasons if both seasons are targeted.

The reference emissions are calculated as shown in the equations below. Reference emissions of CH_4 in cropping season s ($RE_{CH4,s}$) is calculated based on the averaged seasonal total emissions or multiplying daily emissions and the number of days. The calculation method for seasonal total emissions and daily emissions based on the measured data is shown in the Appendix A.

$$RE_{CH4,p} = \sum_{s=1}^{S} RE_{CH4,s}$$

$$RE_{CH4,s} = \sum_{st=1}^{ST} \left(EF_{CH4,R,s,st} \times A_{s,st} \right) \times 10^{-3} \times GWP_{CH4}$$

or

$$RE_{CH4,s} = \sum_{st=1}^{ST} \sum_{f=1}^{F} \left(EF_{CH4,R,s,d,st} \times D_{s,st,f} \times A_{s,st,f} \right) \times 10^{-3} \times GWP_{CH4}$$

Where:

$RE_{CH4,p}$ = Reference emissions of CH_4 during the period p (tCO_2e/period)

$RE_{CH4,s}$ = Reference emissions of CH_4 in cropping season s (tCO_2e/season)

$EF_{CH4,R,s,st}$ = Reference emission factor of CH_4 in stratum st in cropping season s ($kgCH_4$/ha/season)

$A_{s,st}$ = Area of project fields of stratum st in cropping season s (ha)

$EF_{CH4,R,s,d,st}$ = Reference emission factor of CH_4 per day in stratum st in cropping season s ($kgCH_4$/ha/day)

$D_{s,st,f}$ = Total number of days under the project in cropping season s in field f of stratum st (days/season)

$A_{s,st,f}$ = Area of project field f of stratum st in cropping season s (ha)

GWP_{CH4} = Global warming potential of CH_4 (tCO_2e/tCH_4): 28.0

st = Index for stratum, covers all project fields with the same condition as determined in Table 1. (ST = total number of stratum)

s = Index for cropping season (*S* = total number of cropping season during a period under the project)
f = Index for project filed in stratum *st* (*F* = total number of fields in stratum *st*)

In the measurement, three representative fields need to be chosen in each stratum. At least two chambers are arranged in each of three fields, and the total area covered by the chambers in each field should be greater than or equal to 0.25 m^2. See Appendix A for more detailed information. The stratification of all project fields is defined in the following table.

Table 1: Parameters for definition of stratification

Parameter	Categories	Element
Water regime - on-season	Continuously flooded	w1
	Single Drainage	w2
	Multiple Drainage	w3
Water regime - pre-season	Flooded	p1
	Short drainage (<180 d)	p2
	Long drainage (≥180 d)	p3
Soil type	Andosols	s1
	Histosols	s2
	Thionic soils*1	s3
	Other soils	s4
Organic amendment (type)*2	Straw on-season	o1
	Straw off-season	o2
	Green manure	o3
	Farm yard manure	o4
	Compost	o5
	No organic amendment (only low stubbles are left after harvesting or straw is almost burnt after burning at the site)	o6
Application rate for straw amendment*2	Low rate (high stubbles are left after harvesting or some portion of straw is left after burning at the site)	q1
	High rate (almost all straw is left at the site)	q2

**1: Rice growth in thionic soils (actual or potential acid sulfate soils) can be inhibited by several factors,*

including the produced hydrogen sulfide and the lowered pH (<4) after drainage. Project participants should make a prior assessment if using fields of thionic soils to avoid rice yield loss.

**2: If the project site is classified into two or more strata based on a type of organic amendment and/or application rates for straw amendment, the most conservative stratum (the least organic amendment rate) may be selected for all classified strata instead of setting multiple strata. However, the conservativeness of different types of organic amendments cannot be compared.*

2) Country Specific Emission Factor Combined with Direct Measurements

For each stratum, project participants select appropriate or more conservative values from either the country specific emission factors for CH_4 emission in dry season and wet season in the Philippines or the emission factor derived from direct measurement. See the section 5 of Appendix C for more detailed information on the selection.

The reference emissions are calculated as follows:

$$RE_{CH4,p} = \sum_{s=1}^{S} RE_{CH4,s}$$

$$RE_{CH4,s} = \sum_{st=1}^{ST} \sum_{f=1}^{F} \left(EF_{CH4,R,s,d,st} \times D_{s,st,f} \times A_{s,st,f} \right) \times 10^{-3} \times GWP_{CH4}$$

If the emission factor calculated by multiplying the country specific emission factors and the latest IPCC default scaling factors is selected to be used for reference emissions:

$$EF_{CH4,R,s,d,st} = EF_{CH4,c,s,d} \times SF_{R,w} \times SF_p \times SF_o$$

Where:

$RE_{CH4,p}$ = Reference emissions of CH_4 during the period p (tCO_2e/period)

$RE_{CH4,s}$ = Reference emissions of CH_4 in cropping season s (tCO_2e/season)

$EF_{CH4,R,s,d,st}$ = Reference emission factor of CH_4 per day in stratum st in cropping season s ($kgCH_4$/ha/day)

$D_{s,st,f}$ = Total number of days under the project in cropping season s in field f of stratum st (days/season)

$A_{s,st,f}$ = Area of project field f of stratum st in cropping season s (ha)

GWP_{CH4} = Global warming potential of CH_4 (tCO_2e/tCH_4): 28.0

$EF_{CH4,c,s,d}$ = Emission factor of CH_4 per day for continuously flooded fields without organic amendments in cropping season s ($kgCH_4$/ha/day): 1.46 (kg/ha/day) for dry season or 2.95 (kg/ha/day) for wet season in the Philippines.

$SF_{R,w}$ = Reference scaling factors to account for the differences in water regime during the cultivation period: 1 for continuous flooding.

SF_{p} = Scaling factors to account for the differences in water regime in the pre-season before the cultivation period: 1.00 for non-flooded pre-season <180 d, 0.89 for non-flooded pre-season >180 d, 2.41 for flooded pre-season (>30 d), and 0.59 for non-flooded pre-season >365 d

SF_{sto} = Scaling factors to account for the differences in both type and amount of organic amendment applied

st = Index for *s*tratum, covers all project fields with the same condition as determined in Table 1. (*ST* = total number of stratum)

s = Index for cropping season (*S* = total number of cropping season during a period under the project)

f = Index for project filed in stratum *st* (*F* = total number of fields in stratum *st*)

$$SF_o = \left(1 + \sum_{i=1}^{I} ROA_i \times CFOA_i\right)^{0.59}$$

Where:

SF_o = Scaling factors to account for the differences in both type and amount of organic amendment applied

ROA_i = Application rate of organic amendment *i*, in dry weight for straw and fresh weigh for others (t/ha)

$CFOA_i$ = Conversion factor for organic amendment *i* (in terms of its relative effect with respect to straw applied shortly before cultivation)

i = Index for type of organic amendment (I = total number of organic amendment types)

3) Frequency and Interval of Measurements

Measurement is conducted at least once a week (frequency) throughout each cropping season in a year.

The yearly interval of measurements is three consecutive years either from one year prior to or at the start of the project implementation. The following measurements are carried out every three to five years, and different uncertainty deduction values are applied depending on the intervals, which is detailed in Section H. below.

a) Direct Measurement

Measurement interval
Every 3 years
Every 4 to 5 years

b) Country Specific Emission Factor Combined with Direct Measurements

Measurement interval
Every 5 years

2. N_2O emissions

Regarding N_2O emissions, project participants may choose one option from 1) or 2) below.

1) Direct measurement

Reference emissions are calculated from monitored N_2O emissions measured at reference fields, in the same manner as the reference CH_4 emissions.

$$RE_{N2O,p} = \sum_{s=1}^{S} RE_{N2O,s}$$

$$RE_{N2O,s} = \sum_{st=1}^{ST} \left(EF_{N2O,R,s,st} \times A_{s,st}\right) \times 10^{-3} \times GWP_{N2O}$$

Where:

$RE_{N2O,p}$ = Reference emissions of N_2O during the period p (tCO_2e/period)

$RE_{N2O,s}$ = Reference emissions of N_2O in cropping season s (tCO_2e/season)

$EF_{N2O,R,s,st}$ = Reference emission factor of N_2O in stratum st in cropping season s (kgN_2O/ha/season)

$A_{s,st}$ = Area of project fields of stratum st in cropping season s (ha)

GWP_{N2O} = Global warming potential of N_2O (tCO_2e/tN_2O): 265

st = Index for stratum, covers all project fields with the same condition as determined in Table 1. (ST = total number of stratum)

s = Index for cropping season (S = total number of cropping season in a year under the project)

2) **Emission Factor for Fertilizer**

Reference emissions of N_2O are calculated using the application rate of N fertilizer in the reference area.

The reference emission is calculated as follows;

$$RE_{N2O,p} = \sum_{s=1}^{S} RE_{N2O,s}$$

$$RE_{N2O,s} = \sum_{st=1}^{ST} ((Q_{N2O,R,s,st} \times A_{s,st}) \times EF_{N2O,C} \times 44/28) \times 10^{-3} \times GWP_{N2O}$$

Where,

$RE_{N2O,p}$ = Reference emissions of N_2O during the period p (tCO_2e/period)

$RE_{N2O,s}$ = Reference emissions of N_2O in cropping season s (tCO_2e/season)

$Q_{N2O,R,s,st}$ = Application rate of N-input in the refence field of stratum st in cropping season s (kg N input/ha/season)

$A_{s,st}$ = Area of project fields of stratum st in cropping season s (ha)

$EF_{N2O,C}$ = Emission factor of N_2O for continuous flooding: 0.003 kg N_2O-N/kg N input

GWP_{N2O} = Global warming potential of N_2O (tCO_2e/tN_2O): 265

st = Index for stratum, covers all project fields with the same condition as determined in Table 1. (ST = total number of stratum)

s = Index for cropping season (S = total number of cropping season in a year under the project)

3) Frequency and Interval of Measurements

Measurement is conducted at least once a week (frequency) throughout each cropping season in a year.

The yearly interval of measurements is three consecutive years either from one year prior to or at the start of the project implementation. The following measurements are carried out every three to five years, and different uncertainty deduction values are applied depending on the intervals, which is detailed in Section H. below.

a) Direct Measurement

Measurement interval
Every 3 years
Every 4 to 5 years

b) Country Specific Emission Factor

Measurement interval
Every 5 years

3. CO_2 emissions

CO_2 emissions due to drainage pumps and irrigation pumps are optional for counting.

Reference CO_2 emissions are calculated as follows:

$$RE_{CO2,p} = \sum_{i=1}^{n} (EF_{fuel,i} \times Q_{F,i,p})$$

Where:

$RE_{CO2,p}$ = Reference emission of CO_2 during the period p (tCO_2/period)

$Q_{F,i,p}$ = Quantity of fuel type i during the period p (quantified as energy input) (TJ/period)

$EF_{fuel,i}$ = Emission factor of fuel type i based on IPCC guidelines (tCO_2e/TJ)

G. Calculation of project emissions

$$PE_p = PE_{CH4,p} + PE_{N2O,p} + PE_{CO2,p}$$

Where:

PE_p = Project emissions during the period p (tCO_2e/period)

$PE_{CH4,p}$ = Project emissions of CH_4 during the period p (tCO_2e/period)

$PE_{N2O,p}$ = Project emissions of N_2O during the period p (tCO_2e/period)

$\underline{PE_{CO2,p}}$ = Project emission of CO_2 during the period p (tCO_2e /period)

1. CH_4 emissions

Regarding CH_4 emissions, project participants may choose one option from 1) or 2) below. Frequency and interval of measurements for both 1) and 2) are explained in 1. 3) in Section F.1 above.

1) Direct Measurement

Project emissions are calculated based on the monitored CH_4 emissions measured at project field, in the same manner as the reference CH_4 emissions.

$$PE_{CH4,p} = \sum_{s=1}^{S} PE_{CH4,s}$$

$$PE_{CH4,s} = \sum_{st=1}^{ST} \left(EF_{CH4,P,s,st} \times A_{s,st}\right) \times 10^{-3} \times GWP_{CH4}$$

or

$$PE_{CH4,s} = \sum_{st=1}^{ST} \sum_{f=1}^{F} \left(EF_{CH4,P,s,d,st} \times D_{s,st,f} \times A_{s,st,f} \right) \times 10^{-3} \times GWP_{CH4}$$

Where:

$PE_{CH4,p}$ = Project emissions of CH_4 during the period p (tCO_2e/period)

$PE_{CH4,s}$ = Project emissions of CH_4 in cropping season s (tCO_2e/season)

$EF_{CH4,P,s,st}$ = Project emission factor of CH_4 in stratum st in cropping season s ($kgCH_4$/ha/season)

$A_{s,st}$ = Area of project fields of stratum st in cropping season s (ha)

$EF_{CH4,P,s,d,st}$ = Project emission factor of CH_4 per day in stratum st in cropping season s ($kgCH_4$/ha/day)

$D_{s,st,f}$ = Total number of days under the project in cropping season s in field f of stratum st (days/season)

$A_{s,st,f}$ = Area of project field f of stratum st in cropping season s (ha)

GWP_{CH4} = Global warming potential of CH_4 (tCO_2e/t CH4): 28.0

st = Index for stratum, covers all project fields with the same condition as determined in Table 1. (ST = total number of stratum)

s = Index for cropping season (S = total number of cropping season in a year under the project)

f = Index for project filed in stratum st (F = total number of fields in stratum st)

2) **Country Specific Emission Factor Combined with Direct Measurements**

Project participants select appropriate or more conservative values from either the country specific emission factors for CH_4 emission in dry season and wet season in the Philippines or the emission factor derived from direct measurements, and also from either IPCC scaling factors to account for the differences in water regime or the scaling factor derived from direct measurement. See the section 5 of Appendix C for more detailed information on the selection.

$$PE_{CH4,p} = \sum_{s=1}^{S} PE_{CH4,s}$$

$$PE_{CH4,s} = \sum_{st=1}^{ST} \sum_{f=1}^{F} \left(EF_{CH4,P,s,d,st} \times D_{s,st,f} \times A_{s,st,f} \right) \times 10^{-3} \times GWP_{CH4}$$

If the emission factor selected for reference emissions is the one calculated by multiplying the

country-specific emission factors by the latest IPCC default scaling factors:

$EF_{CH4,P,s,d,g} = EF_{CH4,c,s,d} \times SF_{P,w} \times SF_p \times SF_o$

Where:

$PE_{CH4,p}$ = Project emissions of CH_4 during the period p (tCO_2e/period)

$PE_{CH4,s}$ = Project emissions of CH_4 in cropping season s (tCO_2e/season)

$EF_{CH4,P,s,d,st}$ = Project emission factor of CH_4 per day in stratum st in cropping season s ($kgCH_4$/ha/day)

$D_{s,st,f}$ = Total number of days under the project in cropping season s in field f of stratum st (days/season)

$A_{s,st,f}$ = Area of project field f of stratum st in cropping season s (ha)

GWP_{CH4} = Global warming potential of CH_4 (tCO_2e/t CH_4): 28.0

$EF_{CH4,c,s,d}$ = Emission factor of CH_4 per day for continuously flooded fields without organic amendments in season s ($kgCH_4$/ha/day): 1.46 (kg/ha/day) for dry season or 2.95 (kg/ha/day) for wet season in the Philippines.

$SF_{P,w}$ = Project scaling factors to account for the differences in water regime during the cultivation period: 0.55 for multiple drainage periods or 0.71 for single drainage period[2].

SF_p = Scaling factors to account for the differences in water regime in the pre-season before the cultivation period: 1.00 for non-flooded preseason <180 d, 0.89 for non-flooded pre-season >180 d, 2.41 for flooded preseason (>30 d), and 0.59 for non-flooded pre-season >365 d.

SF_o = Scaling factors should vary for both type and amount of organic amendment applied

st = Index for stratum, covers all project fields with the same condition as determined in Table 1. (ST = total number of stratum)

s = Index for cropping season (S = total number of cropping season during a period under the project)

f = Index for project filed in stratum st (F = total number of fields in stratum st)

$$SF_o = \left(1 + \sum_{i=1}^{I} ROA_i \times CFOA_i\right)^{0.59}$$

Where:

SF_o = Scaling factors to account for the differences in both type and amount of organic amendment applied

[2] See Appendix C for more details.

ROA_i = Application rate of organic amendment *i*, in dry weight for straw and fresh weigh for others (t/ha)

$CFOA_i$ = Conversion factor for organic amendment *i* (in terms of its relative effect with respect to straw applied shortly before cultivation)

i = Index for type of organic amendment (I = total number of organic amendment types)

2. N_2O emissions

Regarding N_2O emissions, project participants may choose one option from 1) or 2) below. Frequency and interval of measurements for 1) are explained in 2. 3) in Section F.1 above.

1) Direct measurement

Project emissions are calculated based on the monitored N_2O emissions measured at project field, in the same manner as the reference CH_4 emissions.

$$PE_{N2O,p} = \sum_{s=1}^{S} PE_{N2O,s}$$

$$PE_{N2O,s} = \sum_{st=1}^{ST} \left(EF_{N2O,P,s,st} \times A_{s,st}\right) \times 10^{-3} \times GWP_{N2O}$$

Where:

$PE_{N2O,p}$ = Project emissions of N_2O during the period *p* (tCO_2e/period)

$PE_{N2O,s}$ = Project emissions of N_2O in cropping season *s* (tCO_2e/season)

$EF_{N2O,P,s,st}$ = Project emission factor of N_2O in stratum *st* in cropping season *s* (kgN_2O/ha/season)

$A_{s,st}$ = Area of project fields of stratum *st* in cropping season *s* (ha)

GWP_{N2O} = Global warming potential of N_2O (tCO_2e/tN_2O): 265

st = Index for *s*tratum, covers all project fields with the same condition as determined in Table 1. (*ST* = total number of stratum)

s = Index for cropping season (*S* = total number of cropping season in a year under the project)

2) Emission Factor for Fertilizer

Project emissions of N_2O is calculated using the N fertilizer application rate in the project area, in the same manner as the reference N_2O emissions.

$$PE_{N2O,p} = \sum_{s=1}^{S} PE_{N2O,s}$$

$$PE_{N2O,s} = \sum_{st=1}^{ST} ((Q_{N2O,P,s,st} \times A_{s,st}) \times EF_{N2O,D} \times 44/28) \times 10^{-3} \times GWP_{N2O}$$

Where:

$PE_{N2O,p}$ = Project emissions of N_2O during the period p (tCO_2e/period)

$PE_{N2O,s}$ = Project emissions of N_2O in cropping season s (tCO_2e/season)

$Q_{N2O,P,s,st}$ = Application rate of N-input in the project fields of stratum st during period p (kg N input/ha/period)

$A_{s,st}$ = Area of project fields of stratum st in cropping season s (ha)

$EF_{N2O,D}$ = Emission factor for single and multiple drainage: 0.005 kg N_2O-N/kg N input.

GWP_{N2O} = Global warming potential of N_2O (tCO_2e/tN_2O)

st = Index for stratum, covers all project fields with the same condition as determined in Table 1. (ST = total number of stratum)

s = Index for cropping season (S = total number of cropping season in a year under the project)

3. CO_2 emissions

CO_2 emissions due to drainage pumps are counted, while those from irrigation pumps are optional for counting.

Project CO_2 emissions are calculated as follows:

$$PE_{CO2,p} = \sum_{i=1}^{n} (EF_{fuel,i} \times Q_{F,i,p})$$

Where:

$PE_{CO2,p}$ = Project emission of CO_2 during the period p (tCO_2e/period)

$Q_{F,i,p}$ = Quantity of fuel of type i during the period p (quantified as energy input) (TJ/period)

$EF_{fuel,i}$ = Emission factor of fuel type i based on IPCC guidelines (tCO_2e/TJ)

H. Calculation of emissions reductions

1) In Case When CH_4 Emissions are Calculated based on Direct Measurement

$ER_p = (RE_p - PE_p) \times (1 - Ud_{DM})$

Where:

ER_p = Emission reductions during period p (tCO_2e)

RE_p = Reference emissions during period p (tCO_2e)

PE_p = Project emissions during period p (tCO_2e)

Ud_{DM} = Uncertainty deduction (fraction: 0.05 for measurement interval of every three years and 0.1 for measurement interval of every four to five years)

Ud_{DM} values for case 1)

Measurement interval of CH_4	Ud_{DM} values
Every 3 years	0.05
Every 4 to 5 years	0.10

* If accuracy of measurement improves, *Ud* values of less than or equal to 0.10 may be accepted subject to consideration by the Joint Committee.

2) In Case When CH_4 Emissions are Calculated Using Country Specific Emission Factor Combined with Direct Measurements

$ER_p = (RE_p - PE_p) \times (1 - Ud_{EF})$

Where:

ER_p = Emission reductions during period p (tCO_2e)

RE_p = Reference emissions during period p (tCO_2e)

PE_p = Project emissions during period p (tCO_2e)

Ud_{EF} = Uncertainty deduction (fraction: 0.15 for measurement interval of every five years)

Ud_{EF} value for case 2)

Measurement interval of CH_4	Ud_{EF} value
Every 5 years	0.15

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below

Parameter	Description of data	Source
$EF_{N2O,c}$	Emission factor for continuous flooding: 0.003 kg N_2O-N/kg N input	IPCC guidelines (2019)

<table>
<tr><td>$EF_{N2O,D}$</td><td>Emission factor for single and multiple drainage: 0.005 kg N_2O-N/kg N input</td><td>IPCC guidelines (2019)</td></tr>
<tr><td>$EF_{fuel,i}$</td><td>Emission factor of fuel type i (t CO_2e/TJ)</td><td>IPCC guidelines (2019)</td></tr>
<tr><td>$EF_{CH4,c,s,d}$</td><td>Emission factor of CH_4 per day for continuously flooded fields without organic amendments in cropping season s ($kgCH_4$/ha/day)
- For dry season: 1.46 (kg/ha/day) For wet season: 2.95 (kg/ha/day)</td><td>Corton et al. (2000), Wassman et al. (2000)</td></tr>
<tr><td>$SF_{R,w}$</td><td>Reference scaling factors to account for the differences in water regime during the cultivation period: 1 for continuous flooding.</td><td>IPCC guidelines (2006)</td></tr>
<tr><td>SF_p</td><td>Scaling factors to account for the differences in water regime in the pre-season before the cultivation period: 1.00 for non-flooded pre-season <180 d, 0.89 for non-flooded pre-season >180 d, 2.41 for flooded pre-season (>30 d), and 0.59 for non-flooded pre-season >365 d</td><td>IPCC guidelines (2019)</td></tr>
<tr><td>$CFOA_i$</td><td>Conversion factor for organic amendment i (in terms of its relative effect with respect to straw applied shortly before cultivation):

<table>
<tr><td>Organic amendment</td><td>CFOA</td></tr>
<tr><td>Straw incorporated shortly (<30 days) before cultivation</td><td>1.00</td></tr>
<tr><td>Straw incorporated shortly (>30 days) before cultivation</td><td>0.19</td></tr>
<tr><td>Compost</td><td>0.17</td></tr>
<tr><td>Farm yard manure</td><td>0.21</td></tr>
<tr><td>Green manure</td><td>0.45</td></tr>
</table>
*Straw application means that straws are incorporated into the soil. It does not include cases where straws are just placed on soil surface, and straws that were burnt on the field.</td><td>IPCC guidelines (2019)</td></tr>
</table>

$SF_{P,w}$	Project scaling factors to account for the differences in water regime during the cultivation period: 0.55 for multiple drainage periods, and 0.71 for single drainage period.	IPCC guidelines (2019)
Ud_{DM}	Uncertainty deduction (fraction: 0.05 for measurement interval of every three years and 0.1 for measurement interval of every four to five years)	Expert judgement * If accuracy of measurement improves, Ud values of less than or equal to 0.10 may be accepted subject to consideration by the Joint Committee
Ud_{EF}	Uncertainty deduction (fraction: 0.15 for measurement interval of every five years)	Expert judgement

Appendix A: Guidelines for Measuring Methane and Nitrous Oxide Emissions From Rice Paddy Fields

Appendix B: Supplement for Water Management in Rice Paddy Fields

Appendix C: Supplement for Monitoring Methods

History of the document

Version	Date	Contents revised