Food and Agriculture Organization of the United Nations

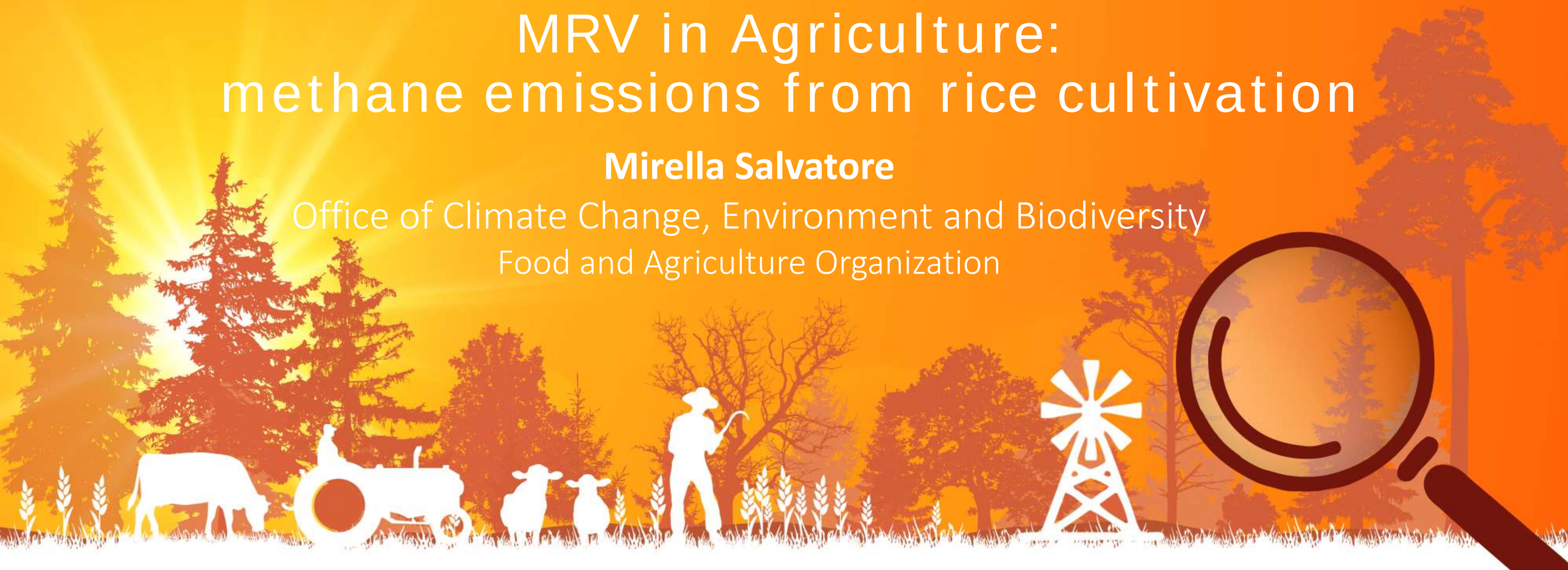
FAO and the Enhanced transparency framework

MRV in Agriculture: methane emissions from rice cultivation

Mirella Salvatore

Office of Climate Change, Environment and Biodiversity

Food and Agriculture Organization



What is a GHG inventory?

A set of **estimates** of emissions and removals of greenhouse gases (GHG) from a defined **area** in a specific **period** of time.

Examples of **human activities that generate/remove** GHG emissions are:




Why a country needs a GHG inventory

GHG inventory is at the core of the UNFCCC convention which aims to achieve **stabilization of GHGs in the atmosphere**

Article 4 and 12 of the Convention **- Commitments**

*1. All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, **shall**:*

- *(a) Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, **national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases ……***

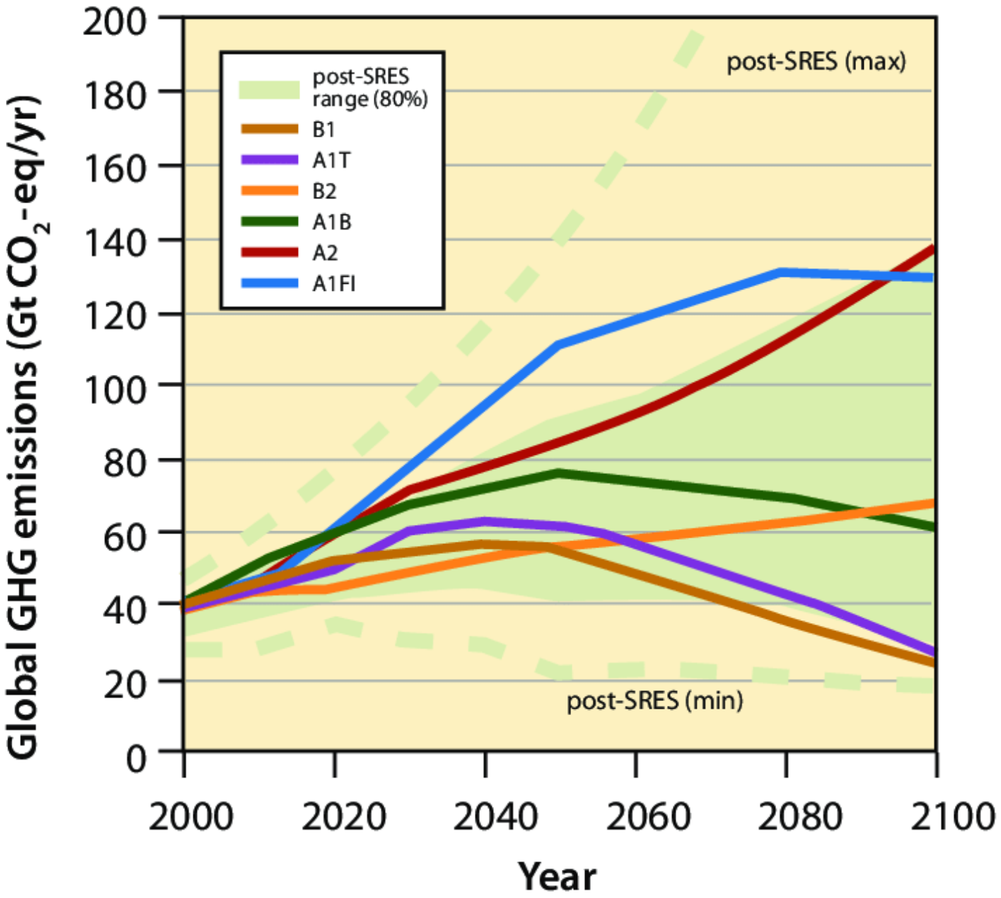
Why a country needs a GHG inventory

Understand where a country stands –**planning flows from there**

Identify the **greatest sources or sinks** of GHG emissions and removals

Understand emission and removal **trends**

Develop strategies and policies and track their progress



IPCC, 2007

LESSON

Measurement - Intergovernmental Panel on Climate Change (IPCC) guidelines

The Measurement component of the MRV framework entails the estimation of emissions and removals following methodological guidance and approaches. Upon request from the UNFCCC, a series of guidelines for preparing the NGHGI have been produced by the Intergovernmental Panel on Climate Change (IPCC). The full collection can be found at the IPCC TFI web site.

What is the IPCC?

The IPCC is the leading international body for the assessment of climate change and its impacts.

Click on the logo for more information.

During the past two decades, IPCC has produced several guidelines. This course focuses on the 2006 IPCC guidelines and integrates the 2013 Wetlands Supplement.

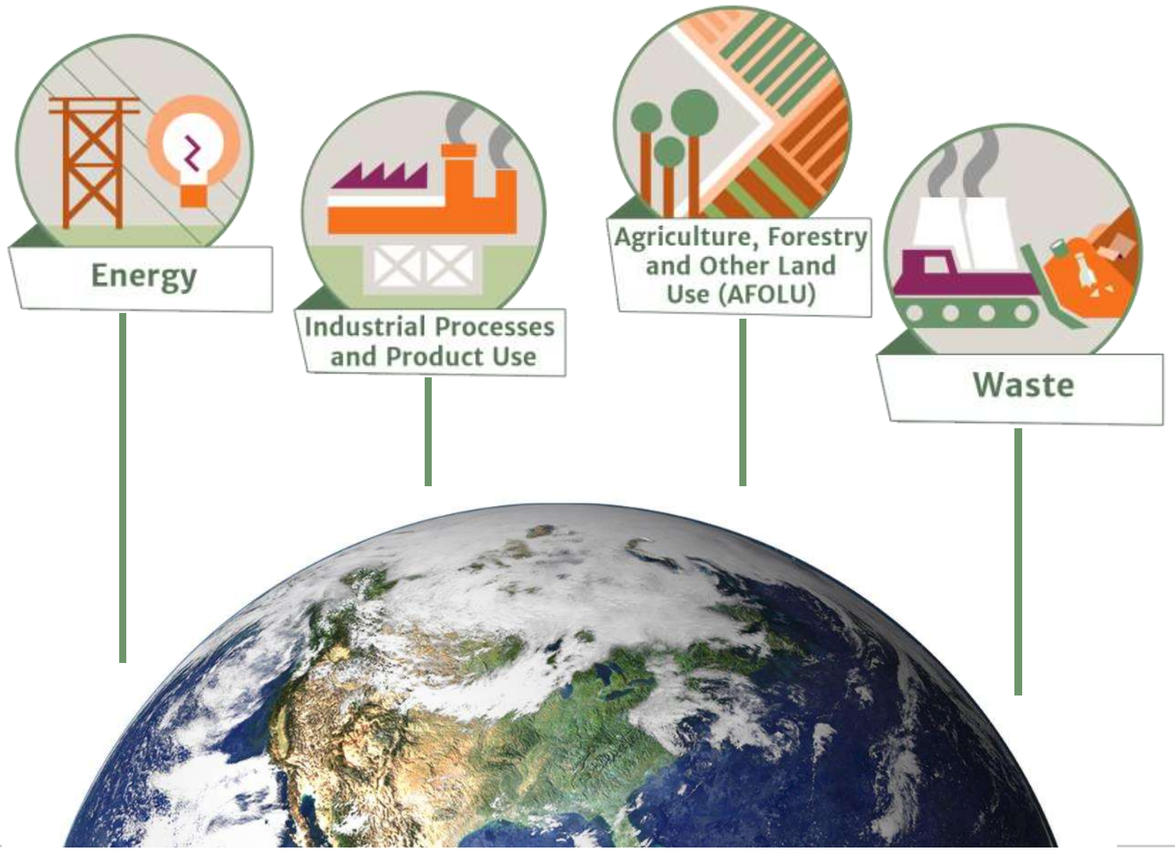
2019 Refinement to the 2006 Guidelines were recently released and Parties can use them.

LESSON

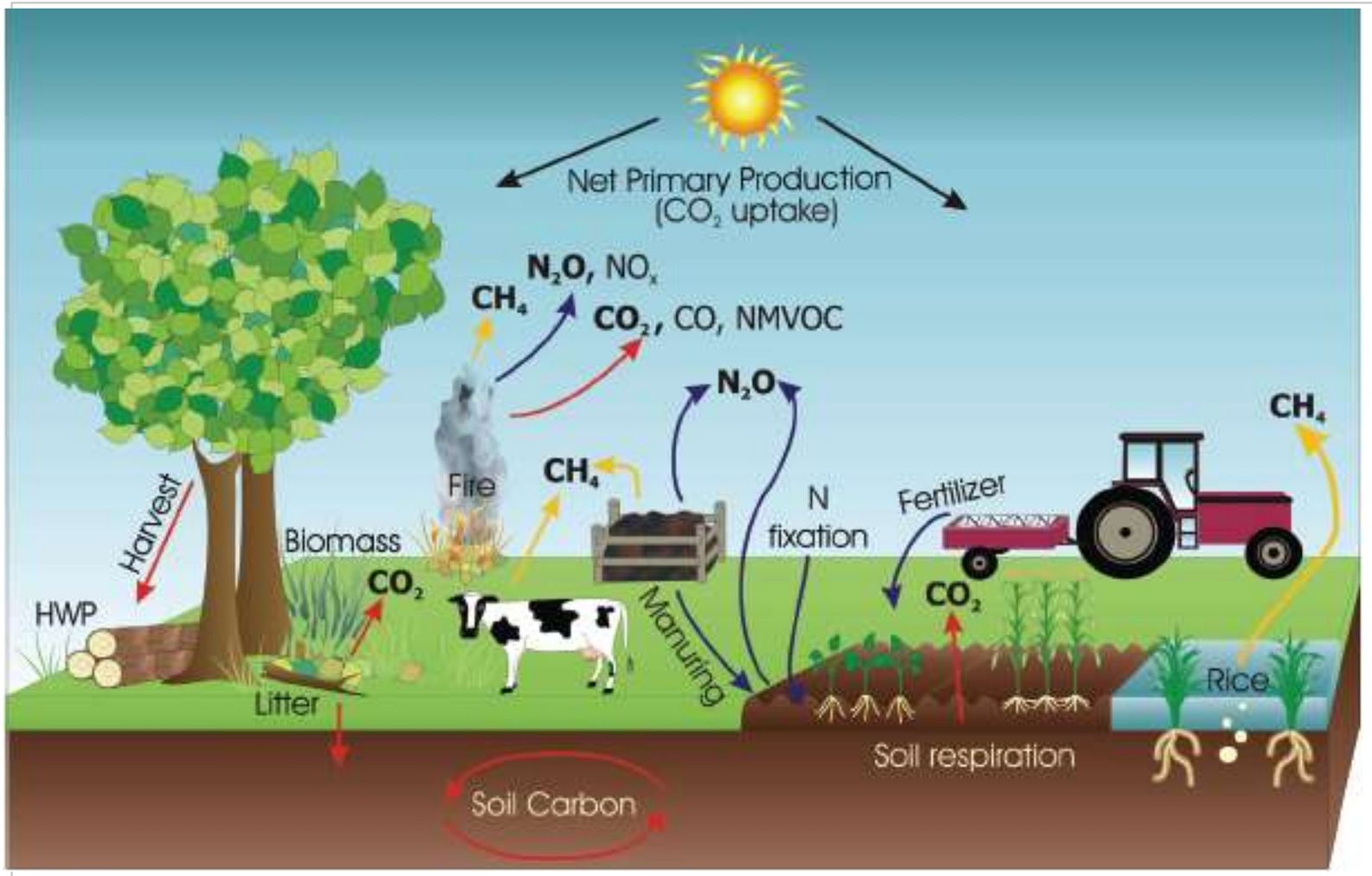
The four GHG sectors of the 2006 IPCC Guidelines

The 2006 IPCC Guidelines consist of five volumes:

- General Guidance and Reporting
- four volumes covering methodologies to calculate GHG emissions and removals from corresponding sectors.



Agriculture, Forestry and Other Land Use

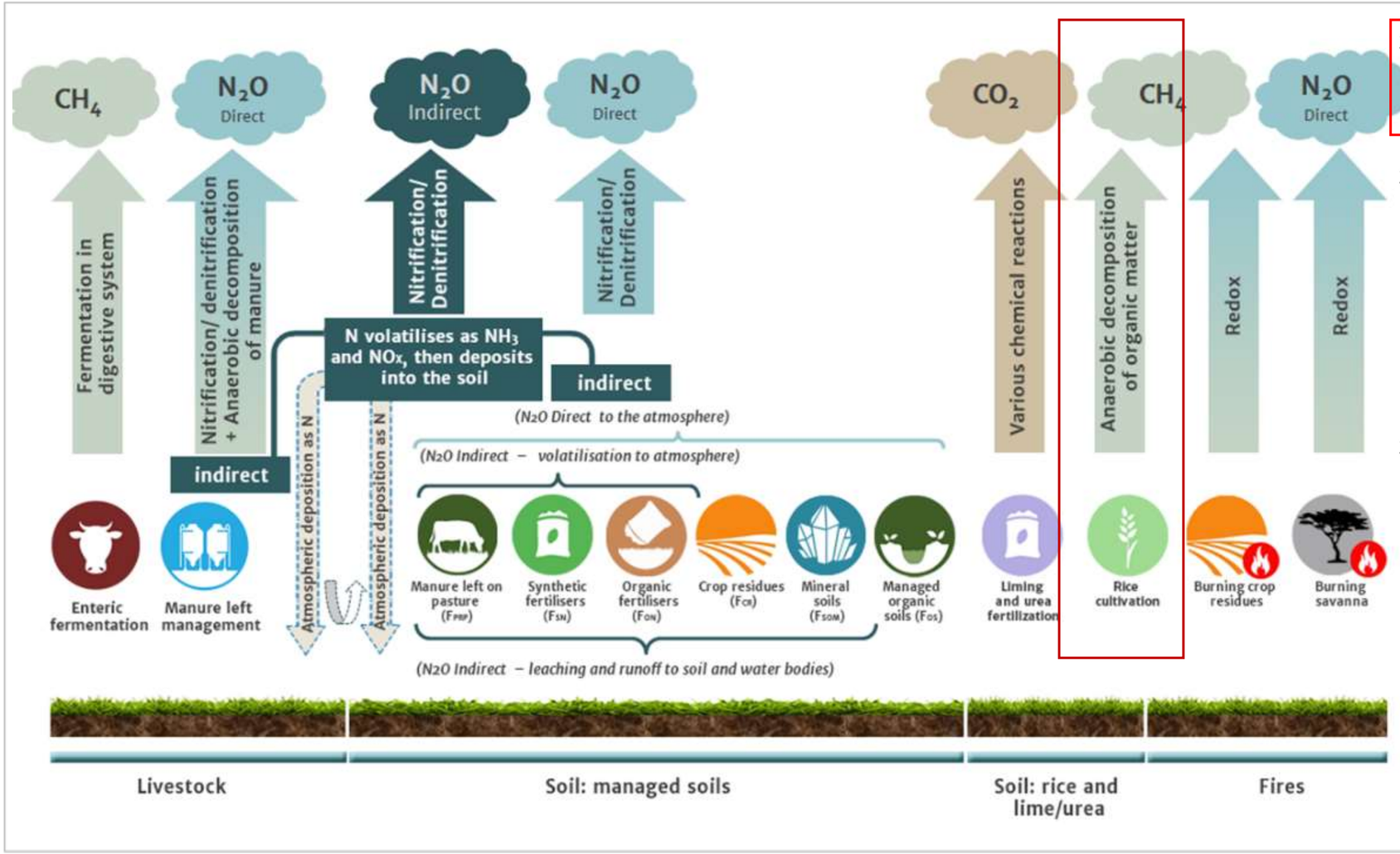


3A Livestock
- 3A1 Enteric Fermentation
- 3A2 Manure Management (MM)

3B Land
- 3B1 Forest Land
- 3B2 Cropland
- 3B3 Grassland
- 3B4 Wetlands
- 3B5 Settlements
- 3B6 Other Land

3C Aggregate sources and non-CO2 emissions on land
- 3C1 Emissions from Biomass Burning
- 3C2 Liming
- 3C3 Urea Application
- 3C4/5 Direct and Indirect N2O from Managed Soils
- 3C6 Indirect N2O from MM
- 3C7 Rice Cultivation
- 3C8 Other

Agriculture



3A Livestock
- 3A1 Enteric Fermentation
- 3A2 Manure Management (MM)

3B Land
- 3B1 Forest Land
- 3B2 Cropland
- 3B3 Grassland
- 3B4 Wetlands
- 3B5 Settlements
- 3B6 Other Land

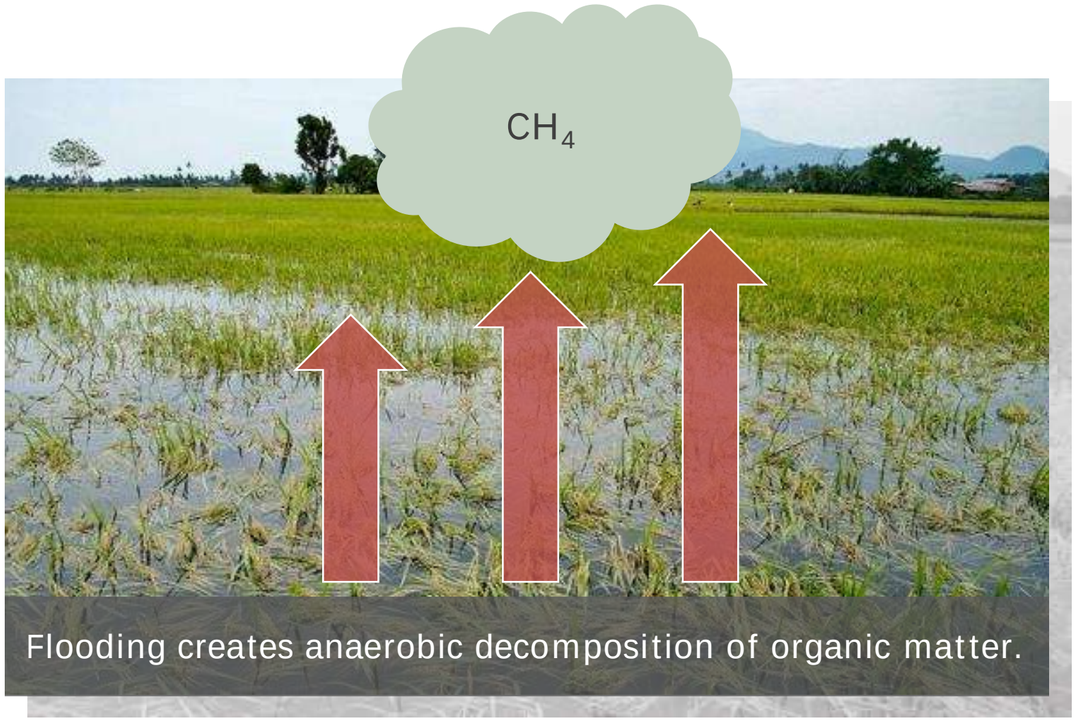
3C Aggregate sources and non-CO2 emissions on land
- 3C1 Emissions from Biomass Burning
- 3C2 Liming
- 3C3 Urea Application
- 3C4/5 Direct and Indirect N2O from Managed Soils
- 3C6 Indirect N2O from MM
- 3C7 Rice Cultivation
- 3C8 Other

CH_4 from rice cultivation

CH_4 emissions from rice cultivation are produced by the anaerobic decomposition of organic matter in flooded lands. CH_4 is released into the atmosphere through: diffusion loss across the water surface, bubbles, and rice plants themselves, which is the most common.

The annual amount of CH_4 emissions from a given area of rice is a function of:

- Cultivation period (days).
- Water regimes (before and during cultivation period).
- Organic amendments applied to the soil.
- Others (soil type, temperature, rice cultivar).



Flooding creates anaerobic decomposition of organic matter.

It is important to note that upland rice fields do not produce significant quantities of CH_4.

CO_2 from rice cultivation – How to Do

This is the formula to estimate emissions from rice cultivation and the steps to follow.

$$CH_{4\,Rice} = \sum_{i,j,k} (EF_{i,j,k} \cdot t_{i,j,k} \cdot A_{i,j,k} \cdot 10^{-6})$$

Equation 5.1

1	Due to the complexity and variability of rice production management, it is good practice to disaggregate hierarchically the total harvested area into sub-units according to the *i*, *j* and *k* conditions (ecosystems, water regimes, type and amount of organic amendments), as well as the cultivation period and the emission factor (e.g., harvested areas under different water regimes).
2	For each sub-unit, calculate the emissions by multiplying the respective emission factor by the cultivation period (t) and the annual harvested area (A).
3	Then, sum the emissions from each sub-unit of harvested area to determine the total annual national emissions in rice cultivation.

[PREVIOUS SLIDE WITH POPUP CONTENT DISPLAYED]

LESSON

CH_4 from Rice Cultivation - How To Do

Lesson topics

$$CH_{4\ Rice} = \sum_{i,j,k} (EF_{i,j,k} \cdot t_{i,j,k} \cdot A_{i,j,k} \cdot 10^{-6})$$ Equation 5.1

Click on the equation to read more.

1 Due to the complexity and variability of rice production management, it is good practice to disaggregate hierarchically the total harvested area into sub-units

This is the formula to estimate emissions from rice cultivation and the steps to follow.

Equation 5.1

- $CH_{4\ Rice}$= Annual methane emissions from rice cultivation, Gg CH_4 yr^{-1}.
- EF_{ijk}= A daily emission factor for i, j, and k conditions, kg CH_4 ha^{-1} day^{-1}.
- t_{ijk}= Cultivation period of rice for i, j, and k conditions, day.
- A_{ijk}= Annual harvested area of rice for i, j, and k conditions, ha yr^{-1}.
- i, j, and k= Represent different ecosystems, water regimes, type and amount of organic amendments, and other conditions under which CH_4 emissions from rice may vary.

CH_4 from rice cultivation - How To Do

Lesson topics

Efren, what do the conditions *i*, *j*, and *k* represent?

These variable represent the conditions that influence CH_4 emissions from rice cultivation. Let's examine them in detail...

Variable *i* - Water Regime	Variable *j* - Organic Amendment to Soils	Variable *k* - Other Conditions
Combination of (i) *ecosystem type* (i.e., irrigated, rainfed, and deep water rice production) and, (ii) *flooding pattern* (continuously/ intermittently flooded, regular rainfed, drought prone, and deep water).	The impact on CH_4 emissions depends on type and amount of the applied material, that can either be of (i) *endogenous* (straw, green manure, etc.) or (ii) *exogenous origin* (compost, farmyard manure, etc.)	It is known that other factors, such as soil type, rice cultivar or sulphate containing amendments can significantly influence CH_4 emissions.

Box 5.2 Simplified

CH_4 from rice cultivation - How To Do

Lesson topics

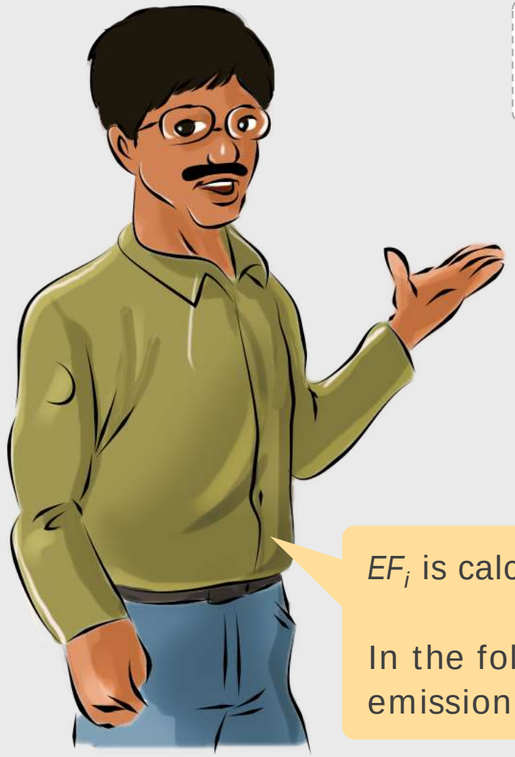
Calculating the adjusted daily emission factor requires applying equation 5.2 shown below.

$$CH_{4\,Rice} = \sum_{i,j,k} \left(EF_{i,j,k} \cdot t_{i,j,k} \cdot A_{i,j,k} \cdot 10^{-6} \right)$$

Equation 5.1

$$EF_i = EF_c \cdot SF_w \cdot SF_p \cdot SF_o \cdot SF_{s,r}$$

Equation 5.2



EF_i is calculated by multiplying a *baseline emission factor* EF_c by various scaling factors (SF).

In the following screens we will identify the default values and methods needed to calculate the daily emission factor. As a reminder, the following information is provided by the 2006 IPCC Guidelines.

CH_4 from rice cultivation - How To Do

Lesson topics

Let's review the emission factor equation in more detail.

$$EF_i = EF_c \cdot SF_w \cdot SF_p \cdot SF_o \cdot SF_{s,r}$$

Equation 5.2

EF_c
Baseline emission factor

The Baseline emission factor is for continuously flooded fields without organic amendments. The default value for EF_c could be found in Table 5.11 shown below.

TABLE 5.11
DEFAULT CH_4 BASELINE EMISSION FACTOR ASSUMING NO FLOODING FOR LESS THAN 180 DAYS PRIOR TO RICE CULTIVATION, AND CONTINUOUSLY FLOODED DURING RICE CULTIVATION WITHOUT ORGANIC AMENDMENTS

CH_4 emission (kg CH_4 ha^{-1} d^{-1})	Emission factor	Error range
	1.30	0.80 - 2.20

Source: Yan et al., 2005

This variable is used as a starting point and is then adjusted according to the scaling factors. It applies to areas with no flooded fields for less than 180 days, prior to rice cultivation and continuously flooded during the rice cultivation period without organic amendments.

CH_4 from rice cultivation - How To Do

Lesson topics

Let's review the emission factor equation in more detail.

$$EF_i = EF_c \cdot SF_w \cdot SF_p \cdot SF_o \cdot SF_{s,r}$$

Equation 5.2

When to use SF_w disaggregated or aggregated scaling factors

SF_W
Water during cultivation

SF_p
Water before cultivation

Scaling factor to account for the differences in water regime during and in the pre-season before during the cultivation period.

SF_0
Organic amendment

Scaling factor to account for type and amount of organic amendment applied. Organic amendments applied to rice cultivation include: compost, farmyard manure, green manure and rice straw.

$SF_{s,r}$
Other conditions

Scaling factor to account for soil type, rice cultivar, etc. Both experiments and mechanistic knowledge confirm the importance of these factors, but large variations within the available data do not allow to define reasonably accurate default values. Country-specific scaling factors should only be used if they are based on well-researched and documented measurement data, and if they are stratified by soil type and rice cultivar, at least.

LESSON

CH_4 from rice cultivation - How To Do

Lesson topics

As described at the beginning, there are conditions that influence CH_4 emissions from rice cultivation. These conditions need to be considered when collecting harvested area ($A_{i,j,k}$) statistics.

Harvested area should, at a minimum, be disaggregated by three baseline water regimes shown here.


Irrigated

Further stratification on water regime (during or before cultivation) and organic amendments is encouraged.


Rainfed and Deep water


Upland


Rice Irrigation


Organic Amendment:
Manure and Straw

CH_4 from rice cultivation – Mitigation options

Land preparation

In common practice, water is drained out of the field during vegetative period.

Seedling practice

- Shifting drainage time from vegetative period to reproductive period
- Alternate wetting and drying (AWD) implementation

Rice varieties

Methane emissions are proportional to the number of days the crop is flooded.

Organic amendment

Water management

- By switching from long duration varieties to short duration varieties of rice cultivars, the number of flooded days will decrease.

FAO support on GHG inventory

- E-learning curricula “Building a National Greenhouse Gas Inventory for Agriculture, Forestry and Other Land Use”

  - ✓ The national greenhouse gas inventory for agriculture: https://elearning.fao.org/course/view.php?id=327

Food and Agriculture Organization of the United Nations

FAO and the Enhanced transparency framework