METHODOLOGY

FOR PUBLIC CONSULTATION

Small-scale methodology

METHANE EMISSION REDUCTION BY ADJUSTED WATER MANAGEMENT PRACTICE IN RICE CULTIVATION

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SUMMARY

This Methodology document, hereafter "the Methodology" is based on small scale CDM methodology AMS-III.AU. Changes have been made in the methodology based on Chapter 5.5. of IPCC 2019. In addition, new sub-sections (Subsections 6.10-6.8) have been included to reflect research-based development of emission and scaling factors. Guidelines for developing baselines and scaling factors has been included with the example for Spain.

This methodology is applicable for reduced anaerobic decomposition of organic matter in rice cropping soils. This includes activities such as rice farms that change the water regime during the cultivation period from continuously to intermittent

flooded conditions and/or a shortened period of flooded conditions; alternate wetting and drying method and aerobic rice cultivation methods; and rice farms that change their rice cultivation practice from transplanted to direct seeded rice (DSR).

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1. Definition

1. For the purpose of this methodology the following definitions[1] apply:

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

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

    (c) **IPCC approach** – the most recent version of the applicable IPCC guidance on methane emission from rice cultivation. The applicable version is from chapter 5.5, volume 4 of the 2019 refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;

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

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

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

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

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

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

Table 1. Parameters for the definition of cultivation patterns

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

[1] IPCC approach provides for the definitions (e) to (h) (see volume 4 of the 2019 Refirement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for further details).

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

Comments:

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

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

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

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

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

(f) Climate zone: use agroecological zones as shown in the Rice Almanac (Third Edition, 2002), or by HarvestChoice.

3. With the help of this field characterisation, project area can be stratified according to their cultivation pattern. All fields with the same cultivation pattern form a stratum.

2. Scope, applicability, and entry into force

2.1. Scope

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

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

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

(c) Rice farms that change their rice cultivation practice from transplanted to direct seeded rice.[2]

2.2. Applicability

5. This methodology is applicable under the following conditions:

(a) Rice cultivation in the project area is predominantly characterised by irrigated, flooded fields for an extended period of time during the growing season, i.e. farms whose water regimes can be classified as *upland* or *rainfed and deep water* are not eligible to apply this methodology. This shall be shown from a representative survey conducted in the geographical region of the proposed project or by using national data. This project area characterisation shall also include information on pre-season water regime and applied organic amendments, so that all dynamic parameters as shown in Table 2 are covered by the baseline study;

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

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

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

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

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

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

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

2.3. Entry into force

6. The date of entry into force is the date of the publication on 20/10/2022.

3. Baseline methodology

3.1. Project boundary

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

3.2. Baseline

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

3.3. Baseline emissions

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

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

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

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e)
BE_s	=	Baseline emissions from project fields in season *s* (t CO_2e)
$EF_{BL,s,g}$	=	Baseline emission factor of group *g* in season *s* (kgCH_4/ha per season)
$A_{s,g}$	=	Area of project fields of group *g* in season *s* (ha)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)
g	=	Group *g*, covers all project fields with the same cultivation pattern as determined with the help of Table 2 (*G* = total number of groups)

3.4. Determination of baseline emission factor on reference fields

10. Baseline reference fields shall be set up in a way that they are representative of baseline emissions in the project rice fields. For each group of fields with the same cultivation pattern, as defined with the help of Table 2, at least three reference fields with the same

pattern shall be determined in the project area. On these fields, measurements using the closed chamber method shall be carried out, each resulting in an emission factor expressed as $kgCH_4/ha$ per season. The seasonally integrated baseline emission factor $EF_{BL,s,g}$ shall be derived as average value from the three measurements for each group (see the appendix for guidelines on methane measurement).

3.5. Leakage

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

3.6. Project emissions

12. Project emissions consist of the CH_4 emissions, which will still be emitted under the changed cultivation practice. Due to the optimised *N* fertilisation practice (cf. applicability criteria in paragraph 3(d), *N* fertiliser control), N_2O emissions do not significantly deviate from the baseline emissions and hence are not considered.

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

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

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

Where:

PE_y	=	Project emissions in year *y* (t CO_2e)
PE_s	=	Project emissions from project fields in season *s* (t CO_2e)
$EF_{P,s,g}$	=	Project emission factor of group *g* in season *s* ($kgCH_4/ha$ per season)

3.7. Determination of project emission factor on reference fields

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

3.8. Emission reductions

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

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

Where:

ER_s = Emission reductions in season s (t CO_2e)

3.8.1. Ex ante estimation of emission reductions

15. For the ex-ante estimation of emission reductions within the project design document (PDD), project participants shall either refer to own field experiments or estimate baseline and project emissions with the help of national data or IPCC tier 1 default values for emission and scaling factors. The approach shall be explained and justified in the PDD.

3.8.2. Emission reductions using IPCC tier 1 approach or default values

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

17. **Option 1:** Using the IPCC tier 1 approach but undertaking measurements to determine baseline emission factors for continuously flooded fields, as per the following formula:

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

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

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

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

18. Where:

ER_y = Emission reductions in year *y* (t CO_2e)

EF_{ER} = Adjusted daily emission factor (kgCH_4/ha/day). Alternatively, seasonal emission factor (kgCH_4/ha/season) may be determined[3]

[3] In this methodology, “season” means an entire cropping season (from land preparation until harvest or post season drainage). If a seasonal emission factor is opted, it should be based on measurements over the entire period of flooding, and should account for fluxes of soil-entrapped methane that typically occur upon drainage.

A_y = Area of project fields in year *y* (ha)

L_y = Cultivation period of rice in year *y* (days/year). This is not applicable when seasonal emission factor is determined

GWP_{CH4} = Global warming potential of CH_4 (t CO_2e/t CH_4)

EF_{BL} = Baseline emission factor (kgCH_4/ha/day) or (kgCH_4/ha/season)

EF_P = Project emission factor (kgCH_4/ha/day) or (kgCH_4/ha/season)

$EF_{BL,c}$ = Baseline emission factor for continuously flooded fields without organic amendments (kgCH_4/ha/day) or (kgCH_4/ha/season)

$SF_{BL,w}$ or $SF_{P,w}$ = Baseline or project scaling factors[4] to account for the differences in water regime during the cultivation period

$SF_{BL,p}$ or $SF_{P,p}$ = Baseline or project scaling factors to account for the differences in water regime in the pre-season before the cultivation period

$SF_{BL,o}$ or $SF_{P,o}$ = Baseline or project scaling factors should vary for both type and amount of organic amendment applied

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

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

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

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[4] For all scaling factors used in the methodology, the average values in 2019 refinement to the 2019 refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories are chosen. Uncertainties related to scaling factors may be considered in the future revision of the methodology.

Table 2. IPCC default values for $SF_{BL,w}$ or $SF_{P,w}$

Water regime during the cultivation period		$SF_{BL,w}$ or $SF_{P,w}$
Irrigated	Continuously flooded	1
	Single drainage period	0.71
	Multiple drainage periods	0.55

Source: IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 4, chapter 5.5, Table 5.12

Continuously flooded: Fields have standing water throughout the rice growing season and may only dry out for harvest (end-season drainage).

Single drainage period: fields have a single drainage event and during the cropping season, in addition to an end of season drainage.

Multiple drainage periods: fields have more than one drainage event and period of time without flooded conditions during the cropping season, in addition to an end of season drainage, including alternate wetting and drying (AWD).

22. IPCC default for $SF_{BL,p}$ or $SF_{P,p}$ is provided in the following table. For regions/countries where it can be demonstrated by official government data or peer-reviewed literature that double cropping is practiced, a default value of 1.0 is used. Otherwise, 0.89 is used.

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

Water regime prior to rice cultivation	$SF_{BL,p}$ or $SF_{P,p}$
Non flooded pre-season < 180 days (indicating double cropping)	1
Non flooded pre-season > 180 days (indicating single cropping)	0.89

(a) Source: IPCC 2019, volume 4, chapter 5.5, Table 5.13.

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

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

Where:

ROA_i = Application rate of organic amendment type *i*, in dry weight for straw and fresh weight for others, tonne ha^{-1}.

5 tonne/ha of straw is assumed as the baseline quantity of organic amendment, because the value of leftover straw after harvest is in the range of 3 tonne/ha (when harvested manually to the ground level, leaving very little stubble and the root residues) to 7 tonne/ha (harvested mechanically leaving behind large amount of crop residues on the field)

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

0.19 is used for a single crop and 1.0 for a double crop[5]

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

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

Water regime prior to rice cultivation	$SF_{BL,o}$ or $SF_{P,o}$	
Non flooded pre-season < 180 days (indicating double cropping)	2.88	$SF_{BL,o}$ or $SF_{P,o}$ = $(1 + 5 \times 1)^{0.59} = 2.88$
Non flooded pre-season > 180 days (indicating single cropping)	1.48	$SF_{BL,o}$ or $SF_{P,o}$ = $(1 + 5 \times 0.19)^{0.59} = 1.48$

(b) Source: calculated using equation (10) above with default values from IPCC 2019, volume 4, chapter 5.5, Table 5.14.

25. The above table is for rice straw only. To include other organic amendments following IPCC 2019 Table 5.14, the data will be:

(a) For compost, the $SF_{BL,o}$ or $SF_{P,o}$ will be $(1 + C \times 0.17)^{0.59}$;

(b) For farm yard manure, the $SF_{BL,o}$ or $SF_{P,o}$ will be $(1 + YM \times 0.21)^{0.59}$;

(c) For green manure, the $SF_{BL,o}$ or $SF_{P,o}$ will be $(1 + GM \times 0.45)^{0.59}$;

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

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

[5] For a single crop, where the rice straw is usually ploughed back to the soil after the harvest of the crop and left for long period of time (i.e. rice straw is incorporated for a duration of > 30 days before cultivation), the straw is already mineralised being left in the dry field. Therefore, the readily fermentable C component of the rice straw is less at flooding. This gives rise to lesser methane production when the soil is flooded for cultivation, therefore, 0.19 (IPCC 2019) is used.

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

Table 6. Specific emission factors for baseline, project and emission reductions ($kgCH_4$/ha/day) or ($kgCH_4$/ha/season)

	$EF_{BL,c}$	Baseline				Project scenarios	Project				Emission reduction factor (EF_{ER})
		$SF_{BL,w}$	$SF_{BL,p}$	$SF_{BL,o}$	Emission factor (EF_{BL})		$SF_{P,w}$	$SF_{P,p}$	$SF_{P,o}$	Emission factor (EF_{P})	
For regions/ countries where double cropping is practiced	$EF_{BL,c}$	1.00	1.00	2.88	$EF_{BL,c}$ x 2.88	**Scenario 1:** change the water regime from continuously to intermittent flooded conditions (single drainage)	0.71	1.00	2.88	$EF_{BL,c}$ x 2.04	$EF_{BL,c}$ x 0.84
						Scenario 2: change the water regime from continuously to intermittent flooded conditions (multiple drainage)	0.55	1.00	2.88	$EF_{BL,c}$ x 1.58	$EF_{BL,c}$ x 1.30
For regions/ countries where single cropping is practiced	$EF_{BL,c}$	1.00	0.89	1.48	$EF_{BL,c}$ x 1.32	**Scenario 1:** change the water regime from continuously to intermittent flooded conditions (single drainage)	0.71	0.89	1.48	$EF_{BL,c}$ x 0.94	$EF_{BL,c}$ x 0.38
						Scenario 2: change the water regime from continuously to intermittent flooded conditions (multiple drainage)	0.55	0.89	1.48	$EF_{BL,c}$ x 0.72	$EF_{BL,c}$ x 0.6

27. **Option 2:** using global default values derived from IPCC tier 1 approach.

28. Emission reductions shall be calculated, as per the equation (6), using both default emission values from IPCC 2019, volume 4, chapter 5.5, Table 5.11 and scaling factors summarised in table 6 above. Adjusted daily emission factor EF_{ER} ($kgCH_4$/ha/day) given below in different project scenarios:[6]

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

(i) Use 1.00 ($kgCH_4$/ha/day) for project activities that shift to intermittent flooding (single drainage);

(ii) Use 1.55 ($kgCH_4$/ha/day) for project activities that shift to intermittent flooding (multiple drainage);

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

(i) Use 0.45 ($kgCH_4$/ha/day) for project activities that shift to intermittent flooding (single drainage);

(ii) Use 0.71 ($kgCH_4$/ha/day) for project activities that shift to intermittent flooding (multiple drainage).

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

30. **Tier 2** applies the same methodological approach as Tier 1, but country-specific emission factors and/or scaling factors should be used. These country-specific factors are needed to reflect the local impact of the conditions (i, j, k, etc.) that influence CH4 emissions, preferably being developed through collection of field data (e.g. effects of soil type and rice cultivar). As for Tier 1 approach, it is encouraged to implement the method at the most disaggregated level and to incorporate the multitude of conditions (i, j, k, etc.) that influence CH4 emissions.

31.

EQUATION 5.2A (NEW)
ADJUSTED DAILY EMISSION FACTOR (TIER 2)

$$EF_i = EF_c \bullet SF_w \bullet SF_p \bullet SF_o \bullet SF_s \bullet SF_r$$

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6 Under this option, $EF_{BL,c}$ = 1.19 ($kgCH_4$/ha/day) as an example of the world emission factor from IPCC 2019, volume 4, chapter 5.5, Table 5.11. is used in Table 6 to derive at EF_{ER}. Note that 2019 Refinement to the 2006 IPCC Guidelines for National Gas Inventories includes different emission factors for East Asia, Southeast Asia, South Asia, Europe, North America, South America and Africa. That data should be used instead of the global mean as good practice.

32. Where:

SF_s = scaling factor for soil type

SF_s = scaling factor for rice cultivar

4. Monitoring methodology

4.1. Monitoring of baseline and project emissions

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

Data / Parameter table 1.

Data / Parameter:	**$EF_{BL, s, g}$**
Data unit:	$kgCH_4$/ha per season
Description:	Baseline emission factor
Source of data:	-
Measurement procedures (if any):	As per the instructions in the appendix (Guidelines for measuring methane emissions from rice fields) and IPCC 2019, volume 4, chapter 5.5.
Monitoring frequency:	Regular measurements as per closed chamber method guidance, seasonally integrated
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	**$EF_{BL, c}$**
Data unit:	$kgCH_4$/ha/day or $kgCH_4$/ha/season
Description:	Baseline emission factor for continuously flooded fields without organic amendments
Source of data:	-
Measurement procedures (if any):	As per the instructions in the appendix (Guidelines for measuring methane emissions from rice fields) and IPCC 2019, volume 4, chapter 5.5.

Monitoring frequency:	Determined ex ante prior to the start of the project activity (in this case, the ex-ante value should be used to calculate emissions reduction during the crediting period) or monitored annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	$\mathbf{EF_{P,s,g}}$
Data unit:	$kgCH_4$/ha per season
Description:	Project emission factor
Source of data:	-
Measurement procedures (if any):	As per the instructions in the appendix (Guidelines for measuring methane emissions from rice fields) and IPCC 2019, volume 4, chapter 5.5.
Monitoring frequency:	Regular measurements as per closed chamber method guidance, seasonally integrated
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 4.

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

Data / Parameter table 5.

Data / Parameter:	A_y
Data unit:	ha
Description:	Aggregated project area in year *y*.
Source of data:	-
Measurement procedures (if any):	To be determined by collecting the project field sizes in a project database. The size of project fields shall be determined by GPS or satellite data. Should such technologies not be available, established field size measurement approaches shall be used provided that uncertainties are taken into account in a conservative manner
Monitoring frequency:	Every year
QA/QC procedures:	-
Any comment:	This parameter is only required to monitor if approach mentioned under paragraph 21 i.e. option 1 or 30 i.e. option 2 is used. Only compliant farms are considered (see paragraph 34 below)

Data / Parameter table 6.

Data / Parameter:	Ly
Data unit:	days/year
Description:	Cultivation period of rice in year *y*
Source of data:	-
Measurement procedures (if any):	To be determined using cultivation logbooks
Monitoring frequency:	Every year
QA/QC procedures:	-
Any comment:	This parameter is only required to monitor if approach mentioned under paragraph 21 i.e. option 1 or 30 i.e. option 2 is used. Also, this parameter is not monitored when seasonal emission factor is applied.

4.2. Monitoring of farmers' compliance with project cultivation practice

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

(a) Sowing (date);

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

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

(d) Yield.

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

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

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

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

5. Project activity under a Programme of Activities

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

Appendix. A. Guidelines for measuring methane emissions from rice fields

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

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

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

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

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

Feature	Conditions	
	water exchange between inside and outside; • Base should be installed at least 24 hours before the first sampling	
Auxiliaries of chamber	• Thermometer for measuring the temperature inside the chamber; • Fan (battery operated) inside the chamber for mix the inside air during sampling; • Sampling port (rubber stopper placed in a bore of the chamber)	
Basal area	Rectangular or rounded, but has to cover minimum of four rice hills (ca. 0.1 m² minimum)	
Height	Option 1: Fixed height Total height (protruding base + chamber) should exceed plant height	Option 2: Flexible height • Adjustable to plant height; • Chambers with different heights or modular design

Table 2. On the field – air sampling

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

Table 3. Laboratory analysis

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

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

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

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

Where:

$m_{CH4,t}$ = Mass of CH_4 in chamber at time t (mg)

t = Point of time of sample (e.g. 0, 15, 30 in case of three samples within 30 minutes)

$c_{CH4,t}$ = CH_4 concentration in chamber at time *t*, from gas analysis (ppm)

$V_{Chamber}$ = Chamber volume (L)

M_{CH4} = Molar mass of CH_4: 16 g/mol

$1atm$ = Assume constant pressure of 1atm, unless pressure measurement is installed

R = Universal gas constant: 0,08206 L atm K-1 mol-1

T_t = Temperature at time *t* (K)

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

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

Where:

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

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

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

Where:

RE_{ch} = Emission rate of chamber *ch* (mg/h × m²)

ch = Index for replicate chamber on a plot

$A_{Chamber}$	=	Chamber area (m²)

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

Equation (4)

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

Where:

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

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

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Appendix. B. Guidelines for developing baselines and scaling factors. The example for Spain.

a. Development of a new country-specific baseline: the example for Spain

1. According to the IPCC 2019 (Refinement to the 2006 IPCC Guidelines for national Greenhouse for national Greenhouse Gas Inventories), it is encouraged to use direct measurements to calculate country specific emission factors. This procedure is referred as **Tier 3**[7].The default country specific value for Spain reported in the National Inventory[8] of 2022 (1.3 kg CH_4/ha/day) was calculated based on the $EF_{BL,c}$ and scaling factors ($SF_w, SF_p, and\ SF_o$) provided by IPCC 2006 (Tier 1). The scientific articles described in Table 4 could be used to calculate new baseline emission factors. These articles have determined baseline emission values ($EF_{BL,c}$) for the main cultivation areas in Spain: Andalucía, Aragón, Ebro Delta and Extremadura (see Figure 1., from Gomez de Barreda et al., 2020).

Table 4. Description of scientific literature used to calculate the Emission Factors.

Location	Scientific reference	Years evaluated	DOI / link
Andalucía. MG	Seiler et al., 1983	1982	https://doi.org/10.1007/BF00058731
Extremadura. EX	Fangueiro et al., 2017	2011, 2012, 2013	http://dx.doi.org/10.1016/j.atmosenv.2016.11.020
Albufera, Valencia. VA	Sanchis, MSc´s Thesis, 2014	2013	https://riunet.upv.es/handle/10251/47780?show=full
Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2018	2015	https://doi.org/10.1371/journal.pone.0198081
Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2021a	2015, 2016	https://doi.org/10.1007/s11104-020-04809-5
Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2021b	2016, 2017	https://doi.org/10.1016/j.agwat.2021.107164

[7] IPCC 2019-Guidelines for national Greenhouse for national Greenhouse Gas Inventories (Figure 5.2, Volume 4,).

[8] Spain Nacional Inventory (2022): Report on the National Inventory of Greenhouse Gas Emissions Ministry for the Ecological Transition and the Demographic Challenge General Technical Secretariat. Publication Center 2022 NIPO: 665-22-007-8: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/es_nir_edicion2022_tcm30-523942.pdf

Ebro Delta, Catalunya. DE	BelenguerManzanedo et al., 2022	2018	https://doi.org/10.1007/s11104-021-05234-y
Ebro Delta, Catalunya. DE	Maris et al., 2016	2012	https://doi.org/10.1016/j.scitotenv.2016.06.040
Aragon. AR	Maris et al., 2016	2012	https://doi.org/10.1016/j.scitotenv.2016.06.040

2. These scientific articles have different experimental settings which hamper the direct calculation of mean emission values (e.g. they are not all following continuously flooded conditions without organic amendment). To consider these different experimental conditions applied it is proposed to calculate the $EF_{BL,c}$ from the baseline emission factor (EF_{BL}) calculated for each of the experiments (Table 5). $SF_w, SF_p, and\ SF_o$ values used in Table 5 have been calculated following the information from the scientific articles described in Table 4 and the guidelines of Chapter 5.5. from 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories[9].

[9] IPCC 2019: Section 5.5.2., Volume 4, Chapter 5.5 https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf

Table 5. Calculation of $EF_{BL,c}$ from the baseline EF_{BL} . $EF_{BL,c}$ refers to methane emissions during the growing period in the following conditions: continuous flooding during cultivation, winter flooding, and no organic amendment included.

Location	EF_{BL} (kgCH4/ha/year)	SFw	SFp	ROA[1]	CFOA	SFo[2]	**$EF_{BL,c}$ (kgCH4/ha/year)**
Andalucia. MG	120.00	1	0.89	0	0.19	1.00	134.83
Extremadura. EX	353.00	1	0.89	5	0.19	1.48	267.46
Albufera. Valencia. VA	557.50	1	1	8	0.19	1.73	323.16
Ebro Delta. Catalunya. DE	98.40	1	1	5	0.19	1.48	66.36
Ebro Delta. Catalunya. DE	96.60	1	1	5	0.19	1.48	65.14
Ebro Delta. Catalunya. DE	44.15	1	1	5	0.19	1.48	29.77
Ebro Delta. Catalunya. DE	141.01	1	1	5	0.19	1.48	95.09
Ebro Delta. Catalunya. DE	437.00	1	1	5	0.19	1.48	294.69
Aragon. AR	157.00	1	1	5	0.19	1.48	105.87
Mean	222.74					Mean	**153.60**
CI - 95%	84.23					CI - 95%	**68.33**
	361.25						**238.87**

ROA[1] = 5 tonne/ha of straw is assumed as the baseline quantity of oganic ammendent (CDM, AMS-III.AU.26)

SFo[2] = $(1+ \sum ROA \times CFOA)^{0.59}$

3. The calculated $EF_{BL,c}$ (153.60 kgCH4/ha/year) is within the interval calculated values estimated by the national Inventory Report of Spain (195 kgCH4/ha/year) and the work of Wang, 2018 (128.82 kgCH4/ha/year).

4. The application of $SF_w, SF_p, and\ SF_o$ prior to the calculation of the mean values has reduced the 95% Confidence Interval EF_{BL} (84.23-361.25) to $EF_{BL,\ C}$ (68.33-238.87), suggesting the validity of the proposed approach. The reduction of EF_{BL} (222.74) to $EF_{BL,\ C}$, (153.60) suggests that the direct use of EF_{BL} could have overestimated the real values by not considering the specific experimental settings of each of the studies considered.

5. Regarding the scaling factors, the IPCC 2019[10] states that if no national factors are available, the default IPCC scaling factors can be used. Therefore,

[10] IPCC 2019: Section 5.5.2., Volume 4, Chapter 5.5 https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf

the default scaling factors in IPCC 2019 (Vol. 4) are used for the establishment of this baseline.

6. As an example, in this table, the Emission Factor (EF_{BL}) for irrigated rice fields (kgCH4/ha/season) has been calculated based on: scaling factor for the water regime (SF_w), scaling factor for pre-season water regime (SF_p) and for scaling factor for organic amendment (SF_o). This scaling factor values are based on the IPCC 2019[11].

Table 6. Calculation of emission factor (EF_{BL}) for irrigated rice fields

		EFc	Baseline*			
			SFw	SFp	SFo	Emission Factor (EF_{BL})
For single cropping	Continuously flooded	153,6	1	0,89	1,48	202,32
	Intermittent flooded-single drainage	153,6	0,71	0,89	1,48	143,65
	Intermittent flooded-multiple drainage	153,6	0,55	0,89	1,48	111,28

*Scaling factor values are based on IPCC 2019

b. Requirements for the development of a new country-specific baseline

1. The example above for Spanish conditions may be applicable for countries or regions with similar agroclimatic and cultural practices. Nonetheless, if data of methane emission is available, it is recommended the development of new country-specific following the example above (i.e. rice fields in Italy where emission data are available). The data should be obtained from reputed academic institutions or scientific articles published in indexed scientific journals. Still, considering the variability among the experimental settings of the scientific articles, it is recommended to have a minimum set of 10 sites*year data, and if possible, three years. In the example above, nine experiments were selected with a total of 13 sites*year (some sites having more than one year). This strategy will help minimising the variability. In addition, the calculation of $EF_{BL,c}$ from EF_{BL} using the default values from IPCC can help reducing the variability related to the experimental settings of the scientific articles. This strategy reduces the variability in the emission factors associated to water regime prior and during to rice cultivation, and to organic amendments.

[11] IPCC 2019: Section 5.5.2., Volume 4, Chapter 5.5 https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf

2. Peer-reviewed scientific literature on methane emission in rice fields may be scarce in some countries where projects are developed. In this case, a still feasible option is the use of scientific articles from zones with similar agroclimatic conditions and cultural practices. The emission factors calculated using this approach may still be yielding more accurate country-specific emission factors that those proposed by statistical modelling from IPCC or national inventory values, which may not be updated (i.e. the emission factor for Spanish National Inventory in 2022 was still taken from IPCC 2006[12]).

c. A proposal for the consideration of post-harvest period (fallow season) in the calculation of baseline emission factors. An example for Spanish conditions.

3. An important finding regarding methane emissions in rice fields in temperate conditions is the high emission level during the fallow season when straw is incorporated after the growing cycle (referred as "off-season" straw incorporation in the IPCC 2019). Martinez-Eixarch et al., (2021a,b) have shown that neglecting the fallow season can significantly underestimate annual methane emissions in Ebro Delta rice fields (Spain, temperate conditions).

4. Martinez-Eixarch et al. 2021a showed that 36.9% of methane was emitted during the growing season and 63.1% during the flooded fallow season, mainly in October, when temperatures remain high in most of Spanish rice culture areas. October indeed accounted for over 45% of the annual emissions. This high value is related to the favorable conditions for methanogenesis in Ebro Delta rice paddy fields in October: 1) off-season straw incorporation, 2) flooding conditions and 3) the high temperatures.

5. Nonetheless, most of the field analysis of methane circumvents this fact, since it is assumed that most of the CH4 from the previous season will be emitted during the next growing season, but this is not the case (Martinez-Eixarch et al., 2021a,b). Thus, to avoid the underestimation of methane emissions, it is proposed the use of an off-season scaling factor as described in Table 7:

Table 7. Calculation for the scaling factor for off-season (fallow) measurements in Spanish conditions (SF_{FS}).

Location	Scientific reference	Year evaluated	DOI / link	Treatment	EF (kgCH4/ha/season)
Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2021a	2015, 2016	https://doi.org/10.1007/s11104-020-04809-5	Cultivation	96,6

[12] Spanish National Inventory (2022): Report on the National Inventory of Greenhouse Gas Emissions Ministry for the Ecological Transition and the Demographic Challenge General Technical Secretariat. Publication Center 2022 NIPO: 665-22-007-8: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/es_nir_edicion2022_tcm30-523942.pdf, https://unfccc.int/documents/228014, accessed on 18.08.2022.

Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2021a	2015, 2016	https://doi.org/10.1007/s11104-020-04809-5	Off-season	163,9
				Total	**260,50**

Scaling factor fallow season	**Winter flooding**	**SF_{FS}**	**Error range[1]**
Measurements include off-season	-	1	0.73-1.27
Measurements does not include off-season	Yes	2,70	1,97-3,43
	No	1,1	0,80-1,40

[1] Error ranges are proportional to the values calculated for continuosuly flooded conditions in Annex 5.A.2 using statistical model and updated database
SF_{FS} = 1,1 is obtained combining the data from BelenguerManzanedo et al., 2022 and Martinez-Eixarch et al. 2021b

6. This scaling factor is proposed to be applied to the calculation of baseline emissions when the post-harvest period has not been measured. In the case of Spain, this scaling factor would be applied to the values of $EF_{BL,c}$ given in Table 8. The application of a scaling factor (2.7) highly increases the emission baseline, but according to the scientific literature supporting the post-harvest emission, this value should be considered. Indeed, a similar value is considered by the IPCC[13] for flooded pre-season conditions ($\boldsymbol{SF_p} = 2.41$), which may reflect the high methane emission from the decomposition of organic matter under anoxia, just before the growing period. This high value ($\boldsymbol{SF_p} = 2.41$) comes from the analysis of Wang et al., 2008, which used a dataset where subtropical and tropical rice fields are overrepresented compared to temperate fields. The different cultural practices between temperate and tropical and subtropical paddy rice fields could explain the different need of scaling factors for different regions. This would support the definition of scaling factors for regions based on scientific evidence as shown above.

d. Calculation of scaling factors for pre-season water regime (SF_p) and multiple drainage period (AWD) (SF_w). An example for Spanish conditions.

d.1. Pre-season water regime ($\boldsymbol{SF_p}$)

[13] IPCC 2019: Table 5.13, Section 5.5.2., Volume 4, Chapter 5.5 https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf

7. Recent scientific literature developed in Spain has provided a basis to quantify new scaling factors for pre-season flooding and water regime during crop cultivation.

8. The values of the scaling factors developed in the IPCC 2019 (Vol 4, 5.55) for the water regime -before the cultivation period to (SF_p) may not be fully representative to the cultural practices used in Spanish, or even, in other temperate rice areas.

9. Belenguer-Manzanedo et al., (2022) showed that removing the pre-season flooding (referred as “winter flooding” in their manuscript; that is from end of September—after harvest- to end of December) significantly reduced the methane emissions. In this way, and according to the data from Belenguer-Manzanedo et al., (2022), a post-harvest (or, as defined in terms of Table 5.13 of IPCC 2019, pre-season flooding) scaling factor for water regime can be proposed, as shown in Table 8:

Table 8. Calculation of a post-harvest water regime scaling factor (SF_p)

Location	Scientific reference	Year evaluated	DOI / link	Treatment	EF (kgCH4/ha/ season)
Ebro Delta, Catalunya. DE	BelenguerManzanedo et al., 2022	2018	https://doi.org/10.1007/s11104-021-05234-y	Pre-season flooding	258,90
Ebro Delta, Catalunya. DE	BelenguerManzanedo et al., 2022	2018	https://doi.org/10.1007/s11104-021-05234-y	Pre-season flooding	294,30
				Mean	**276,60**
Ebro Delta, Catalunya. DE	BelenguerManzanedo et al., 2022	2018	https://doi.org/10.1007/s11104-021-05234-y	Pre-season flooding	153,20
Ebro Delta, Catalunya. DE	BelenguerManzanedo et al., 2022	2018	https://doi.org/10.1007/s11104-021-05234-y	Pre-season flooding	155,80
				Mean	**154,50**

Scaling factor for pre-season flooding (SF_p)=		(∑ Non-off-season flooding) / (∑ Off-season flooding) =	**0,56**
		Error range[1]	0,49-0,63

[1] Error ranges are proportional to the values calculated in Annex 5.A.2 using statistical model and updated database.

10. Thus, it can be proposed for its use in Spain a SF_p = 0.56, in non-flooded (end of September—after harvest- to end of December) rice fields where rice straw is incorporated after harvest.

d.2. Multiple drainage period (AWD) (SF_w)

11. Regarding the water regime during the cultivation period, Martinez Eixarch et al., (2021b) have shown that alternate wetting and drying (AWD) treatments can reduce the CH4 emissions from 44.15 to 2.45 kgCH4/ha/season. The large CH4 mitigation capacity of AWD shown by Martinez Eixarch et al., (2021b) is comparable to that reported by other authors Linquist et al. (2015) and Peyron et al. (2016), in other regions. Therefore, a new scaling factor (SF_w = 0,06 instead of 0.55 as used in the IPCC2019) is suggested for multiple drained periods in the Spanish conditions as shown in table 9:

Table 9. Calculation for the scaling factor for multiple drainage periods in Spanish conditions (SF_w).

Location	Scientific reference	Year evaluated	DOI / link	Treatment	EF (kgCH4/ha/season)
Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2021b	2016	https://doi.org/10.1016/j.agwat.2021.107164	Continuously flooded	18,5
Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2021b	2017	https://doi.org/10.1016/j.agwat.2021.107164	Continuously flooded	69,8
				Mean	**44,15**
Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2021b	2016	https://doi.org/10.1016/j.agwat.2021.107164	AWD	1,7
Ebro Delta, Catalunya. DE	Martinez-Eixarch et al. 2021b	2017	https://doi.org/10.1016/j.agwat.2021.107164	AWD	3,2
				Mean	**2,45**
	Scaling factor for winter flooding (SF_w)=		(∑ AWD) / (∑ Continuously flooded) =	0,06	
			Error range[1]	0,04-0,07	

[1] Error ranges are proportional to the values calculated in Annex 5.A.2 using statistical model and updated database

12. Thus, it can be proposed for its use in Spain a SF_w = 0.06, when using multiple drainage periods during the cultivation of rice.

e. Validity of the proposed standardized baseline

The proposed standardised baseline can be valid until differences in the culture practices are developed, or new scientific evidence provide new emission values of rice fields in Spain.

f. References and any other relevant information

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27. IPPC Guidelines 1996

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29. IPCC 2019 Refinement to the 2006 IPCC Guidelines - https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf/Cr%C3%A8dits%20de%20carboni/IPCC%202019%20-%2019R_V4_Ch05_Cropland.pdf

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g. Development of emissions and scaling factors for CH4 emissions

31. The development of emissions and scaling factors for methane emissions in paddy rice fields in Spain has been done using the published scientific literature relevant to Spain rice growing conditions.

32. Some requirements and criteria that must be considered to develop these emission and scaling factors are described below:

g.1. Requirements and quantification to determine country-specific emission and scaling factors:

33. In Annex 5A.2 IPCC 2019[14] volume 4, there is a good practice guideline that describes the criteria for collecting and selecting data that can be included in the data set. It is based on the publication of Yang et al. 2005.

34. The document for the development of emission factors in the Philippines ASB0008-2020[15], has been used as an example for the development of part of this document. In that report, part of the information is obtained from the version 4.0 of the Small-Scale Methodology AMS-III.AU "Reduction of methane emissions through lean water management practices in rice cultivation" derived from the IPCC 2016.

[14] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 4, chapter 5.5. https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf

[15] Methane Emissions from Rice Cultivation in the Republic of the Philippines (version 01.0).

g.2. Criteria to identify credible data and information:

35. In the CDM[16] guidelines document, it is listed that the most important criteria to identify credible data and information are based on different tools such as: relevance, completeness, consistency, credibility, correctness, accuracy, objectivity, conservativeness, security, transparency and traceability.

g.3. Criteria to determine coverage of data and validity:

36. In the Standard document of CDM[17] for determining data coverage and validity of standardised baselines, there are two types of data coverage period. One for constant standardised baselines and another one for dynamic standardised baselines. For the former, a minimum of three years of historical activity data shall be used to develop a proposed new constant standardised baseline or a revision to an approved constant standardised baseline. Three-year historical activity data is needed to capture seasonal variations and variations in activity data from one year to another (for example, hydroelectric power generation). For the second case, regarding to activity data to develop a new proposed standardised baseline, or a revision to or an update of an approved standardised baseline, the most recent available data with a maximum of five years of data correntness shall be used.

37. Exceptionally, historical activity data covering less than three years, but of a minimum one year, may be used for developing a proposed new constant standardied baseline or its revision, if three years of historical activity data within the past five years are not available with due justification.

38. In this document, we have determined the emission baseline based on scientific data from 1982 to 2018 reaching the minimum of three years.

39. Regarding the scaling factors, less than three years were available for the determination of scaling factors (one year, two years and two years for post-harvest water regime, for multiple drainage periods, and for fallow season, respectively. We consider that the scaling factors proposed in this document are more accurate that model-derived observations for the rice cultivation conditions in Spain. Indeed, similar values obtained by other authors in different climatic conditions for the three scaling factors proposed:

(a) Post-harvest water regime: Fey et al. (2004), Sander et al. (2014) and Zhang et al. (2010);

(b) Multiple drainage periods: Linquist et al., 2014, Peyron et al., 2016;

(c) Fallow season (Fitzgerald et al., 2000, Pittelkow et al., 2013).

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[16] Guideline from de CDM-Quality assurance and quality control of data used in the establishment of standardised baselines:. https://cdm.unfccc.int/filestorage/e/x/t/extfile-20140605162815656-meth_guid46.pdf/meth_guid46.pdf?t=MVJ8cmV1d2hjfDBm8vxwQZvhFLIWyIH-eT-C

[17] Based on CDM Standard- Determining coverage of data and validity of standardised baselines https://cdm.unfccc.int/filestorage/e/x/t/extfile-20201215164216095-methSB_stan01.pdf/methSB_stan01.pdf?t=SzZ8cmVqcDVofDAdmyfmnAiJKZ7ZpxXXrDGV

DOCUMENT HISTORY

Version	Date	Description
1.0	dd/mm/yyyy	First version