

JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	Bangladesh
Name of the methodology proponents submitting this form	Mitsui & Co., Ltd.
Sectoral scope(s) to which the Proposed Methodology applies	15. Agriculture
Title of the proposed methodology, and version number	Methane Emission Reduction by Water Management in Rice Paddy Fields in Bogura District and Joypurhat District, Version 01.0
List of documents to be attached to this form (please check):	<input type="checkbox"/> The attached draft JCM-PDD: <input type="checkbox"/> Additional information
Date of completion	

History of the proposed methodology

Version	Date	Contents revised
01.0	13/03/2026	First edition

A. Title of the methodology

Methane Emission Reduction by Water Management in Rice Paddy Fields in Bogura District and Joypurhat District, Version 01.0

B. Terms and definitions

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. <i>*1: The above requirements do not apply to the end-of-season drainage.</i>

	<p><i>*2: In case the water level does not reach 15 cm 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.</i></p> <p><i>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.</i></p>
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
<i>GHG emission reduction measures</i>	CH ₄ emission reductions achieved through change of water management scheme of rice paddy field, while increases/decreases of N ₂ O and CO ₂ emissions are also considered. Uncertainty concerning both reference and project emissions are conservatively addressed through Uncertainty deduction (Ud) values.
<i>Calculation of reference emissions</i>	Reference emissions are calculated based on CH ₄ and N ₂ O 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 ₂ O emissions. N ₂ O emissions can 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 and/or power consumption of the pumps.
<i>Calculation of project emissions</i>	Project emissions are calculated based on CH ₄ and N ₂ O emissions in project fields. Direct measurement is used to estimate project CH ₄ and N ₂ O emissions. N ₂ O emissions can 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 and/or power consumption of the pumps.
<i>Monitoring parameters</i>	<ul style="list-style-type: none"> ● CH₄ and N₂O emission factors from rice paddy fields from both reference and project water regimes ● Areas of project fields of each stratum and/or each field ● Total number of days under the project in a cropping season, when applicable ● Application rate of nitrogen fertilizer, when applicable ● Fuel and/or power consumption of drainage pumps for the project field (Fuel and/or power consumption of drainage pumps for the reference field is optional) ● Fuel and/or power consumption of irrigation pumps is optional.

D. Eligibility criteria

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

Criterion 1	<p>The project field is rice paddy field in Bogura District or Joypurhat District, that changes water regime¹ during cultivation period from continuously flooded to single or multiple drainage, or from single to multiple drainage.</p> <p>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*</p> <p><i>*If a pilot study is carried out on the same field as the project field, project participants</i></p>
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¹ For supplemental information on water management of rice paddy fields in this methodology, refer to Appendix B

	<p><i>have not conducted single and/or multiple drainage in the past 2 years prior to the start of the pilot study.</i></p> <p><i>See Appendix C for the method to demonstrate water management in the past 2 years prior to the start of the project.</i></p>
Criterion 2	<p>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.</p> <p><i>*1: The above requirements do not apply to the end of season drainage.</i></p> <p><i>*2: In case the water level does not reach 15 cm 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.:</i></p> <p><i>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.</i></p> <p><i>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.</i></p> <p><i>Methods other than those mentioned above may be applied subject to prior expert review as described in the Appendix C.</i></p> <p><i>*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.</i></p>
Criterion 3	<p>Single or multiple drainage is not required by the local or national legislation at the project field.</p>

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 ₂ O emissions from fertilizer application.	N ₂ O
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 anaerobic soil condition.	CH ₄
N ₂ O emissions from fertilizer application.	N ₂ O
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 CH₄ and N₂O 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 CH₄ and N₂O emissions.

In Bangladesh, the availability and accessibility of sustainable rice cultivation practices such as AWD are generally limited due to the high cost of such practices.

Business as usual (BaU) practice, which is considered to be continuous flooding, results in CH₄ emissions due to anaerobic decomposition of organic matter from flooded rice paddies and N₂O emissions from fertilizer application.

CO₂ 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. CO₂ 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

$$RE_p = RE_{CH_4,p} + RE_{N_2O,p} + RE_{CO_2,p}$$

Where:

RE_p = Reference emissions during the period p (tCO₂e/period)

$RE_{CH_4,p}$ = Reference emissions of CH₄ during the period p (tCO₂e/period)

$RE_{N_2O,p}$ = Reference emissions of N₂O during the period p (tCO₂e/period)

$RE_{CO_2,p}$ = Reference emission of CO₂ during the period p (tCO₂/period)

1. CH₄ emissions

** If a national emission factor is developed for Bangladesh in the future, the need to modify this methodology will be considered.*

1) Direct Measurement

Reference emissions are calculated based on the monitored CH₄ 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 the project site. Reference emissions are calculated separately for the dry and wet seasons if both seasons are targeted. Frequency and interval of measurements are explained in 2) below.

The reference emissions are calculated as shown in the equations below. Reference emissions of CH₄ in cropping season s ($RE_{CH_4,s}$) are calculated based on the averaged seasonal total emissions or by 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.

$$RE_{CH_4,p} = \sum_{s=1}^S RE_{CH_4,s}$$

$$RE_{CH_4,s} = \sum_{st=1}^{ST} (EF_{CH_4,R,s,st} \times A_{s,st}) \times 10^{-3} \times GWP_{CH_4}$$

or

$$RE_{CH_4,s} = \sum_{st=1}^{ST} \sum_{f=1}^F (EF_{CH_4,R,s,d,st} \times D_{s,st,f} \times A_{s,st,f}) \times 10^{-3} \times GWP_{CH}$$

Where:

$RE_{CH_4,p}$ = Reference emissions of CH₄ during the period p (tCO₂e/period)

$RE_{CH_4,s}$ = Reference emissions of CH₄ in cropping season s (tCO₂e/season)

$EF_{CH_4,R,s,st}$ = Reference emission factor of CH₄ in stratum st in cropping season s
(kgCH₄/ha/season)

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

$EF_{CH_4,R,s,d,st}$ = Reference emission factor of CH₄ per day in stratum st in cropping season s
(kgCH₄/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_{CH_4} = Global warming potential of CH₄ (tCO₂e/tCH₄): 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 field 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 m². 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	Inceptisols	s1

	Thionic soils* ¹	s2
	Other soils	s3
Organic amendment (type)* ²	Straw or upland crop residue on-season	o1
	Straw or upland crop residue 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) 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.

Measurement interval
Every 3 years
Every 4 to 5 years

2. N₂O emissions

Regarding N₂O emissions, project participants may choose one option from 1) or 2) below.

1) Direct measurement

Reference emissions are calculated from monitored N₂O emissions measured at reference fields, in the same manner as the reference CH₄ emissions.

$$RE_{N_2O,p} = \sum_{s=1}^S RE_{N_2O,s}$$

$$RE_{N_2O,s} = \sum_{st=1}^{ST} (EF_{N_2O,R,s,st} \times A_{s,st}) \times 10^{-3} \times GWP_{N_2O}$$

Where:

$RE_{N_2O,p}$ = Reference emissions of N₂O during the period p (tCO₂e/period)

$RE_{N_2O,s}$ = Reference emissions of N₂O in cropping season s (tCO₂e/season)

$EF_{N_2O,R,s,st}$ = Reference emission factor of N₂O in stratum st in cropping season s (kgN₂O/ha/season)

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

GWP_{N_2O} = Global warming potential of N₂O (tCO₂e/tN₂O): 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 during a period under the project)

2) Emission Factor for Fertilizer

Reference emissions of N₂O are calculated using the application rate of N fertilizer in the reference area.

The reference emission is calculated as follows;

$$RE_{N_2O,p} = \sum_{s=1}^S RE_{N_2O,s}$$

$$RE_{N_2O,s} = \sum_{st=1}^{ST} ((Q_{N_2O,R,s,st} \times A_{s,st}) \times EF_{N_2O,C} \times 44/28) \times 10^{-3} \times GWP_{N_2O}$$

Where,

$RE_{N_2O,p}$ = Reference emissions of N₂O during the period p (tCO₂e/period)

$RE_{N_2O,s}$ = Reference emissions of N₂O in cropping season s (tCO₂e/season)

$Q_{N_2O,R,s,st}$	= Application rate of N-input in the reference field of stratum st in cropping season s (kgN input/ha/season)
$A_{s,st}$	= Area of project fields of stratum st in cropping season s (ha)
$EF_{N_2O,C}$	= Emission factor of N ₂ O for continuous flooding (kgN ₂ O-N/kgN input): 0.003
GWP_{N_2O}	= Global warming potential of N ₂ O (tCO ₂ e/tN ₂ O): 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 during a period 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) Emission Factor for Fertilizer

Measurement interval
Every 5 years

3. CO₂ emissions

CO₂ emissions due to drainage pumps and irrigation pumps are optional for counting.

Reference CO₂ emissions are calculated as follows:

$$RE_{CO_2,p} = \sum_{i=1}^n (EF_{fuel,i} \times Q_{F,R,i,p}) + \sum_{j=1}^n (EF_{elec,R,j} \times EC_{R,j,p})$$

Where:

$RE_{CO_2,p}$	= Reference emission of CO ₂ during the period p (tCO ₂ /period)
$Q_{F,R,i,p}$	= Quantity of fuel type i used for drainage pumps and/or irrigation pumps for the reference field during the period p (quantified as energy input) (TJ/period)

$EF_{fuel,i}$	= Emission factor of fuel type i (tCO ₂ e/TJ)
$EC_{R,i,p}$	= Consumption of power source j used for drainage pumps and/or irrigation pumps for the reference field during the period p (quantified as energy input) (MWh/period)
$EF_{elec,R,j}$	= Reference emission factor of power source j (tCO ₂ e/MWh)
i	= Index for fuel type
j	= Index for power source

G. Calculation of project emissions

$$PE_p = PE_{CH_4,p} + PE_{N_2O,p} + PE_{CO_2,p}$$

Where:

PE_p = Project emissions during the period p (tCO₂e/period)

$PE_{CH_4,p}$ = Project emissions of CH₄ during the period p (tCO₂e/period)

$PE_{N_2O,p}$ = Project emissions of N₂O during the period p (tCO₂e/period)

$PE_{CO_2,p}$ = Project emission of CO₂ during the period p (tCO₂e /period)

1. CH₄ emissions

** If a national emission factor is developed for Bangladesh in the future, the need to modify this methodology will be considered.*

Project emissions are calculated based on the monitored CH₄ emissions measured at project field, in the same manner as the reference CH₄ emissions. Frequency and interval of measurements are explained in 1. 2) in Section F.2 above.

$$PE_{CH_4,p} = \sum_{s=1}^S PE_{CH_4,s}$$

$$PE_{CH_4,s} = \sum_{st=1}^{ST} (EF_{CH_4,p,s,st} \times A_{s,st}) \times 10^{-3} \times GWP_{CH_4}$$

or

$$PE_{CH_4,s} = \sum_{st=1}^{ST} \sum_{f=1}^F (EF_{CH_4,P,s,d,st} \times D_{s,st,f} \times A_{s,st,f}) \times 10^{-3} \times GWP_{CH_4}$$

Where:

$PE_{CH_4,p}$ = Project emissions of CH₄ during the period p (tCO₂e/period)

$PE_{CH_4,s}$ = Project emissions of CH₄ in cropping season s (tCO₂e/season)

$EF_{CH_4,P,s,st}$ = Project emission factor of CH₄ in stratum st in cropping season s (kgCH₄/ha/season)

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

$EF_{CH_4,P,s,d,st}$ = Project emission factor of CH₄ per day in stratum st in cropping season s (kgCH₄/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_{CH_4} = Global warming potential of CH₄ (tCO₂e/tCH₄): 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 field in stratum st (F = total number of fields in stratum st)

2. N₂O emissions

Regarding N₂O 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.2 above.

1) Direct measurement

Project emissions are calculated based on the monitored N₂O emissions measured at project field, in the same manner as the reference CH₄ emissions.

$$PE_{N_2O,p} = \sum_{s=1}^S PE_{N_2O,s}$$

$$PE_{N_2O,s} = \sum_{st=1}^{ST} (EF_{N_2O,P,s,st} \times A_{s,st}) \times 10^{-3} \times GWP_{N_2O}$$

Where:

$PE_{N_2O,p}$	= Project emissions of N ₂ O during the period p (tCO ₂ e/period)
$PE_{N_2O,s}$	= Project emissions of N ₂ O in cropping season s (tCO ₂ e/season)
$EF_{N_2O,P,s,st}$	= Project emission factor of N ₂ O in stratum st in cropping season s (kgN ₂ O/ha/season)
$A_{s,st}$	= Area of project fields of stratum st in cropping season s (ha)
GWP_{N_2O}	= Global warming potential of N ₂ O (tCO ₂ e/tN ₂ O): 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 during a period under the project)

2) Emission Factor for Fertilizer

Project emissions of N₂O are calculated using the N fertilizer application rate in the project area, in the same manner as the reference N₂O emissions.

$$PE_{N_2O,p} = \sum_{s=1}^S PE_{N_2O,s}$$

$$PE_{N_2O,s} = \sum_{st=1}^{ST} ((Q_{N_2O,P,s,st} \times A_{s,st}) \times EF_{N_2O,D} \times 44/28) \times 10^{-3} \times GWP_{N_2O}$$

Where:

$PE_{N_2O,p}$	= Project emissions of N ₂ O during the period p (tCO ₂ e/period)
$PE_{N_2O,s}$	= Project emissions of N ₂ O in cropping season s (tCO ₂ e/season)
$Q_{N_2O,P,s,st}$	= Application rate of N-input in the project fields of stratum st in cropping season s (kgN input/ha/period)
$A_{s,st}$	= Area of project fields of stratum st in cropping season s (ha)
$EF_{N_2O,D}$	= Emission factor of N ₂ O for single and multiple drainage (kgN ₂ O-N/kgN input): 0.005
GWP_{N_2O}	= Global warming potential of N ₂ O (tCO ₂ e/tN ₂ O): 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 during a period under the project)

3. CO₂ emissions

CO₂ emissions due to drainage pumps are counted, while those from irrigation pumps are

optional for counting.

Project CO₂ emissions are calculated as follows:

$$PE_{CO_2,p} = \sum_{i=1}^n (EF_{fuel,i} \times Q_{F,P,i,p}) + \sum_{j=1}^n (EF_{elec,P,j} \times EC_{P,j,p})$$

Where:

- $PE_{CO_2,p}$ = Project emission of CO₂ during the period p (tCO₂e/period)
- $Q_{F,P,i,p}$ = Quantity of fuel of type i used for drainage pumps and/or irrigation pumps for the project field during the period p (quantified as energy input) (TJ/period)
- $EF_{fuel,i}$ = Emission factor of fuel type i (tCO₂e/TJ)
- $EC_{P,j,p}$ = Consumption of power source j used for drainage pumps and/or irrigation pumps for the project field during the period p (quantified as energy input) (MWh/period)
- $EF_{elec,P,j}$ = Project emission factor of power source j (tCO₂e/MWh)
- i = Index for fuel type
- j = Index for power source

H. Calculation of emissions reductions

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

Where:

- ER_p = Emission reductions during period p (tCO₂e/period)
- RE_p = Reference emissions during period p (tCO₂e/period)
- PE_p = Project emissions during period p (tCO₂e/period)
- Ud_{DM} = Uncertainty deduction (fraction: 0.05 for measurement interval of every three years and 0.10 for measurement interval of every four to five years)

Ud_{DM} values

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.

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
$EF_{N_2O,C}$	Emission factor of N ₂ O for continuous flooding (kgN ₂ O-N/kgN input): 0.003	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019)
$EF_{N_2O,D}$	Emission factor of N ₂ O for single and multiple drainage (kgN ₂ O-N/kgN input): 0.005	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019)
$EF_{fuel,i}$	Emission factor of fuel type <i>i</i> (tCO ₂ e/TJ)	2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006)
$EF_{elec,R,j}$	<p>Reference emission factor of power source <i>j</i> (tCO₂e/MWh)</p> <p>When the power source is either grid electricity or captive electricity, the project participant applies either the grid emission factor [$EF_{elec,R,grid}$] or the captive emission factor [$EF_{elec,R,cap}$] respectively.</p> <p>When the power source consists of both grid and captive electricity, the project participant applies the conservative value of the grid or the captive emission factors.</p> <p>[$EF_{elec,R,grid}$]: For grid electricity, the most recent emission factor of Bangladesh grid available at the time of validation.</p> <p>[$EF_{elec,R,cap}$]: For captive electricity, the most recent value for the used fuel type available from Article 6.4 Mechanism approved “Methodological tool: Emissions from electricity generation and consumption” at the</p>	<p>[Grid electricity]</p> <p>The most recent published value by the relevant national authority of Bangladesh at the time of validation.</p> <p>[Captive electricity]</p> <p>Article 6.4 Mechanism approved methodological tool: Emissions from electricity generation and consumption.</p>

	<p>time of validation. An EF value shown in the table below is applied to calculate reference emissions.</p> <p>Default values for the emission factor of power units ($EF_{elec,R,cap}$) (tCO₂/MWh)</p> <table border="1" data-bbox="427 517 796 667"> <tr> <td>Fuel type</td> <td></td> </tr> <tr> <td>Oil</td> <td>0.54</td> </tr> <tr> <td>Natural gas</td> <td>0.3</td> </tr> </table>	Fuel type		Oil	0.54	Natural gas	0.3	
Fuel type								
Oil	0.54							
Natural gas	0.3							
$EF_{elec,P,j}$	<p>Project emission factor of power source j (tCO_{2e}/MWh)</p> <p>When the power source is either grid electricity or captive electricity, the project participant applies either the grid emission factor [$EF_{elec,P,grid}$] or the captive emission factor [$EF_{elec,P,cap}$] respectively.</p> <p>When the power source consists of both grid and captive electricity, the project participant applies the conservative value of the grid or the captive emission factors.</p> <p>[$EF_{elec,P,grid}$]: For grid electricity, the most recent emission factor of Bangladesh grid available at the time of validation.</p> <p>[$EF_{elec,P,cap}$]: For captive electricity, the most recent value for the used fuel type available from Article 6.4 Mechanism approved “Methodological tool: Emissions from electricity generation and consumption” at the time of validation. An EF value shown in the table below is applied to calculate project emissions.</p> <p>Default values for the emission factor of power units ($EF_{elec,P,cap}$) (tCO₂/MWh)</p>	<p>[Grid electricity]</p> <p>The most recent published value by the relevant national authority of Bangladesh at the time of validation.</p> <p>[Captive electricity]</p> <p>Article 6.4 Mechanism approved methodological tool: Emissions from electricity generation and consumption.</p>						

	Fuel type			
	Oil	0.9		
	Natural gas	0.7		
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	
GWP_{CH_4}	Global warming potential of CH ₄ (tCO _{2e} /tCH ₄): 28.0		Box 3.2, Table 1, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the IPCC (2014)	
GWP_{N_2O}	Global warming potential of N ₂ O (tCO _{2e} /tN ₂ O): 265		Box 3.2, Table 1, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the IPCC (2014)	

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

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

This appendix explains how the methane (CH₄) and nitrous oxide (N₂O) emissions can be measured in rice paddy fields. It is necessary that the implementation of CH₄ and N₂O measurement by a closed chamber method involves technicians who have been authorized by the independent experts before the validation and operators who have been trained by the authorized technician.

In order to obtain the independent experts' advice on the competence of the technicians or to propose alternative methods other than those explained in this appendix to be included in this methodology with sufficient scientific evidence, firstly project participants need to contact the Ministry of Agriculture, Forestry and Fisheries of Japan as follows: maff_JCMTML@maff.go.jp

The following tables are arranged sequentially from the chamber design to the calculation of the seasonal CH₄ and N₂O emissions and emission factors. See also "[Guidelines for Measuring CH₄ and N₂O Emissions from Rice Paddies by a Manually Operated Closed Chamber Method](#)" (National Institute for Agro-Environmental Sciences, 2015) for the scientific basis and better understanding of the following guidance through the visual presentation.

Table A-1. Chamber design

Feature	Conditions
Material, color, and shape	<p>In general, chamber shapes and materials are inseparable factors. In addition, chamber shapes allowed are dependent on a rice planting system.</p> <p>Cylinder-shaped chambers with round basal area are usually made of commercially available non-transparent plastic containers. Painting those with whitish color, if not inherent, or a cover with reflective material is recommended to prevent the increase in the inside temperature. Cylinder-shaped chambers can be used only for the direct broadcast seeding system.</p> <p>Rectangular-shaped chambers with square basal area are made of transparent acrylic plates (with stainless steel frames for the reinforcement, if necessary).</p>

	<p>Rectangular-shaped chambers can be used for both transplanting system and the direct seeding system (broadcast or row).</p> <p>The total chamber height (including that of a chamber base) is recommended to be higher than the rice plant height. Double- or triple-deck style is available to the rectangular-shaped chambers, which are adjustable depending on the growing plant height.</p> <p>The constant placement of chambers equipped with upper lids that can be opened and closed is not recommended.</p>
<p>Base material and shape</p>	<p>The chamber base needs to be installed at least one day before the first gas sampling and must remain in the field throughout the season. Base materials and shapes depend on the chamber shapes. The aboveground height of the bases is recommended to be lower than or equal to 30 cm.</p> <p>For cylinder-shaped chambers, a round-shaped base with a water sealing is usually made of plastic materials. A cylinder-shaped base in the soil requires holes on the sidewall to allow water exchange between inside and outside the chamber area.</p> <p>For rectangular-shaped chambers, 4 corner pillars, made of PVC pipes or metal rods, stuck into the plow pan are sufficient when there is surface water. Top of the pillars are required to be underwater for sealing. When there is no or shallow surface water, chambers can be gently placed on the soil. CH₄ ebullition may happen after the placement, and it should be escaped from or well mixed in the chamber headspace before the first gas sampling. Square-shaped bases with water sealings made of plastic materials are also available temporarily or</p>

	constantly during the season.
Basal area	The total area covered by chambers in one field is required to be wider than 0.25 m ² . To accommodate this area, multiple ($n \geq 2$) chambers are used in one field. The minimum distance between each chamber should be 1 m. For the transplanting system, the basal area size of a rectangular-shaped chamber should be a multiple of rice plant spacing to appropriately capture GHG emissions (diffusion and ebullition) from the soil or the surface water. For example, if the plant spacing is 30 cm × 15 cm, the basal area should be 30 cm × 30 cm (covering 2 rice hills), 30 cm × 60 cm (4 hills), or etc. For the direct row seeding system, one side length of the basal area should be a multiple of the row distance.
Accessory	A chamber needs to be equipped with a gas sampling port, an inside fan, an inside thermometer, and an air vent. The port may also serve as the vent. The port should be apart from the chamber wall by using a tube connected to a stopcock. The dead volume in the tube should be replaced before the gas sampling. A weight, such as a battery for the fan operation, can be gently placed on the upper lid to prevent the chamber from falling down in windy weather.

Table A-2. Gas sampling

Feature	Conditions
Chamber area	A scaffold needs to be installed at least one day before the first gas sampling to reach the chamber areas without disturbing the soil. The chamber area needs to be apart 1.5 m from the ridge of the field.

Chamber replication per field	At least 2 chambers, depending on the basal area size (see the basal area feature in Table A-1).
Number of gas samples per chamber placement	At least 3 samples during the chamber closure time (30-40 min). The first gas sample should be collected after ≥ 1 min after the chamber placement to wait for the headspace gas to become well-mixed.
Gas sampling time of day	Morning, especially in the early hours (e.g., 7 am-10 am). If the sampling time must be extended to daytime, the schedule should be designed to prevent the systematic bias since CH ₄ emissions are emitted more in daytime.
Frequency	At least once per week ² . To better trace the possible temporary CH ₄ emission peak during a drainage event and the possible temporary N ₂ O emission peak after nitrogen fertilizer topdressing, additional measurements once or twice are recommended during these events.
Gas storage	The gas sampled from the port should be stored into a glass or plastic evacuated vial (with a rubber stopper), a plastic or aluminum bag, or a plastic syringe. A gas leak test for the expected storage duration needs to be implemented before the start of the season and the gas concentration analyzed needs to be corrected appropriately, if applicable.
Manual	Uniform and gentle manual operation needs to be implemented regardless of time

² In the case of force majeure events such as bad weather or natural disasters, project participants should demonstrate rational reasons for not following the proposed frequency.

operation	<p>and place. Several operators should simultaneously implement the measurement in the reference fields and project fields. When moving a chamber from one location to another, the air inside the chamber should be replaced by pushing the chamber sideways and operating the fan.</p> <p>It is necessary to submit a film recording a series of gas sampling operations by the technicians to the independent experts for authorization of their skill prior to validation. If the technicians' skills are insufficient, the film shall be resubmitted in accordance with the independent experts' advice.</p>
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Table A-3. Laboratory gas analysis

Feature	Conditions
Method	<p>A CH₄ concentration needs to be analyzed by a gas chromatograph (GC) equipped with a flame ionization detector (FID) or a laser spectroscope. A N₂O concentration needs to be analyzed by a GC equipped with an electron capture detector (ECD) or a laser spectroscope.</p> <p>In case of using a laser spectroscope³, project participants should follow the manufacture's instruction for the gas analysis.</p>
GC system	<p>A GC system consists of a gas injection port, a separation column, a gas detector, a data processor, etc. Carrier gas and the standard gas are essential for the steady operation and the analysis.</p> <p>An ECD-GC should be equipped with a multi-port valve to remove oxygen and water vapor for the refined detection of N₂O.</p>

³ A portable laser spectroscope connected online to multiple chambers is to be usable if the method is scientifically sound and if all the requirements are met.

	<p>It is necessary to submit the specification of GC system (product, column packing material, column diagram, carrier gas and the flow rate, temperatures of injector, column, and detector) and photos of GC appearance (the entire GC from multiple angles (exterior) and columns inside the oven) to the independent experts before the validation.</p>
<p>Calibration line or curve</p>	<p>The certified standard gases need to be used to draw a calibration line or curve. 2-point calibration is sufficient for an FID-GC using the CH₄ standard gas with the atmospheric ambient concentration (e.g., ~2 ppm) and a higher concentration (e.g., 50-100 ppm). 2- or 3-point calibration is sufficient for an ECD-GC using the N₂O standard gas with the atmospheric ambient concentration (e.g., ~0.3 ppm) and higher concentrations (e.g., 2-10 ppm). Note that the linearity is not always secured for an ECD-GC to detect the higher concentration of N₂O.</p> <p>A calibration line or curve needs to be drawn each day before and after the analyses.</p>
<p>Quality control</p>	<p>The repeatability of the GC analysis needs to be tested before the start of the season using the certified standard gases. The coefficient of variation (CV) of 10-20 repeated analyses of the same standard gas should be $\leq 5\%$ for all the used standard gases (i.e., ambient and higher concentrations). It is necessary to submit the results of the repeatability test to the independent experts for approval of quality control before the validation.</p> <p>If the results are poor (i.e., $CV > 5\%$), the result of additional blind test is recommended to submit.</p>

Table A-4. Calculation of the seasonal total emission of CH₄ or N₂O and emission factors

Order	Procedure
1	<p>Calculate the mass of CH₄ or N₂O in the analyzed gas sample:</p> $m_t = c_t \times V \times M \times \frac{1atm}{R \times T_t \times 1000}$ <p>Where:</p> <p>m_t = Mass of CH₄ or N₂O in chamber at time t (mg)</p> <p>t = Time point of gas sampling (e.g. 1, 16, and 31 min after chamber placement in case of 3 samples for 30 min)</p> <p>c_t = CH₄ or N₂O concentration in chamber at time t (ppm)</p> <p>V = Chamber volume (L)</p> <p>M = Molar mass of CH₄ (16.042 g mol⁻¹) or N₂O (44.0128 g mol⁻¹)</p> <p>$1atm$ = Assume constant pressure of 1 atm, unless the inside pressure is recorded</p> <p>R = Universal gas constant: 0.08206 L atm K⁻¹ mol⁻¹</p> <p>T_t = Temperature at time t (K)</p>
2	<p>Determine the slope of the line of best fit for the values of over time:</p> $s = \frac{\Delta m}{\Delta t}$ <p>Where:</p> <p>s = Slope of line of best fit (mg min⁻¹)</p>
3	<p>Calculate the hourly flux for one chamber measurement:</p> $F_{ch} = s \times \frac{60min}{A}$ <p>Where:</p> <p>F_{ch} = Flux of chamber ch (mg m⁻² h⁻¹)</p>

	<p>ch = Index for replicated chamber in a field</p> <p>A = Chamber basal area (m²)</p>
4	<p>Calculate the average hourly flux in a field:</p> $F = \frac{\sum_{ch=1}^n F_{ch}}{n}$ <p>Where:</p> <p>F = Average flux of a field (mg m⁻² h⁻¹)</p> <p>n = Number of replicated chambers in a field</p>
5	<p>Calculate the total emission in one measurement interval:</p> $E_i = \frac{(F_i + F_{i+1}) \times 24h \times D_i}{2}$ <p>Where:</p> <p>E_i = Total emission in interval i (mg m⁻²)</p> <p>i = Index for measurement interval in a season</p> <p>F_i = Hourly flux at the start of interval i (mg m⁻² h⁻¹)</p> <p>F_{i+1} = Hourly flux at the end of interval i (mg m⁻² h⁻¹)</p> <p>D_i = Number of days in interval i (d)</p> <p>Note that flux on planting day and flux on harvest day can be assumed to be zero if measurement is not implemented on those days.</p>
6	<p>Calculate the seasonal total emission in a field:</p> $E = \sum_{i=1}^N E_i$ <p>Where:</p> <p>E = Total emission in a season (mg m⁻²)</p> <p>N = Number of measurement intervals in a season</p>
7	<p>Calculate the emission factor in stratum st in season s</p>

	$EF_{s,st} = \frac{\sum_{f=1}^F E_f \times 10^{-2}}{F \times 100}$ <p>Where:</p> <p>$EF_{s,st}$ = Emission factor in stratum st in season s ($\text{kg ha}^{-1} \text{ season}^{-1}$)</p> <p>$E_f$ = Total emission in field f of stratum st in season s ($\text{mg m}^{-2} \text{ season}^{-1}$)</p> <p>$F$ = Number of (representative) fields of stratum st in season s</p>
8	<p>Calculate the emission factor per day in stratum st in season s</p> $EF_{s,d,st} = \frac{\sum_{f=1}^F \left(\frac{E_f \times 10^{-2}}{D_f} \right)}{F \times 100}$ <p>Where:</p> <p>$EF_{s,d,st}$ = Emission factor per day in stratum st in season s ($\text{kg ha}^{-1} \text{ d}^{-1}$)</p> <p>$E_f$ = Total emission in field f of stratum st in season s ($\text{mg m}^{-2} \text{ season}^{-1}$)</p> <p>$D_f$ = Total number of rice growing days in field f of stratum st in season s (d season^{-1})</p> <p>F = Number of (representative) fields of stratum st in season s</p>

Appendix B: Supplemental guidance for Water Management in Rice Paddy Fields

The success of water management to reduce methane (CH₄) emissions from rice paddy fields depends on weather and anthropogenic factors. Water management also needs to consider the effect on rice growth and yield. This appendix details specific requirements, recommendations, and tips to implement water management in rice paddy fields.

1. Rice growth stages not to be severely drained

Rice paddy fields do not need to be continuously flooded to produce sufficient rice yields. However, there are known specific rice growth stages in which the fields should not be severely drained. One is the rooting stage for stable plant establishment, and another is the heading stage for physiological water demand. To avoid the risk of rice yield loss, these growth stages should be taken into consideration when designing the water management plan before the project starts.

2. Artificial drainage

Artificial drainage by using pumps and/or opening water outfalls is not originally implemented under AWD for the primary purpose of water saving. However, there are cases where irrigation water is plentiful depending on the time and location. This methodology therefore does not exclude the implementation of the artificial drainage, as long as it does not cause a significant rice yield reduction.

3. Timing of implementing single drainage

Single drainage, known as midseason drainage, is a common practice in East Asia for sound rice growth and the better yields. The midseason drainage is typically implemented in the tillering stage. This period usually coincides with when the CH₄ flux (emission rate) increases, thereby it reduces the total seasonal emission. The timing of the single drainage should be decided taking into account CH₄ emission reduction as well as sound rice growth.

4. Number of days during which the water level is between 0 cm and –15 cm

This methodology assumes that each farmer aims at lowering the water level to –15 cm in order to achieve one drainage event as defined. However, lowering the water level to –15 cm is not always achievable because of rainfalls (especially in wet seasons), low location, etc. By compiling the scientific evidence⁴, this methodology considers the following conditions are practically

⁴ [Jiang et al. \(2019\)](#) analyzed a global dataset and reported that CH₄ emission decreased with increasing the number of unflooded days during a rice growing period except the end of season drainage. By recalculating raw data in [Minamikawa et al. \(2021\)](#), it is confirmed that keeping the water level between 0 cm and –15 cm for total of 10 days

equivalent to one drainage event in a conservative manner: keeping the water level between 0 cm and –15 cm for a total of 10 days, consisting of at least 3 consecutive days. This alternative index can also be used to monitor the (non-)existence of water by remote sensing if project participants demonstrate its satisfactory accuracy.

5. Water level during nitrogen fertilizer topdressing

The water level for a few days during and after the nitrogen (N) fertilizer topdressing affects the N-use efficiency of rice plants and the N₂O emission. To minimize the N loss through the ammonia volatilization and N₂O emission, fields should be kept flooded during this period, if not flooded continuously. Therefore, farmers need to pay attention to the water level when conducting N fertilizer topdressing in single- or multiple-drained fields. The water level at the basal fertilizer application can be assumed to be equivalent among the fields with different water management practices.

during a rice growing period except the end of season drainage can decrease CH₄ emission comparable to the single drainage (i.e., SF_w; reduction by 29%).

Appendix C: Supplemental Guidance for Monitoring Methods and GHG Emission Calculations

This appendix provides additional explanations for the monitoring parameters and methods used in this methodology. Project participants have a certain degree of freedom to select the monitoring methods depending on the situation. This appendix also explains the procedures how to calculate CH₄ and N₂O emissions in specific cases regarding the success of water management. This methodology makes much of the results.

1. Water management in the past 2 years prior to the start of the project

In order to satisfy the eligibility criterion 1 of the methodology, project participants need to demonstrate the water management practices over the past 2 years through history assessments with resources such as the following:

- Reviewing logbooks (if available) and local experts' comments.

2. Selection of representative fields in each stratum for direct measurement

As to the direct measurement of CH₄ and N₂O emissions, the 3 representative fields in terms of environmental and agronomic settings need to be prepared for both project and reference areas in every stratum. This is to avoid over- or under-estimation of the calculated CH₄ and N₂O emission reductions. A pair of project and reference fields should be provided from one farmer to avoid the effect of historical difference in agronomic practices on the CH₄ and N₂O emissions and rice yield. Each of the 3 paired fields should have the same agronomic history for ≥ 2 year and at least similar environmental settings (i.e., topography and soil texture). Project participants are required to provide the materials to demonstrate this.

3. Confirmation of avoidance of significant rice yield reduction

To demonstrate the eligibility criterion 2 of the methodology for maintained rice yield, rice yield sampling is implemented at the total of 6 representative fields in each stratum to confirm that there is no rice yield reduction by the project. For the direct seeding system, 1 m × 2 m area should be selected from each field whereas a rectangle area with 50 rice hills for the transplanting system. Alternatively, the comparison can be made by the yield of each field by the calculation of the field total yield/field area derived from machine harvested data only if the harvesting machine is emptied by each field before harvesting. Unhulled rice grain yield adjusted to the moisture content of 14% needs to be measured. A sampling area with normal rice growth should be visibly selected at harvest.

The 95% confidence interval (CI) of the yield in 3 fields needs to be calculated for both project and reference areas. If the intervals do not overlap each other, it is considered that there is significant change in rice yield.

The lower and upper limits of 95% CI is calculated using the CONFIDENCE.T function in Excel as follows:

$$\text{Lower limit} = Y_m - \text{CONFIDENCE.T}(0.05, \text{STDEV.S}(Y_1, Y_2, Y_3), 3)$$

$$\text{Upper limit} = Y_m + \text{CONFIDENCE.T}(0.05, \text{STDEV.S}(Y_1, Y_2, Y_3), 3)$$

Where:

Y_m , Y_1 , Y_2 , and Y_3 are the mean rice yield of the 3 fields, rice yield at the first field, rice yield at the second field, and rice yield at the third field, respectively.

4. Water level monitoring for confirmation of drainage

It is necessary for project participants to demonstrate the fulfillment of the eligibility criterion 2 of the methodology by submitting the followings to a Third-Party Entity at the time of verification: photos of the monitored water level with location and time information as well as a handwritten or digital logbook for the water level and/or the number of drained days. If the project participants are unable to submit above mentioned geotagged photos, they should provide rational reasons along with their alternative supplementary information that meets the eligibility criterion. In the specific cases listed in Table C-1, daily rainfall data recorded using an on-site weather station or at the nearest metrological station also needs to be provided to ensure that the water level during non-monitoring days is within the allowed range. Remote sensing can be an option for monitoring water existence (>0 cm) and non-existence (≤ 0 cm) when project participants demonstrate its sufficient accuracy and reliability to the independent experts described in the Appendix A before the validation. In addition to remote sensing, other improved methods to monitor water level could be applied when the independent experts approve those by reviewing the submitted base data before the validation.

There are several required timings of taking photos: (1) when the water level reaches -15 cm, (2) at least 3-day interval when the water level maintains ≤ 0 cm for a total of 10 days consisting of at least 3 consecutive days (e.g., 3 d + 3 d + 4 d and 4 d + 6 d) in case of using the number of drained days as the index, and (3) when the water level reaches ≤ 0 cm for the first time.

There are 4 cases of the water level change to decide which timing photos should be taken (Table C-1). In each case, it is strongly recommended to take photos of the water level on the first day when the water level reaches below the soil surface, to secure flexibility in case the water level does not reach -15 cm. These “first day photos” must be taken in the case II and III.

*Logbook must be recorded appropriately in all the cases to support the data.

*The examples in Table C-1 are representatives and do not cover all the cases.

Table C-1. Four cases of taking photos

Case	Scenario, condition, and required photos
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I	<p>Expected water level: –15 cm. Result: water level –15 cm achieved.</p> <p>Applicable only in case that the water level previously reached –15 cm in the same cropping season at the same area.</p> <p>➤ Photos taken when the water level reaches –15 cm.</p> <p>Example I</p> <table border="1" data-bbox="424 517 1026 712"> <tr> <td>Day</td> <td colspan="5">Any date</td> </tr> <tr> <td>Water Level</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤ –15</td> </tr> <tr> <td>Photo</td> <td>(X)</td> <td></td> <td></td> <td></td> <td>X</td> </tr> </table>	Day	Any date					Water Level	≤0	≤0	≤0	≤0	≤ –15	Photo	(X)				X																							
Day	Any date																																									
Water Level	≤0	≤0	≤0	≤0	≤ –15																																					
Photo	(X)				X																																					
II	<p>Expected water level: –15 cm. Result: water level –15 cm not achieved.</p> <p>Applicable only in case that the water level previously reached –15 cm in the same cropping season at the same area.</p> <p>➤ Principle:</p> <p>Photos taken when the water level reaches ≤0 cm for the first time. Photos taken at least once every 3 days while the water level maintains ≤0 cm. The water level needs to maintain ≤0 cm for the total of 10 days consisting of at least 3 consecutive days.</p> <p>Example II-A</p> <table border="1" data-bbox="376 1205 1272 1400"> <tr> <td>Day</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> </tr> <tr> <td>Water Level</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> <td>≤0</td> </tr> <tr> <td>Photo</td> <td>X</td> <td></td> <td></td> <td>X</td> <td></td> <td></td> <td>X</td> <td></td> <td></td> <td>X</td> </tr> </table> <p>➤ Alternatives:</p> <p>Photos taken when the water level reaches ≤0 cm for the first time and taken to prove that the water level remains below the soil surface when the total of 10 days have passed since the first day of the water level reaching ≤0 cm. The water level needs to maintain ≤0 cm for the total of 10 days consisting of at least 3 consecutive days. The days in between two photos are deemed the water level remaining below the soil surface consecutively, as long as the rainfall data indicates no rainfall (0 mm d⁻¹) during the period.</p> <p>Example II-B</p> <table border="1" data-bbox="376 1832 1034 1973"> <tr> <td>Day</td> <td>1</td> <td>2-9</td> <td>10</td> </tr> <tr> <td>Water Level</td> <td>≤0</td> <td>(≤0)</td> <td>≤0</td> </tr> </table>	Day	1	2	3	4	5	6	7	8	9	10	Water Level	≤0	≤0	≤0	≤0	≤0	≤0	≤0	≤0	≤0	≤0	Photo	X			X			X			X	Day	1	2-9	10	Water Level	≤0	(≤0)	≤0
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Water Level	≤0	≤0	≤0	≤0	≤0	≤0	≤0	≤0	≤0	≤0																																
Photo	X			X			X			X																																
Day	1	2-9	10																																							
Water Level	≤0	(≤0)	≤0																																							

	Photo	X	No rainfall (proved by data)	X																																							
	Example II-C																																										
	Day	1	2-5	6	7	8	9*	10*	11																																		
	Water Level	≤ 0	(≤ 0)	≤ 0	> 0	≤ 0	≤ 0	≤ 0	≤ 0																																		
	Photo	X	No rainfall (proved by data)	X	Rainfall	X			X																																		
	*The water level can be deemed below the soil surface for the day 9 and 10 as these days are between the day 8 and the day 11 where photos are taken once every 3 days to indicate the water level ≤ 0 cm (see the Principle of Case II).																																										
	As of Example II-C and D, when there is appropriate rainfall data as well as logbook records, the water level during this period (the day 2-5) can be deemed below the soil surface. A photo of the first day of the water level reaching below the soil surface again (the day 8) must be taken for the record of the following days.																																										
	Example II-D																																										
	Day	1	2-5*	6-7	8	9	10	11	12																																		
	Water Level	≤ 0	≤ 0	> 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0																																		
	Photo	X	No rainfall (proved by data)	Rainfall	X			X	X																																		
III	<p>Expected water level: below the soil surface but above -15 cm. Result: water level -15 cm not achieved. Applicable also in case that the previous water level data are not available.</p> <p>➤ Principle: Photos taken when the water level reaches ≤ 0 cm for the first time. Photos then taken at least once every 3 days while the water level remains ≤ 0 cm. These photos prove that the water level remains ≤ 0 cm for the total of 10 days consisting of at least 3 consecutive days.</p> <p>Example III-A</p> <table border="1"> <tr> <td>Day</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> </tr> <tr> <td>Water Level</td> <td>≤ 0</td> <td>≤ 0</td> <td>≤ 0</td> <td>≤ 0</td> <td>≤ 0</td> <td>≤ 0</td> <td>≤ 0</td> <td>≤ 0</td> <td>≤ 0</td> <td>≤ 0</td> </tr> <tr> <td>Photo</td> <td>X</td> <td></td> <td></td> <td>X</td> <td></td> <td></td> <td>X</td> <td></td> <td></td> <td>X</td> </tr> </table> <p>➤ Alternatives: Photos taken when the water level reaches ≤ 0 cm for the first time and taken</p>										Day	1	2	3	4	5	6	7	8	9	10	Water Level	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	Photo	X			X			X			X
Day	1	2	3	4	5	6	7	8	9	10																																	
Water Level	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0																																	
Photo	X			X			X			X																																	

to prove that the water level remains below the soil surface when total of 10 days have passed since the first day of the water level reaching ≤ 0 cm. The water level needs to maintain ≤ 0 cm for the total of 10 days consisting of at least 3 consecutive days. The days in between two photos are deemed the water level remaining below the soil surface consecutively, as long as the rainfall data indicates no rainfall during the period.

Example III-B

Day	1	2-9	10
Water Level	≤ 0	(≤ 0)	≤ 0
Photo	X	No rainfall (proved by data)	X

Example III-C

Day	1	2-5	6	7	8	9*	10*	11
Water Level	≤ 0	(≤ 0)	≤ 0	> 0	≤ 0	≤ 0	≤ 0	≤ 0
Photo	X	No rainfall (proved by data)	X	Rainfall	X			X

*The water level can be deemed below the soil surface for the day 9 and 10 as these days are between the day 8 and the day 11 where photos are taken once every 3 days to indicate the water level ≤ 0 cm (see the Principle of Case III).

As of Example III-C and D, when there is appropriate rainfall data as well as logbook records, this period (the day 2-5) can be deemed the water level below the soil surface. A photo of the first day of the water level reaching below the soil surface again (the day 8) must be taken for the record of the following days.

Example III-D

Day	1	2-5*	6-7	8	9	10	11	12
Water Level	≤ 0	(≤ 0)	> 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0
Photo	X	No rainfall (proved by data)	Rainfall	X			X	X

IV	<p>Expected water level: below the soil surface but above -15 cm. Result: water level -15cm achieved. Applicable also in case that the previous water level data are not available. ➤ Photos taken when the water level reaches -15 cm.</p> <p>Example IV</p> <table border="1" style="width: 100%;"> <tr> <td>Day</td> <td>Any date</td> </tr> </table>	Day	Any date
Day	Any date		

	Water Level	≤0	≤0	≤0	≤0	≤ -15	
	Photo	(X)		(X)		X	

In multiple drainage, project participants cannot start counting the days of water level until the project field is flooded (>0 cm water level) by irrigation after the completion of the previous drainage. The examples are shown in Table C-2.

As shown in the single drainage case (Table C-2), it is considered as a single drainage even if 10 days drainage (the case II or III in Table C-1) is achieved more than once during a rice season.

However, as shown in the case of multiple drainage (Table C-2), it is considered as a multiple drainage when both -15 cm drainage (the case I or IV in Table C-1) and 10 days drainage (the case II or III in Table C-1) are implemented and these two types of drainage can be distinguished by the flooding (>0 cm water level) by irrigation after the completion of the previous drainage.

Table C-2. Examples of single drainage scenario and multiple drainage scenario

Case	Scenario and condition						
Single drainage	Day	1	2-3	4	5-11	12-14	15-24
	Water Level	≤0	≤0	>0	≤0	>0	≤0
	Photo	X		Rainfall	X (the day 5, 8, and 11)	Irrigation	
	The day 1-3 and the day 5-11 are counted into the 10 days drainage. However, the day 15-24 cannot be counted as the 10 days drainage since it can be applied only once in a rice growing season.						
Multiple drainage	Day	1-5	6	7-10	11-14	15-16	17-22
	Water Level	≤0	-15	>0	≤0	>0	≤0
	Photo	(X)	X	Irrigation	X (the day 11 and 14)	Rainfall	X (the day 17, 20, and 22)
	The -15 cm drainage completed on the day 6. Field is flooded for the day 7-10 by irrigation on the day 7. Then, 10 days drainage starts from the day 11 and completed on the day 22 with the interruption by rainfall on the day 15.						

5. Calculation of CH₄ and N₂O emission reductions by the direct measurement

Calculation methods for CH₄ and N₂O emission reductions by the direct measurement differ year by year. In the years when the direct measurement is implemented, the measured EF_{CH₄,R,s,st} or EF_{CH₄,R,s,d,st}, EF_{CH₄,P,s,st} or EF_{CH₄,P,s,d,st}, and EF_{N₂O,R,s,st} or EF_{N₂O,P,s,st} (hereafter, simply referred to as EF in this section) need to be used for the calculation. On the other hand, in the years when the direct measurement is not implemented, the mean EF of the previous ≥ 3 -year measurements needs to be used⁵. The 3-year initial measurements are conducted to derive the initial daily EF. The maximum interval of the direct measurement is every 5 years after the 3-year initial measurements. The examples 1 and 2 in Table C-3 show 3-year interval measurement. More frequent measurements are available as shown in the example 3 (every 2 years) or every year after the 3-year initial measurements. If the initial measured daily EF is not reasonable for project participants due to abnormal weather conditions and/or poor water management, additional measurement is possible to derive the initial daily EF as shown in the example 4. Using the example 1, if the newly measured EF in “Y”ear 5 [Meas (in)] is with “in” of the 95% confidence interval of the previously calculated mean daily EF [Calc (B12), see table footnote for details], Calc (B12) can be still used in “Y”ears 6 and 7. On the other hand, using the example 2, if the newly measured EF in “Y”ear 6 [Meas (out)] is “out” of the 95% confidence interval of the previously calculated mean daily EF [Calc (123)], the mean daily EF needs to be recalculated by adding the newly measured EF [Meas (out) in “Y”ear 6] as Calc (1236) for “Y”ears 7 and 8. The examples of the schedule for the direct measurement of 5-year and 4-year intervals are shown in Table C-4.

Table C-3. Examples of schedule for the direct measurement at 3-year interval

Year	Example 1	Example 2	Example 3	Example 4
Before	Meas	No meas	No meas	Meas
Y1	Meas	Meas	Meas	Meas
Y2	Meas	Meas	Meas	Meas (bad weather)
Y3	Calc (B12)	Meas	Meas	Additional meas
Y4	Calc (B12)	Calc (123)	Calc (123)	Calc (B13)
Y5	Meas (in)	Calc (123)	Meas (in)	Calc (B13)
Y6	Calc (B12)	Meas (out)	Calc (123)	Meas (in)
Y7	Calc (B12)	Calc (1236)	Meas (out)	Calc (B13)
Y8	Meas (in)	Calc (1236)	Calc (1237)	Calc (B13)
Y9	Calc (B12)	Meas (out)	Meas (in)	Meas (in)

⁵ We assume that 3-year measurement is scientifically sound duration to derive the mean (representative) EF in a certain area in case there is no temporal change in environmental and agronomic settings. However, this assumption may not apply to several years later (due to climate change, etc.). To confirm and correct (if necessary) the initial EF, once per 3-5 years measurement is required after the 3-year initial measurement.

Y10	Calc (B12)	Calc (12369)	Calc (1237)	Calc (B13)
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Meas: Measurement, No meas: No measurement, Calc: Calculation, B: Before.

Figures in parentheses indicate the years of measurement used to calculate the mean EF. For instance, Calc (B13) is derived using the data from the year “B”efore the project, “Y”ear 1, and “Y”ear 3.

Table C-4. Examples of schedule for the direct measurement at 5-year and 4-year intervals.

Year	Example 5 (5-year)	Example 6 (5-year)	Example 7 (5-year)	Example 8 (4-year)
Before	Meas	No meas	Meas	No meas
Y1	Meas	Meas	Meas	Meas
Y2	Meas	Meas	Meas (bad weather)	Meas
Y3	Calc (B12)	Meas	Additional meas	Meas
Y4	Calc (B12)	Calc (123)	Calc (B13)	Calc (123)
Y5	Calc (B12)	Calc (123)	Calc (B13)	Calc (123)
Y6	Calc (B12)	Calc (123)	Calc (B13)	Calc (123)
Y7	Meas (in)	Calc (123)	Calc (B13)	Meas (out)
Y8	Calc (B12)	Meas (out)	Meas (in)	Calc (1237)
Y9	Calc (B12)	Calc (1238)	Calc (B13)	Calc (1237)
Y10	Calc (B12)	Calc (1238)	Calc (B13)	Calc (1237)

6. Spatial heterogeneity of water management

It is unrealistic to apply water management uniformly across all the project fields, due to factors other than stratification parameters, such as different elevation, different soil permeability, and different water availability. This may cause the spatial heterogeneity in the success of water management. For example, it could happen that multiple drainage events are achieved in the representative project fields where the direct measurement is implemented, whereas only one drainage event is achieved in other many project fields, and vice versa.

Because the former causes the overestimation of CH₄ emission reduction, it is necessary to calculate it in a conservative manner. The CH₄ emission reduction by single drainage should be estimated by multiplying the measured CH₄ emission reduction by the conversion ratio derived from IPCC’s scaling factor to account for the differences in water regime during the cultivation period (SF_w) $[(1-0.71)/(1-0.55) = 0.29/0.45]$. On the other hand, for the latter case, the measured CH₄ emission reductions by single drainage needs to be applied to all the project fields.

7. Unexpected change from multiple drainage to single drainage

It is difficult to accurately predict the success of water management before the start of the season. For example, no or only one drainage event can be achieved due to intermittent rainfalls throughout the season, even if the farmers originally had aimed for multiple drainage events. There are two unexpected changes in the planned drainage practice. One is the change from the planned multiple drainage to the resultant single drainage (M to S), and the other is the opposite change from the planned single to the resultant multiple (S to M). Project participants need to decide on the suitable project EF of CH₄ following the procedures described in Table C-5.

Table C-5. Four cases to decide project EF used for the calculation.

Case	Procedure
M to S with the direct measurement	The measured EF is used in that year/season. Additional measurement is possible to derive suitable calculated EF for multiple drainage as shown in Tables C-3 and C-4.
M to S without the direct measurement	The calculated EF for multiple drainage needs to be corrected by multiplying by 0.71/0.55.
S to M with the direct measurement	The measured EF is used in that year/season. However, this measured EF cannot be directly used to derive the calculated EF for single drainage to be used for the following year(s)/season(s). To derive the calculated EF for single drainage, the measured EF needs to be corrected by multiplying by 0.71/0.55.
S to M without the direct measurement	The calculated EF for single drainage needs to be used in a conservative manner.

8. N₂O emission factor not affected by the success of water management

The description in the above section 6 and 7 is not applied to the calculation of N₂O emission. This is because the current IPCC's N₂O emission factor (EF_{1FR}) does not distinguish between single drainage and multiple drainage. That is, the same EF_{1FR} is used without regard to the number of drainage events achieved (i.e., one or more). This is true for the direct measurement. The measured EF_{N₂O,R,s,st} is used in that year/season and the calculated EF_{N₂O,R,s,st} is derived from the previous ≥3-year measurements without regard to the number of drainage events achieved. It is possible but not necessary to implement additional measurement for deriving suitable EF_{N₂O,R,s,st}.

9. Transitional measure for the shape of chambers

This methodology permits cylinder-shaped chambers to be used, however limited to the direct

measurement before the project (see Tables C-3 and C-4)⁶.

10. Fields with crop rotation

There can be fields with crop rotation, where rice and upland crops are cultivated consecutively, in the project areas. Such fields are classified with the parameters, water regime – pre-season and organic amendment (type). However, there can be several upland crops, including dry fallow (no crop), within the same project area. This causes a problem that different quantity and quality of upland crop residues are returned to the field on-season or off-season within the same stratum. To avoid an excess number of strata, project participants can aggregate into one stratum in case there are several upland crops, including dry fallow. In this case, the representative fields for direct measurement should be established in where the quantity of crop residue is smallest among the crops, including dry fallow, in order to conservatively estimate CH₄ emissions in the following rice season. For example, if the upland crops include maize, wheat, and dry fallow within the same stratum, project participants should select the representative fields from the fields with dry fallow.

⁶ Only in this paragraph, “direct measurement before the project” also applies to projects where their cultivation periods started before the date on which the methodology was announced on the website for approval by the Joint Committee, and where the use of rectangular-shaped chambers can be confirmed for the following rice growing seasons.