



United Nations
Climate Change

UNFCCC BTR REVIEW TRAINING: COURSE B

**TECHNICAL REVIEW OF NATIONAL
INVENTORY REPORTS OF
ANTHROPOGENIC EMISSIONS BY
SOURCES AND REMOVALS BY SINKS OF
GHG**

**SUB COURSE B4: AGRICULTURE
SECTOR**

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GHG Inventory Review Training Course

Agriculture sector

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Abbreviations and acronyms

2006 IPCC Guidelines	2006 IPCC Guidelines for National Greenhouse Gas Inventories
2019 Refinement to the 2006 IPCC Guidelines	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
AD	activity data
AFOLU	agriculture, forestry and other land use
B ₀	maximum methane-producing potential
C	confidential
CH ₄	methane
CO	Carbon monoxide
CO ₂	carbon dioxide
CO ₂ eq	carbon dioxide equivalent
CRF	common reporting format
CRT	common reporting tables
EEA	European Environment Agency
EF	emission factor
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
GHG	greenhouse gas
HFC	hydrofluorocarbon
IE	included elsewhere
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
IPPU	industrial processes and product use
LULUCF	land use, land-use change and forestry
MCF	methane conversion factor
MPGs	modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, set out in the annex to decision 18/CMA.1
N	nitrogen
N ₂	dinitrogen
NA	not applicable
NE	not estimated
Nex	nitrogen excretion

NF ₃	nitrogen trifluoride
NH ₃	ammonia
NID	national inventory document
NMVOC	non-methane volatile organic compound
NO	not occurring
NO _x	Nitrogen oxides
N ₂ O	nitrous oxide
PFC	perfluorocarbon
QA/QC	quality assurance/quality control
SF ₆	sulfur hexafluoride
SO ₂	sulfur dioxide
SO _x	sulfur oxides
Revised 1996 IPCC Guidelines	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
TERR	technical expert review report
TACCC	transparency, accuracy, consistency, comparability and completeness
TERT	technical expert review team
VS	volatile solid(s)
Wetlands Supplement	2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

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Lesson 1: Introduction

1. Overview of the course

Welcome to the introductory lesson of the agriculture course.

The lesson consists of three topics:

Overview and learning objectives;

Basic documentation;

Initial quiz to test your knowledge of the 2006 IPCC Guidelines

Expected time needed to complete lesson 1:



- For readers with experience: 15–30 minutes
- For readers with less experience: 45 minutes

1.1. Structure of the agriculture course

The course is composed of eight lessons, including this introductory lesson. Each subsequent lesson summarizes the methodological background, key reporting and review elements, and possible actions by the TERT in its review of agriculture sector GHG emissions inventories.

	Lesson title
Lesson 1	Introduction
Lesson 2	Reviewing the agriculture sector inventory
Lesson 3	Enteric fermentation
Lesson 4	Manure management
Lesson 5	Agricultural soils
Lesson 6	Rice cultivation
Lesson 7	Prescribed burning of savannahs and field burning of agricultural residues
Lesson 8	Liming and urea application to soils

1.2. Course learning objectives

This course is a part of the online training programme for technical expert reviewers of the national GHG inventories submitted by Parties. The course covers the key actions and elements of the technical review of agriculture sector emissions reported in the national GHG inventory. Upon successful completion of this course you will be able to successfully participate as an agriculture expert in the review of a Party's inventory.

At the end of this lesson, you will be able to:

- Identify methodological references and reporting components relevant to each category of the agriculture sector;
- Understand how the categories interlink with other categories within the agriculture sector;
- Focus on reviewing key points and be aware of possible actions by the TERT in its review of GHG emissions for each category of the agriculture sector;
- Understand how to formulate clarification questions to a Party in the context of a review;
- Identify findings or issues and draft relevant encouragements or recommendations in TERR;
- Classify issues into the transparency, accuracy, consistency, comparability and completeness (TACCC) principles;

2. Relevant documentation

2.1. Reference documentation related to the enhanced transparency framework under the Paris Agreement

The review of GHG inventories is a complex process which requires the use of a large amount of material, including the following:

- Decision 18/CMA.1 encompasses the detailed guidance on the reporting and review processes for the information to be submitted by a Party and reviewed by the TERT. The main guidance and overarching principles related to the expert technical review of national GHG inventories according to the MPGs set out in that decision are discussed in the “Overview and cross-cutting” course (lesson 1, topic 2 and lesson 2, topic 3);
- Annex I to decision 5/CMA.3 contains a link to the set of CRTs (click here to open CRTs from the UNFCCC website¹). In addition, information is provided on reporting on the agriculture sector in the NID, the outline of which is contained in annex V to decision 5/CMA.3 (<https://unfccc.int/documents/460951>).

2.2. Methodological background

The main methodological background consists of:

- **The 2006 IPCC Guidelines:**
 - Volume 1 provides general guidance on the cross-cutting issues that you have studied in the “Overview and cross-cutting” course;
 - Volume 4 covers the specific methodological background for the development of the agriculture sector of a national GHG inventory (chaps. 1, 2, 5, 10 and 11);
- **The Wetlands Supplement;**

¹ <https://unfccc.int/documents/311076>.

- **The 2019 Refinement to the 2006 IPCC Guidelines.** Paragraph 28 of decision 5/CMA.3 notes that Parties may use the 2019 Refinement to the 2006 IPCC Guidelines on a **voluntary basis**.



Volumes 1 and 4 of the 2006 IPCC Guidelines and the Wetlands Supplement can be downloaded from the following links:

- www.ipcc-nggip.iges.or.jp/public/2006gl/vol1.html
- www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html
- www.ipcc-nggip.iges.or.jp/public/wetlands/index.html

The set of CRTs is available at:

- <https://unfccc.int/documents/311076>

During the course we will refer many times to these IPCC guidelines and the CRTs – have them handy and consult them as necessary.



Note that in addition to the originally published English version of the guidelines there are five other versions (Arabic, Chinese, French, Russian and Spanish); however, the corrections (corrigenda) are mainly maintained and updated in the English version only, hence it is recommended to consult the English version when drawing any final conclusions. Because the corrections are made from time to time, you should download the latest version of the 2006 IPCC Guidelines to ensure that all corrigenda since 2007 are reflected.



Note that technical knowledge of the methodologies in the 2006 IPCC Guidelines and the Wetlands Supplement is a prerequisite to taking part in the “Overview and cross-cutting” course and this agriculture sector course. These courses have been devised for technical expert reviewers of national GHG inventories who would like to become expert reviewers under the enhanced transparency framework. Therefore, this course does not replace the need to be familiar with methods and guidance reported as good practice in the above-mentioned IPCC Guidelines.

3. Initial quiz

This brief quiz is intended to help you evaluate your existing knowledge of the 2006 IPCC Guidelines with respect to the agriculture sector. It will not comprehensively assess your knowledge, but it will help you to evaluate how much time you should invest in refreshing your technical background before studying this course.

If you score less than 70 per cent on this quiz, you should consider taking time to refresh your knowledge of agriculture by reviewing the relevant chapters of the 2006 IPCC Guidelines. Nevertheless, with any score, you should carefully complete the practical exercise sections of this course. Please note that the quiz includes 10 questions. After you submit your answer to a question, you will be able to see whether it is correct. You will then be able to move on to the next question. Please go through all the questions by submitting all the answers.

To start the initial quiz, go to the next page.

Question 1

According to the 2006 IPCC Guidelines, the information for a basic livestock characterization includes which of the following?

- I. Complete list of livestock populations that have default EF values in the 2006 IPCC Guidelines, and if these categories are relevant to the country;
- II. Population data for each species and category, including adjustments for seasonal variations;
- III. Annual population distribution according to the types of manure management systems used in the country;
- IV. Dairy cows population (estimated separately) and its average milk production;
- V. Feed intake estimates for the typical animal in each subcategory.

Select one:

- A. All of the above
- B. I, IV and V
- C. II, III and V
- D. I, II and IV
- E. III, IV and V
- F. None of the above

Question 2

According to the 2006 IPCC Guidelines decision tree on estimates of CH₄ from enteric fermentation, an animal species is considered a significant subcategory when its contribution to the total emissions of the category is at least:

Select one:

- A. 50 per cent
- B. 25 per cent
- C. 10 per cent
- D. 95 per cent
- E. 45 per cent

Question 3

Some countries may have domesticated livestock for which there are currently no default EFs and emissions estimating methods (e.g. llamas, alpacas). What is good practice in estimating emissions from these livestock categories?

Select one:

- A. Countries may exclude emissions from these livestock categories, even though emissions may be significant, as the 2006 IPCC Guidelines provide neither a methodology nor default EFs for estimating such emissions;
- B. Countries must assess whether emissions from these livestock categories are likely to be significant within a category. If the emissions from a particular livestock category are determined to be significant, then countries should develop country-specific EFs.

Question 4

In cases where organic forms of bedding material (e.g. straw) are being used in livestock housing systems, it is good practice to consider the nitrogen in the bedding material in estimates of emissions of the following categories:

- I. N₂O emissions from pasture, range and paddock;
- II. Direct N₂O emissions from organic nitrogen fertilizer applied to soils;
- III. N₂O emissions from crop residues left on agricultural fields;
- IV. Indirect N₂O emissions from agricultural soils.

Select one:

- A. All of the above
- B. I, II and III
- C. II, III and IV
- D. I, III and IV
- E. I, II and IV

Question 5

The 2006 IPCC Guidelines provide a tiered approach to estimate indirect N₂O emissions due to leaching and run-off from manure management systems:

- A tier 1 method, which relies on the amount of nitrogen in manure treated in manure management systems that is lost through run-off and leaching multiplied by the default fraction of manure nitrogen that leaches from manure management systems;
- A tier 2 method, which follows the same calculation equation as in tier 1 but includes the use of country-specific data for some or all of these variables. For example, the use of country-specific Nex rates for livestock categories would constitute a tier 2 method;
- A tier 3 method, a detailed bottom-up model that relies on country-specific EFs for nitrogen leaching and run-off based on actual measurements.

Select one:

- A. True
- B. False

Question 6

Direct N₂O emissions from managed soils are produced from inputs of nitrogen from which of the following activities?

- I. Synthetic fertilizer application;
- II. Organic fertilizer application;
- III. Nitrogen mineralization;
- IV. Animal manure from grazing animals;
- V. Nitrogen leaching;
- VI. Uncultivated histosols;
- VII. Crop residues burned;
- VIII. Crop residues returned to soils.

Select one:

- A. All of the above
 - B. II, III and VIII
 - C. I, III, IV and VII
 - D. I, II, III, IV and VIII
 - E. I, III, V, VI and VIII
 - F. None of the above
-

Question 7

In the context of direct N₂O emissions from managed soils which of the following categories is not included under organic nitrogen fertilizers?

Select one:

- A. Annual amount of nitrogen deposited on pasture, range and paddock soils by grazing animals
- B. Bedding material used in solid storage of animal manure
- C. Compost applied to soils
- D. Animal manure
- E. Sewage sludge applied to soils

Question 8

In the context of CO₂ emissions from agricultural soils, which of the following categories is estimated and reported under the agriculture sector:

- I. CO₂ emissions from the application of carbon-containing fertilizers (lime, urea and other);
- II. CO₂ emissions or removals from agricultural soils due to the change of carbon stocks;
- III. CO₂ emissions from cultivation of histosols;
- IV. CO₂ emissions from the application of organic fertilizers (manure).

Select one:

- A. All of the above
- B. None of the above
- C. I
- D. I, II and IV
- E. II, III and IV
- F. I, III and IV

Question 9

What is the estimation of non-CO₂ GHG emissions from the field burning of agricultural residues based on?

Select one:

- A. Total crop residues
- B. Total residues produced by wheat, barley and rice
- C. Fraction of crop residues burned on -site
- D. Fraction of crop residues burned on site and fraction of crop residues applied to soils

Question 10

According to the 2006 IPCC Guidelines a tier 1 method applies to countries where either CH₄ emissions from rice cultivation are not a key category or country-specific EFs are not available. The basic principle to estimate CH₄ emissions from rice cultivation employs data on total annual rice harvested area multiplied by default daily EFs.

Select one:

- A. True
- B. False

3.1. Answer key to initial quiz

Question 1

The correct answer is D.

AD required for a basic livestock characterization are:

- 1) A complete list of livestock populations that have default EF values in the 2006 IPCC Guidelines and if these categories are relevant to the country. More detailed categories should be used if the data are available;
- 2) Annual population data for each species and category, including adjustments for seasonal variations;
- 3) Dairy cow population (estimated separately) and its average milk production. It is also advisable that if the Party's territory encompasses vastly different climate or other environmental conditions, then the Party's animal population data should be disaggregated accordingly.

The basic characterization can be used across all relevant source categories if the enteric fermentation and manure sources are both estimated with tier 1 methods (i.e. data on population number multiplied by the default EFs). An enhanced characterization should be used to estimate emissions across all the relevant sources if the tier 2 method is used for either enteric fermentation or manure management. The tier 2 characterization methodology seeks to define animals, animal productivity, diet quality and management circumstances to support a more accurate estimate of feed intake for use in estimating CH₄ production from enteric fermentation. The same feed intake estimates should be used to provide harmonized estimates of manure and N₂O emissions from manure management (options III and V are incorrect).

For more information on a basic characterization of livestock population, see the 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.2.2, p. 10.8).

Question 2

The correct answer is B.

A livestock species is significant if it accounts for 25–30 per cent or more of emissions from the category.

For more information on CH₄ emissions from enteric fermentation, see the decision tree in the 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.3.1, p.10.25).

Question 3

The correct answer is B.

If the emissions from a particular species are determined to be significant, then country-specific EFs should be developed and a species characterization should be performed to support the development of the EFs.

For more information on characterization for livestock without species-specific emission estimation methods, see the 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.2.4,p.10.23).

Question 4

The correct answer is C.

The nitrogen in the bedding material used in livestock farming should be considered in estimating direct N₂O emissions released due to manure (including bedding) application to agricultural soils (option II). Moreover, since a fraction of above-ground crop residues might be removed from fields and used for bedding, an annual amount of nitrogen in crop residues removed should be subtracted from the total amount of nitrogen available for further decomposition (option III). Both of the indicated are nitrogen sources to evaluate indirect N₂O emissions from agricultural soils (option IV).

For more information on this matter, see the 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.5.4, p. 10.64; and vol. 4, chap. 11, sections 11.2.1.3 and 11.2.2, pp. 11.12 and 11.19, respectively).

Question 5

The correct answer is B.

Estimation of nitrogen losses from leaching and run-off from manure management should be considered part of a tier 2 or tier 3 method; there is no tier 1 method available in the 2006 IPCC Guidelines.

For more information on the tiers developed to estimate indirect N₂O emissions due to leaching and run-off from manure management systems, see the 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.5.1, p.11.12).

Question 6

The correct answer is D.

The 2006 IPCC Guidelines (vol. 4, chap. 11, p.11.6) stipulate that the following nitrogen sources are included in the methodology for estimating direct N₂O emissions from managed soils:

- Synthetic nitrogen fertilizers (F_{SN}) (option I);
- Organic nitrogen applied as fertilizer (e.g. animal manure, compost, sewage sludge, rendering waste) (F_{ON}) (option II);
- Urine and dung nitrogen deposited on pasture, range and paddock by grazing animals (F_{PRP}) (option IV);
- Nitrogen in crop residues (above-ground and below-ground), including from nitrogen-fixing crops and from forages during pasture renewal (F_{CR}) (option VIII);
- Nitrogen mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils (F_{SOM}) (option III);
- Drainage/management of organic soils (i.e. histosols) (F_{OS}).

Note that the remaining options are not correct for the following reasons:

- Option V is considered under indirect N₂O emissions from agriculture soils;
- Option VI is not valid because uncultivated histosols do not lead to any emissions;
- Option VII leads to non-CO₂ emissions from field burning of agricultural residues.

For more information on the coverage of nitrogen sources in the methodology for estimating direct N₂O emissions from managed soils, see the 2006 IPCC Guidelines (vol. 4, chap. 11, section 11.2.1,p.11.6).

Question 7

The correct answer is A. Annual amount of nitrogen deposited on pasture, range and paddock soils by grazing animals.

Only emissions from urine and dung nitrogen deposited on pasture, range and paddock soils by grazing animals manure are not accounted under organic fertilizers. Bedding material used in solid storage as well as all other nitrogen from manure management systems is included under nitrogen applied to soils with animal manure. Emissions from manure applied to soils as compost and sewage sludge, as well as any other organic amendments of regional importance to agriculture (e.g. rendering waste, guano, brewery waste, etc.), are accounted under emissions from organic nitrogen fertilizers.

For more information on the definition and the list of categories included under organic nitrogen fertilizers, see the 2006 IPCC Guidelines (vol. 4, chap. 11, section 11.2.1.3,p.11.12).

Question 8

The correct answer is C.

CO₂ emissions or removals from agricultural soils due to a change in carbon stocks (option II) and CO₂ emissions from cultivation of histosols (option III) should be reported under the LULUCF sector. The 2006 IPCC Guidelines do not provide any methodology to estimate CO₂ emissions from manure applied to agricultural soils (option IV).

Question 9

The correct answer is C. Fraction of crop residues burned on site.

Only the fraction of crop residues burned on site is accounted for under non-CO₂ emissions from field burning of agricultural residues. The fractions used for other purposes (e.g. fuel, compost or animal feed) should be subtracted from the total amount of crop residues.

For more information on the generic approach developed to estimate GHG emissions (both CO₂ and non-CO₂ gases) from fire, see the 2006 IPCC Guidelines (vol. 4, chap. 2, section 2.4, p.2.40).

Question 10

The correct answer is B. False

CH₄ emissions are estimated by multiplying daily EFs by cultivation period of rice and annual harvested areas. Moreover, the disaggregation of the annual harvested area of rice needs to be done for at least three baseline water regimes, including irrigated, rain-fed and upland.

For more information on a tier 1 approach developed to estimate CH₄ emissions from rice cultivation, see the 2006 IPCC Guidelines (vol. 4, chap. 5, section 5.5, p.5.44).

Lesson 2: Reviewing the agriculture sector inventory

1. Introduction

1.1. Learning objectives and time needed to complete the lesson

Lesson 2 provides information on the sources (categories) of GHG emissions released from agricultural activities; introduces the basic methodological principles adopted in the calculation of GHG emissions from the agriculture sector categories; and describes the approaches the TERT should apply in reviewing the cross-cutting elements across all categories of the agriculture sector.

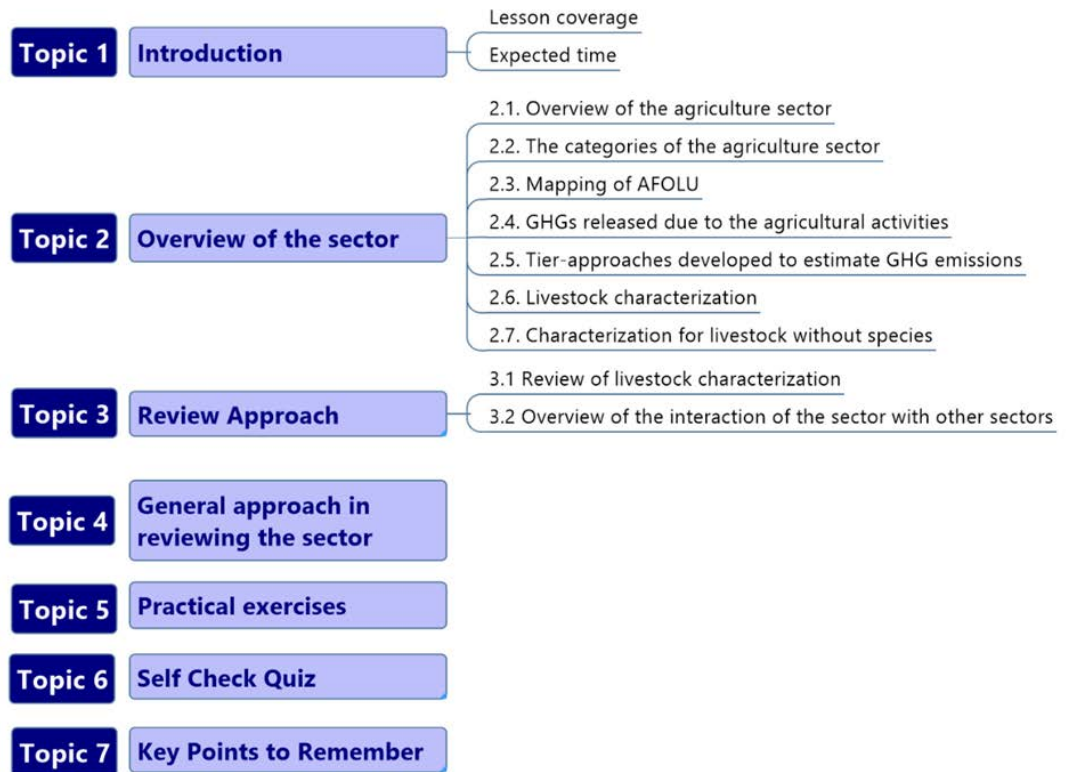
At the end of this lesson, you will have:

- An overview of the gases and the agricultural activities considered under the agriculture sector in the national inventory;
- An overview of a set of tables (i.e. CRTs) that allow Parties to report quantitative and, to a lesser extent, qualitative data (e.g. explanations of notation keys) on GHG emissions from agricultural activities;
- An understanding of how the categories interrelate within the agriculture sector and with categories of other sectors within the national inventory;
- An understanding of the actions of the TERT in its review of the information on livestock population characterization and the cross-cutting inventory elements.



Expected time needed to complete lesson 2: ~60 minutes

1.2. Structure of the lesson



2. Overview of the sector

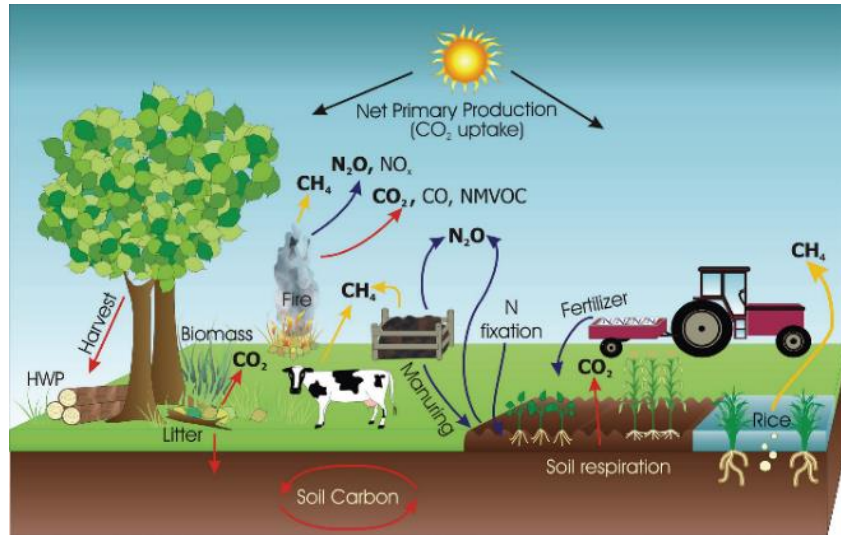
2.1. Overview of the agriculture sector

The agriculture sector of GHG inventories is part of the AFOLU sector as defined in the 2006 IPCC Guidelines (see section 2.3 below for further explanations).

The AFOLU sector is determined as a source/sink of anthropogenic GHG emissions and removals, defined as all those occurring on **managed land**, and those associated with land use, including husbandry.

Managed land is the land where human interventions and practices have been applied to perform production, ecological or social functions.

Figure 2-1 provides an overview of how land use and management influence the various ecosystem processes that affect GHG fluxes, such as photosynthesis, respiration, decomposition, nitrification/denitrification, enteric fermentation and combustion. These processes involve transformations of carbon and nitrogen that are driven by biological processes (activities of microorganisms, plants and animals) and physical processes (combustion, leaching and run-off).



A. Figure 2-1. Main greenhouse gas emissions sources/removals and processes in managed ecosystems

2.2. The categories of the agriculture sector

Table 2-1 lists the categories of the agriculture sector, the chapters of the 2006 IPCC Guidelines that provide the methodologies to estimate GHG emissions and the tables developed to report GHG emissions from these activities. A more detailed explanation is provided within each corresponding lesson.

Table 2-1. The categories of the agriculture sector

Category	IPCC guidelines	CRT	The corresponding lesson of the current course
CH ₄ emissions from enteric fermentation	2006 IPCC Guidelines, volume 4, chapter 10, section 10.3	Table 3.A	3
CH ₄ and N ₂ O emissions from manure management	2006 IPCC Guidelines, volume 4, chapter 10, sections 10.4 and 10.5	Table 3.B(a), Table 3.B(b)	4
Direct and indirect N ₂ O emissions from agricultural soils	The Wetlands Supplement, ² chapter 11, section 11.2	Table 3.D	5
CH ₄ emissions from rice cultivation	2006 IPCC Guidelines, volume 4, chapter 5, section 5.5	Table 3.C	6
Non-CO ₂ emissions from prescribed burning of savannahs and field burning of agricultural residues	2006 IPCC Guidelines, volume 4, chapters 2, 5 and 6	Tables 3.E and 3.F	7
CO ₂ emissions from liming, urea application and other carbon-containing fertilizers	2006 IPCC Guidelines, volume 4, chapter 11, section 11.3	Table 3.G-J	8

² The Wetlands Supplement complements the guidance on agricultural soils in the 2006 IPCC Guidelines by filling the gaps in coverage and providing updated information on inland organic soils, wetlands on mineral soils and coastal wetlands, including mangrove forests, tidal marshes and seagrass meadows.

IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland // <https://www.ipcc-nggip.iges.or.jp/public/wetlands/>

2.3. Evolution of the Intergovernmental Panel on Climate Change guidance on agriculture and land use, land-use change and forestry

The 2006 IPCC Guidelines are an evolutionary development based on the Revised 1996 IPCC Guidelines,³ the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*⁴ and the *Good Practice Guidance for Land Use, Land-Use Change and Forestry*.⁵ One of the most significant changes and outcomes of the 2006 IPCC Guidelines is the ‘combining’ of the LULUCF and agriculture sectors into a single AFOLU sector (to resolve inconsistencies and avoid double counting, etc.). The same sectoral representation has been followed in the 2019 Refinement to the 2006 IPCC Guidelines,⁶ which aimed to update, supplement and/or elaborate the 2006 IPCC Guidelines where gaps or out-of-date science have been identified.

However, Parties agreed to continue separate reporting (and reviewing) of the agriculture sector and the LULUCF sector during the commitment periods of the Kyoto Protocol and later under the enhanced transparency framework. This required an allocation of the AFOLU categories of the 2006 IPCC Guidelines to the agriculture and LULUCF sectors. Thus, the reporting tables published within the Revised 1996 IPCC Guidelines have been used to develop the new CRF tables/CRTs, reflecting the changes in coverage of sectors, categories and gases introduced by the 2006 IPCC Guidelines and further by the 2019 Refinement to the 2006 IPCC Guidelines. Figure 2-2 illustrates the evolutionary development of the reporting tables of the 2006 IPCC Guidelines and their correspondence to the CRTs.

³ Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
Intergovernmental Panel on Climate Change (IPCC) (1997). Houghton J.T., Meira Filho L.G., Lim B., Tréanton K., Mamaty I., Bonduki Y., Griggs D.J. and Callander B.A. (Eds). Revised 1996 IPCC Guidelines for National Greenhouse Inventories. IPCC/OECD/IEA, Paris, France.

<https://www.ipcc.ch/report/revised-1996-ipcc-guidelines-for-national-greenhouse-gas-inventories>

⁴ Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories
Intergovernmental Panel on Climate Change (IPCC) (2000). Penman J., Kruger D., Galbally I., Hiraishi T., Nyenzi B., Emmanuel S., Buendia L., Hoppaus R., Martinsen T., Meijer J., Miwa K., and Tanabe K. (Eds). Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC/OECD/IEA/IGES, Hayama, Japan.

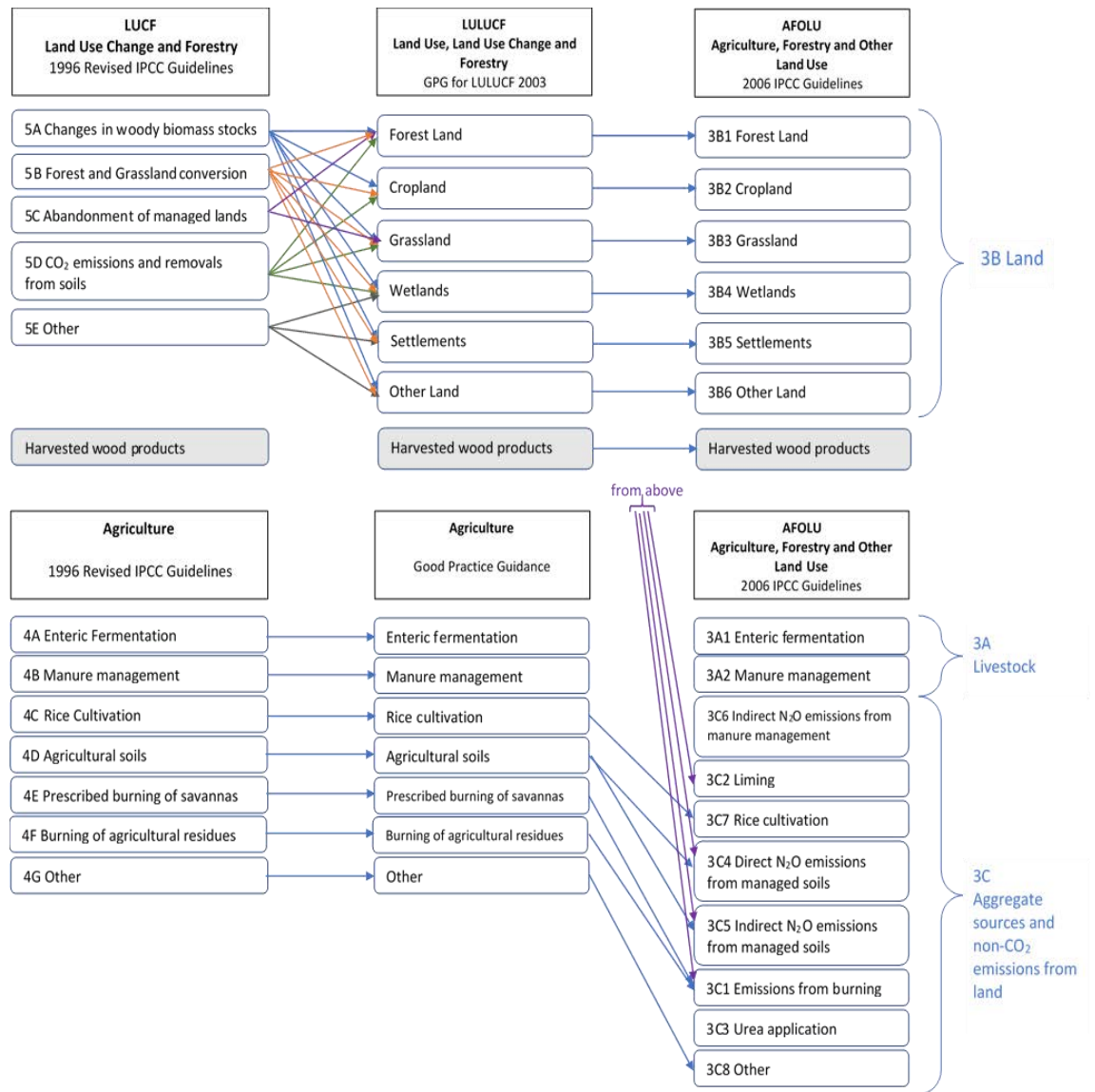
<https://www.ipcc.ch/publication/good-practice-guidance-and-uncertainty-management-in-national-greenhouse-gas-inventories/>

⁵ Good Practice Guidance for Land Use, Land-Use Change and Forestry
Intergovernmental Panel on Climate Change (IPCC) (2003). Penman J., Gytarsky M., Hiraishi T., Krug, T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., and Wagner F (Eds). Good Practice Guidance for Land Use, Land-Use Change and Forestry IPCC/IGES, Hayama, Japan.

<https://www.ipcc.ch/publication/good-practice-guidance-for-land-use-land-use-change-and-forestry/>

⁶ The 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Intergovernmental Panel on Climate Change (IPCC) (2019). Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland.

<https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html>



B. Figure 2-2. Evolution of Intergovernmental Panel on Climate Change guidance on agriculture and land use, land-use change and forestry

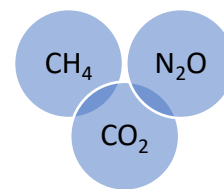
2.4. Correspondence between the 2006 IPCC Guidelines and the common reporting tables

The mapping table illustrates the correspondence between the 2006 IPCC Guidelines and CRTs for the agriculture sector.

Category	Gases	Reporting table of the 2006 IPCC Guidelines, (volume 1, annex 8A.2)	CRT
Enteric fermentation	CH ₄	Table 3A1	Table 3.A
Manure management	CH ₄ N ₂ O	Table 3A2 Table 3A2	Table 3.B(a) Table 3.B(b)
Direct and indirect N ₂ O emissions from agricultural soils	N ₂ O	Table 3C4 Table 3C5	Table 3.D
Rice cultivation	CH ₄	Table 3C7	Table 3.C
Prescribed burning of savannah and field burning of agricultural residues	CH ₄ N ₂ O	Table 3C1	Table 3.E, Table 3.F
CO ₂ emissions from liming and urea application and other carbon-containing fertilizers	CO ₂	Table 3C2 Table 3C3	Table 3.G-J

2.5. Greenhouse gases released due to agricultural activities

Agricultural activities contribute to GHG emissions in the form of CH₄, N₂O and CO₂, and precursors such as CO, NO_x, NMVOCs and SO₂.



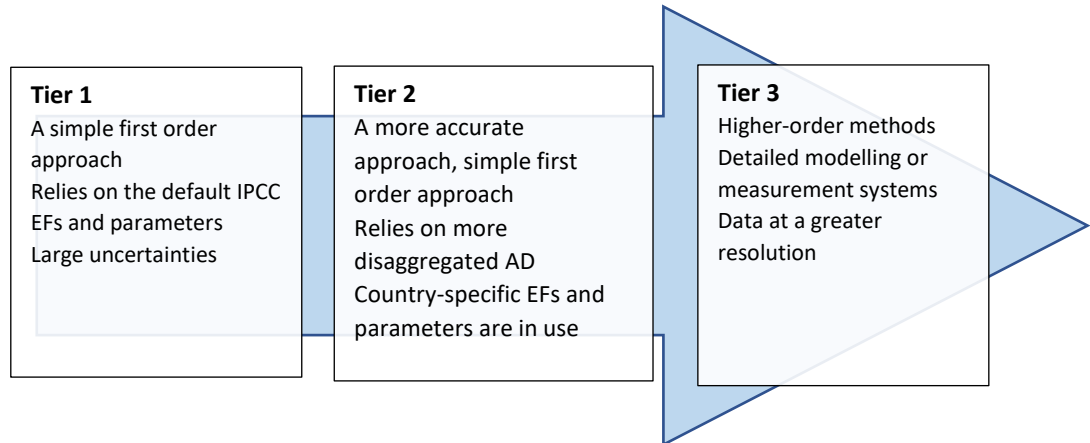
Read through paragraphs 48 and 51 of the MPGs to study 'shall' provisions for reporting the information on the gases mentioned above.

The 2006 IPCC Guidelines do not include methodologies for estimating CO₂ emissions from livestock, as annual net CO₂ emissions are assumed to be zero. Any emissions from the use of fuels in vehicles and machinery or the production of agricultural products (e.g., fertilizers) are not included in the agricultural sector.

CO₂ emissions from the application of inorganic carbon-containing fertilizers, such as lime, dolomite, urea, and others are reported under the agriculture sector. However, any CO₂ emissions resulting from carbon changes in agricultural soil, including the cultivation of histosols, should be reported under the LULUCF sector.

2.6. Intergovernmental Panel on Climate Change tier approaches to estimate greenhouse gas emissions

The 2006 IPCC Guidelines provide three-tiered approaches to estimate GHG emissions released due to agricultural activities (figure 2-3). Moving to a higher tier improves the accuracy of the inventory; however, the level of complexity and the number of resources required to conduct the inventories also increases.



C. Figure 2-3. Key features of the Intergovernmental Panel on Climate Change tier approaches

To learn more about the IPCC tier approaches see below.

<p>Tier 1</p> <ul style="list-style-type: none"> • Tier 1 methods are designed to be the simplest to use, for which equations and default parameter or EF values are provided in the 2006 IPCC Guidelines. • Country-specific AD are needed, but for tier 1 there are often globally available sources of AD estimates (e.g. agricultural production statistics and livestock population data), although these data are usually spatially coarse. • The guidance on how to review information reported under a tier 1 approach used in each category of the agriculture sector is provided within the relevant lesson.
<p>Tier 2</p> <ul style="list-style-type: none"> • Tier 2 can use the same methodological approach as tier 1 but applies EFs that are based on country- or region-specific data better reflecting the national environmental conditions and agricultural practices. Country-defined EFs are more appropriate for the climatic regions, land-use systems, etc. For example, more disaggregated AD are typically used in tier 2 to correspond with country-defined coefficients for specific regions and specialized livestock categories. • It is good practice – and encouraged by the MPG - to develop country-specific EFs or advanced estimation approaches using tier 2 or tier 3 methods, particularly for key categories. • If country-specific EFs are used, their derivation must be transparently documented, for example, by reference to publication in peer-reviewed journals. Any deviations from default values should be clearly explained in the national inventory report. • If country-specific EFs are not available, Parties may consider using factors from other countries with comparable environmental and management conditions. Another source of information could be the IPCC Emission Factor Database. Justifications of the choice of EF should be transparently explained and documented in the NID. • The guidance on how to review information reported under a tier 2 approach used in each category of the agriculture sector is provided within the relevant lesson.
<p>Tier 3</p> <ul style="list-style-type: none"> • At tier 3, higher-order methods are used, including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution AD and disaggregated at the subnational level. These higher-order methods provide estimates of greater certainty than lower

tiers. Detailed disaggregation of livestock population according to animal type, age, body weight, etc., can be used. Models should undergo quality checks, audits and validations and be thoroughly documented.

- When you are reviewing higher tiers or models, you should check the reporting of additional transparent information such as basis and type of model, application and adaptation of the model, main equations/processes, key assumptions, domain of application, how the model parameters were estimated, description of key inputs and outputs, details of calibration and model evaluation, uncertainty and sensitivity analysis, QA/QC procedures adopted and references to peer-reviewed literature.

Further guidance on the choice of a tier method

Paragraph 21 of the MPGs states that each Party shall use methods from the 2006 IPCC Guidelines or its supplements. Each Party should make every effort to use a recommended method (tier level) for key categories in accordance with those IPCC guidelines.

- ✓ As a reviewer, you must assess whether a Party has followed the recommendations and decision trees from the 2006 IPCC Guidelines and its choice of methods and parameters.

Paragraph 23 of the MPGs states that a Party may be unable to adopt a higher-tier method for a particular key category owing to lack of resources. In such cases, the Party may use a tier 1 approach, and shall clearly document why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines. The Party should prioritize for future improvement any key categories for which the good practice method elaborated in the IPCC guidelines referred to in paragraph 20 of the MPGs cannot be used.

- ✓ Hence, as a reviewer, you must seek out any explanatory information that clarifies why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines.

General guidance on the review of a tier method

In its review of **choice of method** for each category, the TERT may consider the following:

- Does the NID include information on the IPCC tier used?
- For key categories, does the NID include an explanation if the recommended methods from the appropriate decision tree in the 2006 IPCC Guidelines and its supplements are not used?
- If a recommended method is not used owing to lack of data or resources, has the Party adequately explained the national circumstances in the NID? Does the Party have plans to improve the situation?
- If a recommended method is not used, has the Party justified its choice of an alternative method?
- Is the Party's reporting on choice of method transparent?

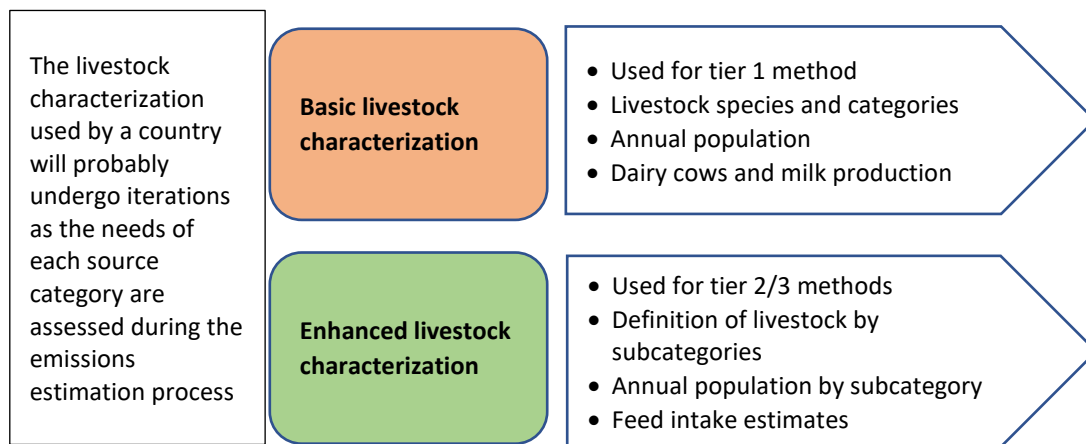
In its review of **use of method** for each category, the TERT may consider the following:

- Has the Party applied the method correctly?
- Is any country-specific method in line with the 2006 IPCC Guidelines and its supplements?

- Does the NID include descriptions, references and sources of information for country-specific methodologies, including higher-tier methods and models, as well as the rationale for their selection?
- For tier 3 methods and/or use of models, does the NID include verification information consistent with the 2006 IPCC Guidelines and its supplements?
- For tier 3 methods, does the NID include additional information for improving transparency, such as information on basis and type of model; application and adaptation of the model; main equations/processes; key assumptions; domain of application; how the model parameters were estimated; description of key inputs and outputs; details of calibration and model evaluation; uncertainty and sensitivity analysis; QA/QC procedures adopted; and references to peer-reviewed literature?
- Are the descriptions of the methods complete and transparent?

2.7. Livestock characterization

The methods for estimating CH₄ and N₂O emissions from livestock-related categories require information on livestock subcategory definitions, annual populations and feed intake estimates. To ensure that these definitions and data are used consistently across the categories, the 2006 IPCC Guidelines clearly indicate that the level of the livestock characterization (i.e. basic or enhanced) is determined after identifying the methods that have to be applied to each category (2006 IPCC Guidelines, vol.4, chap. 10, figure 10.1, p.10.9), which is a function of the key category analysis and the individual significance of the subcategories.



D. Figure 2-4. Basic and enhanced livestock characterization

To learn more about what types of information are necessary to support the emission estimates for basic and enhanced livestock characterizations see below.

For a **basic livestock characterization**, the following information is necessary:

- A **complete list of livestock populations for which default IPCC EF values are available** and if these categories are relevant to the country. More detailed categories should be used if the data are available;

- **Annual population** data for each species and category, including adjustments for seasonal variations (usually from official national statistics, industry sources or FAOSTAT);
- **Dairy cow population** (estimated separately) and its **average milk production** (country-specific data sources are preferred, but FAOSTAT data may also be used).

If relevant, the percentage of animals in each of the climatic regions (cool (<15 °C), temperate (15–25 °C) and warm (>25 °C)) should be defined. For accurate estimation of CH₄ emissions from liquid-based manure management systems, specific annual average temperatures in each climatic range are needed.

For an **enhanced livestock characterization**, Parties must collect, in addition to the information needed for the single characterization, the following:

- **Disaggregation of livestock into subcategories** for each species reflecting country-specific variations in age, type of production and sex structure;
- **Annual livestock population by subcategory**. Adjustments for seasonal variations should be considered as necessary;
- **Average daily feed intake estimates** for a typical animal in each subcategory (units of MJ/ day and/or kg/ day of dry matter); and

Generally, data on average daily feed intake are not available, particularly for grazing livestock. Consequently, data on animal productivity, diet quality and management (e.g. weight, weight gain, milk production per day, feed digestibility, etc.) should be collected to estimate feed intake (measured in MJ/day or kg/day) for each representative animal category by using the equations listed in the 2006 IPCC Guidelines (vol. 4, chap. 10, table 10.3).

The same feed intake estimates used to estimate CH₄ from enteric fermentation should be used to provide harmonized estimates of manure and Nex rates to improve the accuracy and consistency of CH₄ and N₂O emissions from manure management.

- ✓ As a reviewer, you should regularly check whether any new corrigenda for equations or data have been published on the IPCC Task Force on National Greenhouse Gas Inventories website (<https://www.ipcc-nggip.iges.or.jp/>), as some of them relate to default calculations of Gross Energy (GE) intake.

2.8. Characterization for livestock without tier emission estimation methods

Some countries may have domesticated animals for which there are currently no tier 1 or tier 2 emission estimating methods (e.g. llamas, alpacas, wapiti, emus).

Good practice in estimating emissions from these livestock is to first assess whether their emissions are likely to be significant enough to warrant characterizing them and developing country-specific EFs.



If the emissions from a particular subspecies are determined to be significant, then country-specific EFs should be developed, and a characterization should be performed to support the development of the EFs. Research into the estimation of emission levels from these non-characterized species should be encouraged.



An approximate EF could be developed by the use of a tier 1 EF for an animal with a similar digestive system and to scale the EF using the ratio of the weights of the animals raised to the power 0.75.

Animals with **similar digestive systems** are:

- Ruminant animals: cattle, buffalo, sheep, goats, camels, deer;
- Non-ruminant herbivores: horses, mules/asses;
- Poultry: chickens, ducks, turkeys, geese;
- Non-poultry monogastric animals: swine.



For more information, see page 10.23, section 10.2.4, volume 4 of the 2006 IPCC Guidelines.

3. General approach in reviewing the sector

3.1. Review of livestock characterization

In the review of livestock population characterization, the review expert may consider going through the list of potential actions presented below:

Please note that this is not intended to provide an exclusive list of actions; it is a starting point to stimulate your thinking. You may add or modify the questions as appropriate while conducting a review.

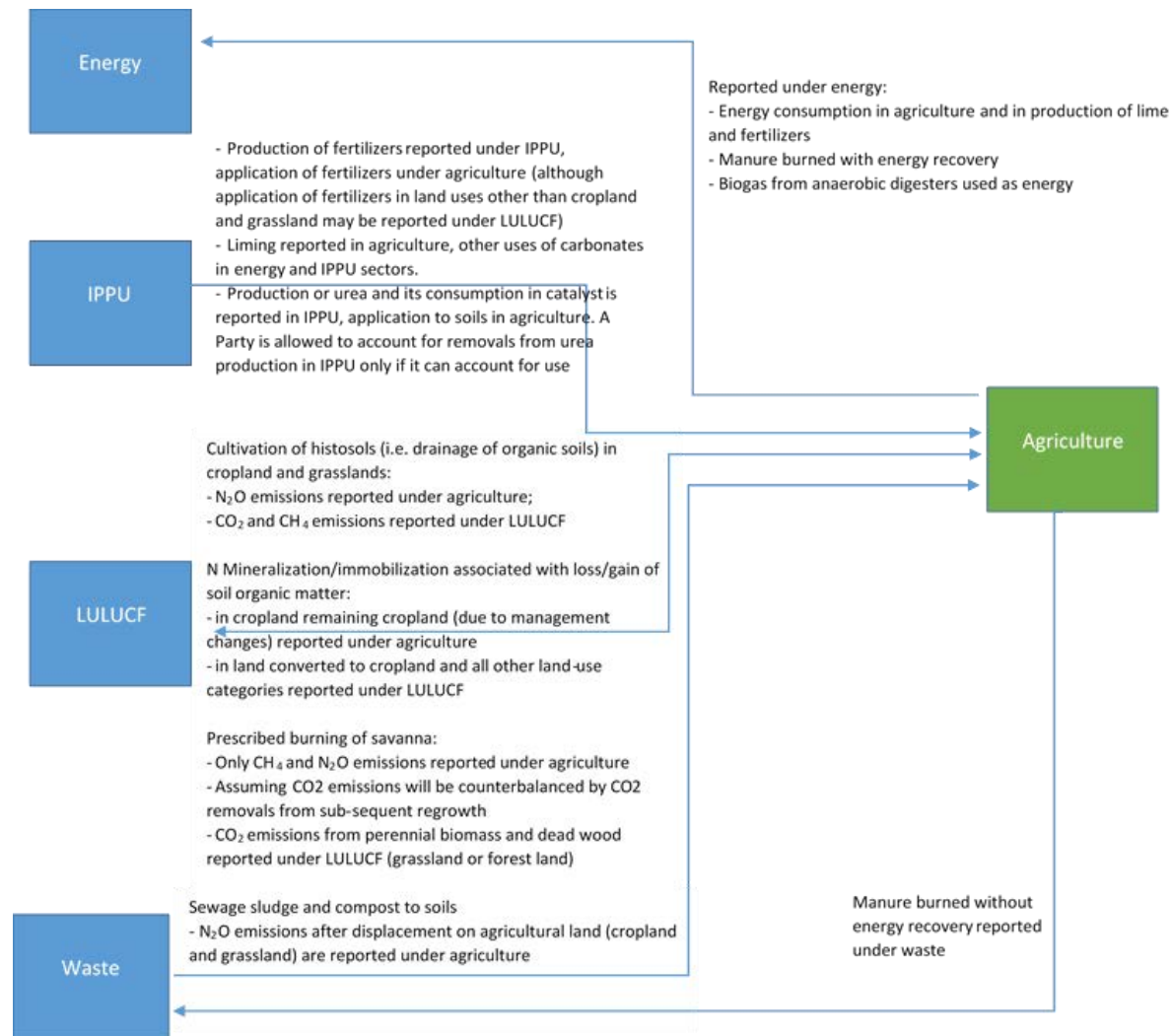
- The appropriate choice of livestock characterization depends upon the overall national circumstances, availability of data and the relevant decision tree in the 2006 IPCC Guidelines (vol. 4, chap. 10, figure 10.2). As a reviewer, you must check whether the recommended level of livestock characterization from the appropriate decision tree has been applied;
- If a recommended level of livestock characterization is not used owing to lack of data or resources, has the Party adequately explained the national circumstances in the NID? Does the Party have plans to improve the situation? If a recommended level of livestock characterization is not used, has the Party justified its choice of an alternative method?
- Has Party prepared an enhanced livestock characterization for the 'significant' animal species of the key categories;
- Check whether the Party has identified any significant animal species for which there are no default IPCC EFs (e.g. llamas, alpacas, wapiti, emus and ostriches). In such cases, the Party should have attempted to estimate emissions using country-specific factors that are based on an enhanced livestock characterization;
- Check whether the Party has prepared a single livestock characterization to allow consistent treatment of data across all relevant categories (e.g. CH₄ emissions from enteric fermentation, CH₄ and N₂O emissions from manure management and N₂O emissions from agricultural soils);
- Check whether the Party has consistently disaggregated animal populations across the entire time series;
- Do the annual population statistics take into account seasonal births or slaughters? Some countries must interpret the agricultural census data (e.g. seasonal births and slaughters are included or excluded, sometimes three-year averages are used);

- Is the feed intake calculated each year or is it based on assumptions?
- If an enhanced characterization is used, is there an expected relationship between digestibility, feed intake and growth (e.g. low digestibility leads to lower feed intake and reduced growth)?
- Does the Party use live weight in accordance with the 2006 IPCC Guidelines instead of slaughter weight? Is average weight increase estimated? How?

The agriculture sector has a high level of interlinkages across its categories and with the categories of other sectors within the national inventory.

A detailed explanation of each interlinkages shown in figure 2-5 is provided in the respective lesson for each category.

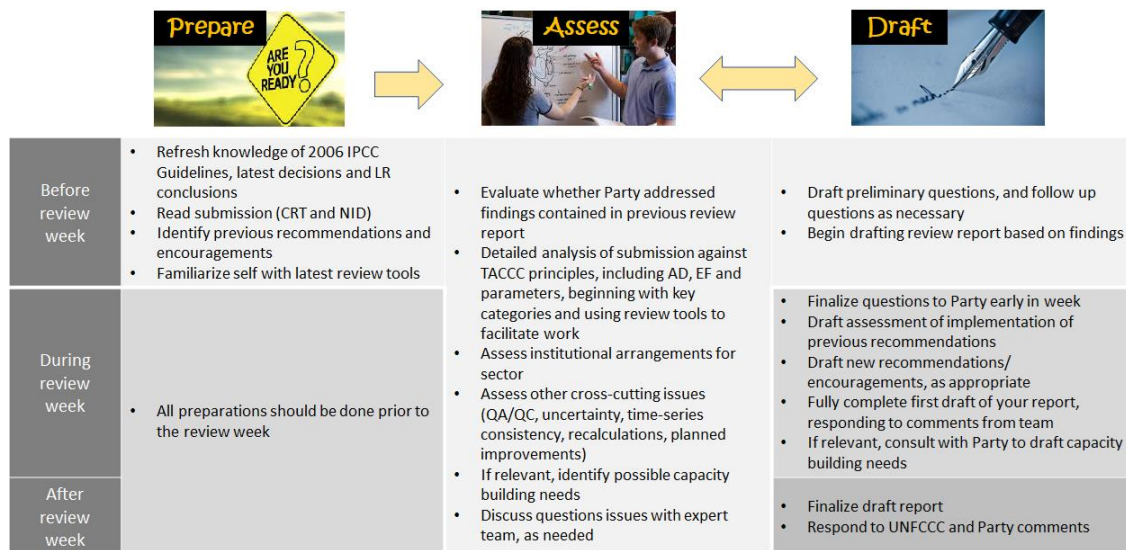
3.2. Overview of the interaction of the agriculture sector with other inventory sectors



E. Figure 2-5. Overview of the interaction of the agriculture sector with other inventory sectors

3.3. Main phases of the review

The main phases of the review are preparation, assessment and drafting. Communication is also a relevant needed skill.



F. Figure 2-6. The main phases of the review

✓ Prepare

Before the review week, familiarize yourself with:

- The Party's submitted NID and CRTs;
- Guidance documents, supporting materials and review tools.

✓ Assess:

- The transparency of the report (i.e. if the data sources, assumptions and methodologies used are clearly explained);
- The completeness, identifying whether any subcategory is missing or only partially reported.

Particular attention is to be paid to the **“shall”** requirements and findings that may be considered as **“issues”**, while the TERT should also review whether a Party has implemented the **“should”** and **“may”** elements in the UNFCCC decisions.

Areas to which the TERT must pay attention:

Methodologies, parameters and data	<ul style="list-style-type: none"> • Paragraphs 20–24 and 39–40 of the MPGs. • Paragraph 28 of decision 5/CMA.3 notes that Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines. • Annex I to decision 5/CMA.3 provides the template of CRTs for the electronic reporting of the information in the national inventory reports of anthropogenic GHG emissions by sources and removals by sinks. • Annex V to decision 5/CMA.3 outlines the NID pursuant to the MPGs.
Key category analysis (FX)	<ul style="list-style-type: none"> • Paragraphs 25 and 41–42 of the MPGs.
Time-series (FX) and recalculations	<ul style="list-style-type: none"> • Paragraphs 26–28, 43 and 57–58 of the MPGs.
Uncertainty assessment (FX)	<ul style="list-style-type: none"> • Paragraphs 29 and 44 of the MPGs.
Assessment of completeness (FX)	<ul style="list-style-type: none"> • Paragraphs 30–33, 45 and 47–50 of the MPGs. • Paragraph 27 of decision 5/CMA.3 notes that when information on EFs, AD and/or emissions by sources and removals by sinks of GHG are not available at the most disaggregated level, the notation key “IE” may be used to indicate that the data are included elsewhere in the inventory instead of under the expected source or sink category. <p>A core task for you as a reviewer is to review the notation keys used by the Party. It is important to remember that notation keys (i.e. “NA”, “C”, “IE”, “NO”, “NE”) are acceptable and consistent with the MPGs.</p> <p>The MPGs allow Parties to exclude from reporting emissions/removals for categories that are considered insignificant (and to use the notation key “NE”), even though emissions occur in the country and methods are available in the 2006 IPCC Guidelines or its supplements. However, the level of significance has to be properly documented in the NID and the CRT (e.g. in CRT 9) in accordance with paragraph 32 of the MPGs.</p> <p>As a reviewer, you should:</p> <ul style="list-style-type: none"> • Look through all the CRTs and identify whether the Party used notation keys to fill in all blanks: <ul style="list-style-type: none"> ○ If yes – check whether the explanation is provided in the NID and CRT 9; ○ Make sure that the notation keys have been used correctly.
QA/QC (FX)	<ul style="list-style-type: none"> • Paragraph 37 of the MPGs; • Paragraph 25 of decision 5/CMA.3 clarifies that the 100-year time-horizon global warming potential values shall be those listed in table 8.A.1 of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, excluding the value for fossil methane.
Metrics	<ul style="list-style-type: none"> • Paragraph 37 of the MPGs.

<p>Category-specific planned improvements</p>	<p>As per paragraph 7 of the MPGs, with flexibility provided to those developing country Parties that need it in the light of their capacities as per paragraph 7(c) of the MPGs.</p> <p>To facilitate continuous improvement, each Party should, to the extent possible, identify, regularly update and include as part of its biennial transparency report information on areas of improvement including, as applicable:</p> <ul style="list-style-type: none"> a) Areas of improvement identified by the Party and the technical expert review team in relation to the Party's implementation of Article 13 of the Paris Agreement; b) How the Party is addressing or intends to address areas of improvement as referred to in paragraph 7(a) of the MPGs, as appropriate; c) Those developing country Parties that need flexibility in the light of their capacities are encouraged to highlight the areas of improvement that are related to the flexibility provisions used; d) Identification of reporting-related capacity-building support needs, including those referred to in paragraph 6 of the MPGs, and any progress made, including those previously identified as part of the technical expert review referred to in chapter VII of the MPGs.
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FX refers to the flexibility provided “to those developing country Parties that need it in the light of their capacities”
Paragraph 5 of decision 5/CMA.3 provides options on how Parties may reflect the application of the specific flexibility in the CRTs.



A list of possible questions you can ask yourself when reviewing the completeness of the inventory and cross-cutting elements is presented below.

Please note that this is not intended to provide an exclusive list of questions; it is only designed to be a starting point to stimulate your thinking. Feel free to add or modify the questions as appropriate.

Review element	Possible question/action by the TERT
Uncertainty analysis	Are uncertainties estimated for the category?
	Is the information on the uncertainty assessment per category sufficiently transparent (e.g. methods, underlying assumptions, data sources and documentation of expert judgments)?
	Is the estimation of uncertainties in line with the 2006 IPCC Guidelines (general guidance on uncertainties in volume 1, and sector-specific guidance in the relevant sectoral volumes)?
Recalculations	It is the TERT's task to review all recalculations carried out by the Party using CRT 8 (using the comparison tool) and the NID to identify them. The TERT can consider the following:
	Does the NID include sufficient information as to why a recalculation was conducted (e.g. error correction, statistical reason or reallocation of categories, changes in methodologies, sources of information and assumptions)?
	Have the recalculations been sufficiently justified by improvement of accuracy or completeness? Are these justifications transparently reported in the NID? If the recalculation was carried out in response to the review process, is this indicated in the NID?
	Have the recalculations been reported for the base year and all subsequent years of the time series up to the latest year for which the recalculations are made?
	Does the NID include a discussion on the impact of the recalculations on the trend in emissions at the category, sector and national total level?
	Does the NID include information on the procedures used for performing the recalculations, changes in the calculation methods, EFs and AD used?
	Does the NID include information on the inclusion of categories not previously covered?
Consistency of time series	Are the same method and AD source used for the entire time series? If not, is consistency of the time series ensured in line with the 2006 IPCC Guidelines, volume 1, chapter 5?

Review element	Possible question/action by the TERT
	<p>Are the parameters and EFs consistent over the time series? If not, are the changes in these factors supported by changes in national circumstances (e.g. technological development)?</p> <p>Is the data set prepared on a calendar year basis and consistently across time? According to the 2006 IPCC Guidelines, use of calendar year data is good practice whenever the data are available. However, if calendar year data are unavailable, then other types of annual year data (e.g. non-calendar fiscal year data, April to March) can be used for certain categories provided that they are used consistently over the time series and the collection period for the data is documented.</p>
General QC procedures	<p>Does the Party apply general QC procedures for each category, in line with its QA/QC plan?</p> <p>If the NID contains a number of errors across different categories, consider (in cooperation with the TERT generalist) whether this may be an indication of lack of sufficient QA/QC procedures or whether the national inventory arrangements/national system are not sufficiently carrying out their functions.</p>
Completeness / notation keys	<p>Has the Party reported in the NID an assessment of completeness, including information and explanations in relation to categories that are reported as “NE” or “IE”, and information related to the geographical scope?</p> <p>Are notation keys used to fill in all blanks in the CRTs? Are notation keys used where data were previously reported? If so, is an explanation provided in the NID? Have any notation keys changed from the previous submission? If so, was the change properly documented in the NID?</p> <p>Use of notation key “NA” Is the notation key “NA” used for activities under a given category that occur within the Party but do not result in emissions or removals of a specific gas? Where “NA” is reported and the 2006 IPCC Guidelines and its supplements provide a method and an EF for the particular category–gas combination, carefully review the justification provided by the Party for using “NA” and consider whether to question the Party as to why “NE” was not reported</p> <p>Use of notation key “C” Is use of the notation key “C” justified (i.e. is its use required to protect confidential business or military information)? Has the Party provided the basis for protecting such information, including any domestic law? Is the TERT confident that the emissions or removals reported as “C” are included in sectoral (or, if necessary, national) totals?</p> <p>Use of notation key “IE”</p>

Review element	Possible question/action by the TERT
	<p>Are emissions that are reported as “IE” actually included elsewhere? Such an assessment may require coordination among TERT members in different sectors. Does CRT 9 document where these emissions are reported? Often Parties use the notation key “IE” because of the way national statistics are collected, and this results in the inability to allocate emissions according to the 2006 IPCC Guidelines and its supplements. If this is the case, the TERT should consider whether a recommendation to report emissions consistent with the allocation in the 2006 IPCC Guidelines and its supplements is appropriate.</p> <p>Use of notation key “NO”</p> <p>Where the notation key “NO” is used, has the Party provided justification that the category or process does not occur within the country?</p> <p>In some cases, it may be difficult for the Party to justify that a category or process is not occurring. The TERT should investigate the use of “NO” if it has a good reason to assume that the activity is occurring in the Party; for example, if the emissions are related to use or production of a product which generally occurs in the Parties or the TERT is aware of other references indicating that the process occurs or the product is produced in the country.</p>

Collect your findings and conclude on which findings become issues in relation to TACCC or other adherence issues.

Even in the case of issues related to transparency (i.e. the NID does not clearly describe how emissions were estimated), the TERT should specifically determine that the lack of transparency in the inventory leads it to question the accuracy of the inventory estimates reported.

Transparency is one of the most common and serious problems in Party inventory submissions identified by review teams. For example, national models and country-specific EFs, which improve the accuracy of the inventory, are often not referenced or explained in sufficient detail.

Your evaluation of the **accuracy, completeness, consistency and comparability** of a Party's inventory submission is dependent upon it being transparent. Therefore, Parties should be strongly encouraged in your review findings to be as transparent as possible with their reporting.

As a review expert, you should request any information necessary that will enable you to assess a Party's inventory submission, especially in the case of in-country reviews. Preferably, information should consist of published documents, peer reviewed in the case of models, and country-specific EFs and parameters.

When you are reviewing higher tiers or models, you should check the reporting of additional transparent information such as basis and type of model, application and adaptation of the model, main equations/processes, key assumptions, domain of application, how the model parameters are estimated, description of key inputs and outputs, details of calibration and model evaluation, uncertainty and sensitivity analysis, QA/QC procedures adopted and references to peer-reviewed literature.

✓ **Communicate**

Effective communication between the TERT and the Party is one key to a successful review process. Pose clear and polite questions to the Party under review and communicate with the lead reviewers and other sectoral reviewers in the team in cases of cross-cutting issues and throughout the review process.

Before sending a question to the Party, you should consider the following:

- (a) Is the question drafted in a clear and concise manner so that the Party understands the underlying issue?
- (b) Does the question convey a polite and neutral tone, asking a question and not suggesting or prejudging the TERT’s final recommendation?
- (c) Have all related answers already provided by the Party been reviewed to ensure that the same question is not asked twice?
- (d) Have any follow-up questions been clearly linked to the original question and the Party’s subsequent response(s)?

Examples of poorly phrased and well-phrased questions are presented below.

Poorly phrased	Well phrased
<p>You have not changed the method for enteric fermentation even though the need to move to tier 2 was discussed during the in-country review two years ago. When will you move to tier 2?</p>	<p>The TERT noted that in the previous review report the TERT recommended that you implement a tier 2 method for enteric fermentation of cattle. The current TERT noted that tier 1 is still used, and did not identify any indication in the NID regarding whether you have plans to move to a tier 2 method. Could you elaborate on the current status of addressing the recommendation? Are you planning to move to tier 2 and if so, when? Please elaborate on any possible constraints, such as availability of data, knowledge or resources.</p>
WHY	WHY
<p>(a) The question is not specific, as the subcategory is not indicated.</p> <p>(b) The TERT is not giving the Party a chance to explain (e.g. based on national circumstances) why it has not implemented the recommendation or whether it is addressing the recommendation.</p> <p>(c) The TERT is suggesting the final recommendation.</p>	<p>(a) The question is specific to the category and references a specific recommendation in the previous TERT.</p> <p>(b) The TERT is not suggesting the outcome but giving the Party a chance to explain the situation.</p> <p>(c) The TERT is trying to anticipate the Party’s response and potential follow-up questions in order to save time.</p>

✓ **Draft**

The outcome of the review consists of a series of documents completed at different stages of your work. As a member of the TERT responsible for the review of the agriculture sector of GHG inventory, you will be providing your contributions to a larger report that is covering all elements of the biennial transparency report review.



To learn more about the approach to the review, see lesson 6 of the “Overview and cross-cutting” course.

4. Practical exercises

4.1. Practical exercise 1

Which of the following statements correctly describes the requirements of methodological selection for estimating CH₄ emissions from enteric fermentation?

- A. The level of livestock characterization (basic or enhanced) should be defined after key category analysis and identification of significant species;
- B. If enhanced livestock characterization is available, it should always be applied;
- C. The tier 1 method cannot be applied to estimate emissions for a significant animal species if enteric fermentation is a key category;
- D. For non-significant species, CH₄ emissions from enteric fermentation can be estimated using default EFs without any investigation of applicability to national circumstances;
- E. Parties are always encouraged to use tier 3 methods for significant animal species;
- F. The methodological choice should be consistent with the decision trees in the 2006 IPCC Guidelines.

Select one:

- A. A, B and F
- B. A, B, C and F
- C. B, C, D, E and F
- D. A, B, C, E and F
- E. All of the above

Tip

See paragraph 21 of the MPGs and the decision trees in the 2006 IPCC Guidelines (vol. 4, chap. 10, figures 10.1 and 10.2) . See also volume 1, chapter 4, of the 2006 IPCC Guidelines, noting section 4.1.2 on limited resources, for a discussion on key categories and use of decision trees.

4.2. Practical exercise 2

Based on the requirements provided in the MPGs and the 2006 IPCC Guidelines, what should be considered during the review to assess the completeness of the inventory of agriculture sector emissions submitted by a developed country Party?

Select one:

- A. The inventory covers at least all sources and sinks, as well as all gases, for which methodologies are provided in the 2006 IPCC Guidelines or for which supplementary methodologies have been agreed by the Conference of the Parties
- B. The full geographical coverage of the inventory
- C. The inventory covers reporting a consistent annual time series starting from 1990, whereas the latest reporting year shall be not more than two years prior the submission of the Party's national inventory report
- D. The inventory covers at least all sources and sinks, as well as all gases, for which methodologies are provided in the 2006 IPCC Guidelines or for which supplementary methodologies have been agreed by the Conference of the Parties; however, insignificant source or sink categories may be reported as "NE" (significant categories for which there are no default methodologies are encouraged to be estimated)
- E. The inventory covers reporting a consistent annual time series starting from 1990, whereas the latest reporting year shall be not more than three years prior the submission of the Party's national inventory report
- F. The agriculture chapter of the NID includes an overview and information on methodological issues, uncertainty, time-series consistency, category-specific QA/QC checks, recalculations and planned improvements
- G. A, B, C and F
- H. B, C, D and F
- I. B, D, E and F
- J. A, B, D, E and F

Tip

See volume 1 of the 2006 IPCC Guidelines and paragraphs 32, 38, 57 and 58 of the MPGs.

4.3. Practical exercise 3

The MPGs allow a Party to exclude from reporting emissions/removals from categories that are considered insignificant, even though they occur in the country and methods are available in the 2006 IPCC Guidelines or its supplements. However, notation keys have to be used and the level of significance has to be properly documented in the NID and the CRT (i.e. in CRT 9).

Which of the following options are in line with the reporting requirements prescribed for the use of notation keys (in assessment of completeness)?

Select one:

- A. Each developed country Party should indicate any sources of the agriculture sector which are considered in the 2006 IPCC Guidelines but not considered in the inventory; in such cases a developed country Party may use the notation key "NE" (in the relevant category in the CRT) and provide an explanation for the reason for not reporting these sources and sinks and to justify that the estimates are insignificant in terms of emission level (e.g. in CRT 9). Developing country Parties may apply flexibility in the light of their capacities and may use the notation key "NE" for a category that is not considered and may decide not to provide any justification that the estimates are insignificant in terms of emission level
- B. Each Party should provide a justification for the use of the notation key "NE" only in CRT 9. However, it is not mandatory to duplicate the description of insignificant categories in a respective section of the NID
- C. For any source of the agriculture sector for which the notation key "IE" is used, each Party should clearly indicate where in the inventory the emissions/removals were allocated and explain the reason for reporting these sources and sinks in a different sector/category than that recommended in the 2006 IPCC Guidelines
- D. All of the above
- E. None of the above

Tip

See paragraphs 30–32 of the MPGs and outline of the NID pursuant to the MPGs.

4.4. Practical exercise 4

Your task, as a member of the TERT, is to review all recalculations carried out by a Party in its inventory of agriculture sector emissions on the basis of CRT's table 8 and the NID.

Review the options listed below. Which of the following might lead to an issue in the reporting of the recalculations in the inventory of the agriculture sector?

Select one:

- A. Detailed explanations of recalculations have not been provided in the NID
- B. Recalculations have been performed for only a few years and the resultant time series is not consistent
- C. No information has been provided on recalculations made in response to the review process
- D. A and C
- E. A, B and C

Tip

See paragraphs 28 and 43 of the MPGs and volume 1, chapter 3, section 3.7.1, of the 2006 IPCC Guidelines.

4.5. Answer key to practical exercises

Practical exercise 1

The correct answer is A.

The level of livestock characterization is determined after identification of the methods that have to be applied to each category, which are a function of the key category analysis and the individual significance of the subcategories (option A). Parties should implement a recommended method in accordance with the decision trees in volume 4 of the 2006 IPCC Guidelines (option F).

The 2006 IPCC Guidelines are clear that the tier 1 method should be used only if all possible avenues to use the tier 2 method have been exhausted, and/or it is determined that the source is not a key category or significant subcategory. Moreover, the decision trees (figures 10.1 and 10.2) stipulate that if enhanced livestock characterization is available, a Party should apply a tier 2 approach to estimate emissions for the species (option B). The use of tier 1 and default EFs for significant animal species may be justified in cases where a Party lacks the necessary information. However, the Party should also demonstrate that it is taking steps to collect the necessary information for future inventories (option C is incorrect). In cases where default EFs are applied, all assumptions implicit in these default factors and methods should be checked by the Party if they are appropriate for specific national circumstances (e.g. milk yields for dairy cows) (option D is incorrect). Although countries are encouraged to go beyond the tier 2 method, it depends on the availability of additional country-specific information and may not always be feasible (option F is incorrect).

Practical exercise 2

The correct answer is H.

The 2006 IPCC Guidelines (vol.1, chap. 1, page 1.8) provide the following definition of completeness: estimates are reported for all relevant categories of sources and sinks, and gases. Geographic areas within the scope of the national GHG inventory are recommended in these Guidelines. Where elements are missing their absence should be clearly documented together with a justification for exclusion.

In addition, the 2006 IPCC Guidelines (vol. 1, chap. 1, page 1.4) define some other key concepts to ensure that inventories are comparable between countries, do not contain double counting or omissions, and that the time series reflect actual changes in emissions. Where, among others, the definition of national territory is provided. Namely, *National territory*: national inventories include GHG emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction.

Hence, the inventory should ensure full geographical coverage (option B is correct) and covers at least all sources and sinks, as well as all gases, for which methodologies are provided in the 2006 IPCC Guidelines or for which supplementary methodologies have been agreed by the Conference of the Parties. However, Parties may use the notation key “NE” when the estimates would be insignificant in terms of emission level (MPGs, para. 32). Therefore, option A is partially correct and option D is fully correct.

Parties must report a consistent annual time series starting from 1990, and the latest reporting year should be no more than two years prior to the submission of the national inventory report (MPGs, paras. 57 and 58) (option C is correct). However, the two paragraphs foresee the flexibility in the reporting of consistent time series; namely, that those developing country Parties that need flexibility in these reporting provisions, instead of reporting a consistent annual time series starting from 1990, may report data covering, at a minimum, the reference year/period for their NDC under Article 4 of the Paris Agreement and, in addition, a consistent annual time series from at least 2020 onward (option E is not correct). They may also have their latest reporting year as three years prior to the submission of their national inventory report.

Moreover, Parties shall provide a national inventory report of anthropogenic emissions by sources and removals by sinks of GHGs (MPGs, para. 38). The national inventory report consists of a NID and the CRTs. the overview and information on methodological issues, uncertainty, time-series consistency, category-specific QA/QC checks, recalculations and planned improvements isto be provided within the NID (option F is correct).

Practical exercise 3

The correct answer is C.

Each Party shall use notation keys where numerical data are not available while completing CRTs (see MPGs, para. 31).

Parties may use the notation key “NE” for emissions sources which are considered in the 2006 IPCC Guidelines but not considered in the inventory. This can be the case when the estimates would be insignificant, that is, the likely level of emissions is below 0.05 per cent of the national total GHG emissions, excluding LULUCF, or 500 kt CO₂ eq, whichever is lower. Developing country Parties have the flexibility to instead consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO₂ eq, whichever is lower.

Developing country Parties can indicate the use of flexibility using the notation keys “NE” or “FX”. Parties indicate any sources and sinks which are considered in the 2006 IPCC Guidelines but are not considered in the submitted inventory and explain the reason for not reporting these sources and sinks, in order to avoid arbitrary interpretations (see footnote 1 to CRT 9)(option A is incorrect).

Documentation boxes in CRTs should be used to provide cross references to detailed explanations placed in the NID (option B is incorrect).

Where “IE” is used in an inventory, the Party should indicate in CRT 9 where in the inventory the emissions or removals for the category have been included. Parties indicate any sources and sinks in the submitted inventory that are allocated to a sector other than that recommended by the 2006 IPCC Guidelines and explain the reason for reporting these sources and sinks in a different sector/category (see footnote 4 to CRT 9) (option C is correct).

Practical exercise 4

The correct answer is E.

Parties shall report recalculations for the starting year, and all subsequent years of the inventory time series if relevant to ensure that changes in emission trends are not introduced as a result of changes in methods or assumptions across the time series, together with explanatory information and justifications for recalculations with an indication of relevant changes and their impact on the emission trends (MPGs, para. 43). As a reviewer, you should check in the NID and CRT 8 whether the Party provided sufficient information on why a recalculation was conducted. If detailed explanations of recalculations have not been provided in the NID, it must be defined as failure to meet the reporting requirements of the MPGs (options A and C may lead to an issue).

Paragraph 28 of the MPGs indicates that each Party should perform recalculations in accordance with the 2006 IPCC Guidelines or its supplements, ensuring that changes in emission trends are not introduced as a result of changes in methods or assumptions across the time series. In other words, recalculations should ensure the consistency of the time series and be carried out to improve accuracy and/or completeness.

For more information, you may wish to consult chapter 5 of volume 1 of the 2006 IPCC Guidelines and lesson 3 of the “Overview and cross-cutting” course.

5. Self-check quiz

Question 1

A Party has applied a tier 1 methodology to estimate direct N₂O emissions from managed soils. EFs were obtained from the 2006 IPCC Guidelines. In its uncertainty assessment performed using approach 2 (Monte Carlo analysis), the Party reported the use of an uncertainty value for the default EF₁ (which refers to N₂O emitted from synthetic and organic nitrogen applications to soils) of ±30 per cent for mineral fertilizers, nitrogen-fixing crops and crop residues and ±50 per cent for animal manure.

As a reviewer, would you agree with the approach applied by the Party?

Select one:

- A. Yes, I agree with the approach)
- B. No, I do not agree with the approach)

Question 2

In its NID, a developing country Party reported the information provided below.

In rare situations where data were completely unavailable both in-country and from international sources, expert judgment was used and the underlying assumptions documented.

Expert judgment has been used in the allocation of percentage share of manure management systems and the proportion of dairy and non-dairy cattle. Hence, the uncertainty rates associated with the AD on the allocation of manure management systems over the whole reporting period are relatively higher than those reported in the 2006 IPCC Guidelines.

The category has been identified as a key category.

As a reviewer, would you accept the information on the uncertainty assessment associated with the manure management category?

Select one:

- A. Yes, I would accept the information provided)
- B. No, I would not accept the information provided)

Question 3

A developing country Party used the default EF from the Revised 1996 IPCC Guidelines to estimate CH₄ emissions from enteric fermentation from dairy cattle.

As a reviewer, would you agree with the approach applied by the Party?

Select one:

- A. Yes, I would agree)
- B. No, I do not agree)

Question 4

As a reviewer, you noted that a developing country Party used the notation key “NE” in CRT 3.D to report on N₂O emissions from sewage sludge applied to soils (3.D.1.b.ii) and from other organic fertilizers applied to soils (3.D.1.b.iii).

During the review, the Party explained that the collection of information on the use of sewage sludge is listed as a planned improvement in chapter 8 of the NID. The Party stated that the use of sewage sludge as a fertilizer on agricultural land is prohibited in the country, but that sewage sludge may be used in remote areas of the country with a specific permit. Moreover, the Environment Agency is currently working with the Agricultural University and with local authorities to gather information on sewage sludge that might be being applied to soils. The Party indicated that information on the use of sewage sludge and of other organic fertilizers would be made available in the next GHG inventory submission. Moreover, the Party specified that the likely level of emissions from sewage sludge and other organic fertilizers applied to soils may reach 650 kt CO₂ eq (0.06 per cent of the national total).

As a reviewer, would you raise the finding as an issue, as the likely level of emissions should be considered as significant?

Select one:

- A. Yes, I would raise an issue)
- B. No, I would not raise an issue)

Question 5

Read through the issue identified by the TERT and the response provided by a Party during the review week.

The TERT noted that the Party performed significant recalculations of N₂O emissions from agricultural soils in the 2025 annual submission compared with the 2023 annual submission (+2.8 per cent for 1990, -36.09 per cent for 1995, -8.10 per cent for 2000, +12.64 per cent for 2005, +22.26 per cent for 2010, +3.11 per cent for 2015 and +0.45 per cent for 2016). In the NID, the Party explained that the recalculations were the result of the use of corrected population numbers for sheep and goats, a corrected calculation of N₂O emissions from mineralization and the use of improved data on crop yields. However, the Party did not include detailed data at the subcategory level in the NID, which would have enabled an assessment of the changes.

In response to a question raised by the TERT during the review, the Party explained that the main contributing factor to the changes was the recalculations of mineralization of organic matter on the basis of data used in the LULUCF sector. The Party provided a table that included the changes of AD at the subcategory level. The TERT agreed with the explanations provided.

The TERT recommends that the Party provide detailed information on the reasons for the recalculations of emissions from category 3.D (direct and indirect N₂O emissions from agricultural soils), including, when relevant, information at the subcategory level, in the recalculation sections of the NID, and tables showing the resulting differences among annual submissions.

Would you agree with the possible recommendation drafted by the TERT?

Select one:

- A. Yes, I agree with the recommendation)
- B. No, I do not agree with the recommendation)

Question 6

In its CRT 3.A, a developing country Party reported CH₄ emissions from dairy cattle enteric fermentation in 1990–2025 and the underlying information provided below used to conduct the estimates. In addition, in its NID, the Party stated that the emissions from dairy cattle enteric fermentation have been identified as a key category only for the latest reporting year (i.e. for 2025).

	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024	2025
Population of dairy cattle, 1000 heads	280.7	264.3	253.4	226.7	138.4	116.5	96.7	96.5	96.2	96.8	97.9	95.6
Implied emission factor, kg CH ₄ /head/year	99.0	99.0	99.0	99.0	101.9	116.6	130.0	131.7	132.9	136.1	140.7	143.2
Emissions, kt CH ₄	27.8	26.2	25.1	22.4	14.1	13.6	12.6	12.7	12.8	13.2	13.8	13.7
Emission factor information	D	D	D	D	CS,D	CS,D	CS,D	CS,D	CS,D	CS,D	CS,D	CS,D
Method	T1	T1	T1	T1	T2	T2	T2	T2	T2	T2	T2	T2

What would be your assessment on ensuring a consistent time series of the estimates conducted by the Party?

Select one:

- A. Consistency of time series is ensured
- B. Consistency of time series is not ensured

Question 7

In its 2027 submission, a developing country Party reported CH₄ emissions from dairy cattle enteric fermentation for 1992–2023. The underlying information used to conduct the estimates is summarized in the table below.

	1992	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Population of dairy cattle, 1000 heads	280.7	264.3	253.4	226.7	138.4	116.5	112.8	108.4	103.0	100.4	96.7	96.5	96.2	96.8
Implied emission factor, kg CH ₄ /head/year	100.8	98.7	93.7	91.7	101.9	116.6	120.1	124.4	126.1	129.0	130.0	131.7	132.9	136.1
Emissions, kt CH ₄	28.3	26.1	23.8	20.8	14.1	13.6	13.5	13.5	13.0	13.0	12.6	12.7	12.8	13.2
Emission factor information	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D	CS, D
Method	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2

What would be your assessment regarding the completeness of information on CH₄ emission trends time series from dairy cattle enteric fermentation?

Select one:

- A. Time series is complete
- B. Time series is not complete

5.1. Answer key to self-check quiz

Question 1

The correct answer is B.

The country noted that the default EF₁ was used in the emissions calculations. Moreover, the Party specified that the uncertainty rate value of ± 30 per cent for the EF₁ for mineral fertilizers, nitrogen-fixing crops and crop residues and ± 50 per cent for animal manure was applied in its uncertainty assessment. However, the 2006 IPCC Guidelines (vol. 4, chap. 11, table 11.1) provide the uncertainty range of 0.003–0.03 kg N₂O-N/kg N for the EF₁. Thus, the Party applied an uncertainty range that is not consistent with those reported for the default EF₁.

Hence, as a reviewer, you should clarify this finding with the Party. Your possible recommendation might be drafted as follows: The ERT recommends that the Party justify in the NID the assumptions used to derive the uncertainty value of ± 30 per cent for the EF₁ for mineral fertilizers, nitrogen-fixing crops and crop residues and ± 50 per cent for animal manure or use the appropriate uncertainty range for the default EF₁ from table 11.1 of the 2006 IPCC Guidelines (vol. 4) (0.003-0.03 kg N₂O-N/kg N) in its Monte Carlo uncertainty analysis.

Question 2

The correct answer is A.

Parties should quantitatively estimate and qualitatively discuss the uncertainty, as well as estimate the trend uncertainty of the emission and removal estimates for all source and sink categories (MPGs, para. 29). Moreover, those developing country Parties that need flexibility in the light of their capacities have the flexibility to instead provide, at a minimum, a qualitative discussion of uncertainty for key categories, using the 2006 IPCC Guidelines, where quantitative input data are unavailable to quantitatively estimate uncertainties and are encouraged to provide a quantitative estimate of uncertainty for all source and sink categories of the GHG inventory.

You might have noted that the Party provided the qualitative discussion of uncertainty for the manure management category. As a reviewer, you may accept the information provided by the Party. Also, you may encourage the Party to provide a quantitative estimate of uncertainty and include the finding in a list of capacity-building needs identified by the TERT.

Question 3

The correct answer is B.

Parties should use the 2006 IPCC Guidelines (MPGs, para. 20). Moreover, each Party should provide information on the category and gas, and the methodologies, EFs and AD used at the most disaggregated level, to the extent possible, according to the 2006 IPCC Guidelines or its supplements (MPGs, para. 40).

Using the default EF from the Revised 1996 IPCC Guidelines to estimate CH₄ emissions from enteric fermentation from dairy cattle is not in line with the MPGs. Therefore, as a reviewer, you must communicate with the Party to get further information and ask the Party to justify the use of the default EF from the Revised 1996 IPCC Guidelines.

Question 4

The correct answer is B.

Paragraph 32 of the MPGs provides that each Party may use the notation key “NE” when the estimates of emissions of a category would be considered insignificant, that is, likely to be below 0.05 per cent of the national total, excluding LULUCF, or 500 kt CO₂ eq, whichever is lower. However, developing country Parties that need flexibility in the light of their capacities have the flexibility to instead consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO₂ eq, whichever is lower.

As you might have noted, the likely level of emissions released due to the application of sewage sludge and other organic fertilizers in the developing country Party is lower than 0.1 per cent of the national total GHG emissions, excluding LULUCF, and 1,000 kt CO₂ eq.

Question 5

The correct answer is A.

Paragraph 43 of the MPGs stipulates that each Party shall report recalculations for the starting year and all subsequent years of the inventory time series, together with explanatory information and justifications for recalculations with an indication of relevant changes and their impact on the emission trends.

As you might have noted, the Party included the general information on the recalculations conducted (e.g. because of the use of corrected population numbers for sheep and goats and improved data on crop yields). However, the justifications for recalculations with an indication of relevant changes and their impact on the emission trends have not been provided in the NID.

Question 6

The correct answer is B.

All emission estimates in a time series should be estimated consistently, which means that as far as possible, the time series should be calculated using the same method and data sources in all years. Using different methods and data in a time series could introduce bias because the estimated emission trend will reflect not only real changes in emissions or removals but also the pattern of methodological refinements.

Moreover, paragraph 26 of the MPGs indicates that to ensure time-series consistency, each Party should use the same methods and a consistent approach to underlying AD and EFs for each reported year.

Hence, as a reviewer, you must communicate with the Party and raise the finding as an issue.

Question 7

The correct answer is (B).

Paragraph 57 of the MPGs stipulates that each Party should report a consistent annual time series starting from 1990. However, those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead report data covering, at a minimum, the reference year/period for their NDC under Article 4 of the Paris Agreement and, in addition, a consistent annual time series from at least 2020 onward.

As you may have noted, the Party reported the consistent annual time series of CH₄ emissions starting from 1992. As a reviewer, you must refer to the NID for information on the reference year/period for the NDC to check whether 1992 could be used as the first year of the time series.

Moreover, the latest reporting year should be no more than two years prior to the submission of the Party's national inventory report; those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead have their latest reporting year as three years prior to the submission of their national inventory report (MPGs, para. 58). As the developing country Party submitted the NID and the CRTs in 2027, the latest reporting year must be 2024 (allowing for flexibility, i.e. three years prior to the submission of its NID). However, as can be seen from the table, the latest reporting year was 2023. Hence, as a reviewer, you must communicate with the Party and raise the finding as an issue.

6. Key points to remember

- The 2006 IPCC Guidelines provide the integrated volume (i.e. volume 4) on the methodologies developed to estimate GHG emissions and removals from the LULUCF and agriculture sectors. Nevertheless, for reporting purposes, the Parties agreed to continue separate reporting of the agriculture sector and the LULUCF sector.
- Paragraph 28 of decision 5/CMA.3 notes that the Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines.
- There are three-tiered approaches elaborated to estimate GHG emissions from the agriculture sector categories: tier 1 is the basic method, tier 2 the intermediate and tier 3 the most demanding in terms of complexity and data requirements.
- In its reporting, each Party should report seven gases: CO₂, CH₄, N₂O, HFCs, PFCs, SF₆ and NF₃. Those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead report at least three gases (CO₂, CH₄ and N₂O) as well as any of the additional four gases (HFCs, PFCs, SF₆ and NF₃). In addition, each Party should provide information on the precursor gases CO, NO_x, NMVOCs and SO_x.
- Annex I to decision 5/CMA.3 provides the CRT template for the electronic reporting of the information in the national inventory reports on anthropogenic GHG emissions by sources and removals by sinks. Agriculture sector emissions are reported in CRT 3 to 3.G-J.
- There are two levels of livestock population characterization:
 - i. Basic characterization – used for tier 1 methods. The approach relies on animal population statistics by species and the IPCC default EFs;
 - ii. Enhanced characterization – used for tier 2 methods. The approach seeks to define animals, animal productivity, diet quality and management circumstances to support a more accurate estimate of feed intake.
- The agriculture sector has a high level of interlinkages across its categories and with the categories of other sectors within the national inventory.
- As a reviewer, you must pay attention to the following cross-cutting areas:
 - Key category analysis;
 - Time series and recalculations;
 - Uncertainty assessment;
 - Assessment of completeness;
 - QA/QC;
 - Areas of improvements for a Party identified by the TERT, as mandated in paragraph 146(d) of the MPGs;
 - Planned improvements.
- The MPGs provide flexibility options for developing country Parties in the light of their capacities:

- Key category analysis – flexibility to identify key categories using a threshold no lower than 85 per cent, instead of the 95 per cent threshold defined in the 2006 IPCC Guidelines;
 - Uncertainty assessment – flexibility to provide, at a minimum, a qualitative discussion of uncertainty for key categories;
 - Insignificant threshold – flexibility to instead consider emissions category insignificant if its level of emissions is likely below 0.1% of national total and 1000 kt CO₂ eq, whichever is lower;
 - QA/AC checks – not mandatory for developing country Parties using flexibility; instead they are encouraged to carry out such checks;
 - Time series – flexibility to report data covering, at a minimum, the reference year/period for the Party's NDC and a consistent annual time series from at least 2020 onward; the latest reporting year may be three years prior to the submission of the national inventory report.
- As a reviewer, you must be aware flexibility options used by developing country Parties.

Lesson 3: Enteric fermentation

1. Introduction

1.1. Learning objectives and time needed to complete the lesson

Lesson 3 describes the methodological basis underlying the estimates of CH₄ emissions from livestock enteric fermentation and addresses the approaches that the TERT should apply in reviewing this category.

At the end of this lesson, you will be able to:

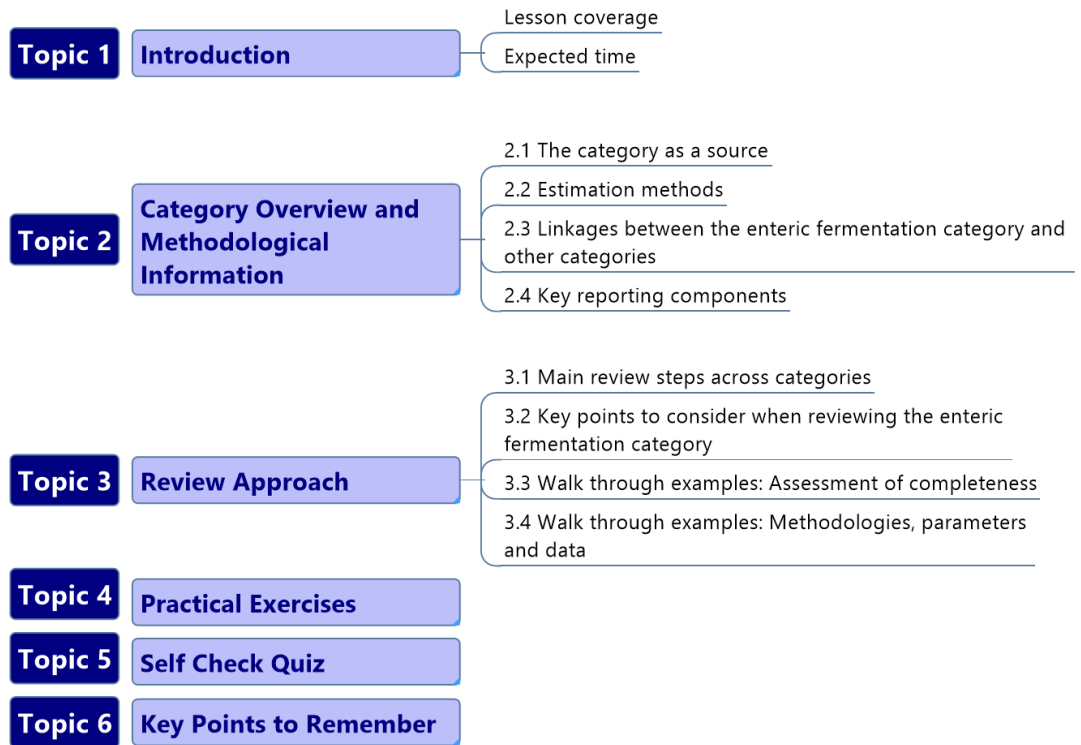
- Identify methodological references and reporting components relevant to the enteric fermentation category;
- Understand how the enteric fermentation category interlinks with other categories within the agriculture sector;
- Focus on the key review points and be aware of possible actions by the TERT in its review of CH₄ emissions for the enteric fermentation category;
- Understand how to formulate clarification questions to a Party in the context of a review;
- Identify and describe findings and issues, and draft relevant encouragements and recommendations;
- Understand issues on the basis of the TACCC principles.

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- Expected time needed to complete lesson 3: 60 minutes

1.2. Structure of the lesson



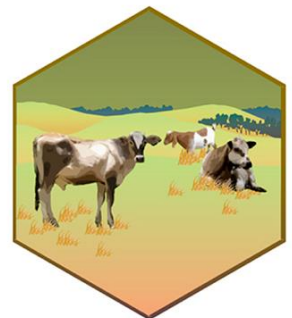
2. Category overview and methodological information

2.1. The enteric fermentation category as a source

Enteric fermentation is a digestive process by which carbohydrates are broken down by microorganisms into simpler molecules for absorption into the bloodstream. CH₄ is produced during the process and released into the atmosphere.

CH₄ is a by-product of enteric fermentation from:

- Ruminant animals (e.g. cattle, buffalo, sheep, goats, deer and camelids);
- Non-ruminant herbivores (e.g. horses, asses and mules);
- Monogastric animals (e.g. swine).



G. Figure 3-1. Cows in pasture

Natural wild ruminants' emissions are not considered for the emission estimates since these emissions are not anthropogenic. Emissions should only be considered from animals under domestic management (e.g. farmed deer, elk and buffalo).

2.2. Methods to estimate CH₄ emissions from enteric fermentation

A general approach to estimate CH₄ emissions from domesticated animals (organized by animal species/subcategory) is expressed as follows:

$$\text{Total emissions} = \sum N_i \times EF_i$$

Where N is the number of animals by category/subcategory *i* and EF is the EF per animal of category/subcategory *i*. To reflect the variation in emission rates among animal types, the population of animals is divided into subgroups, and an EF per animal is estimated for each subgroup.

There are three different methodological tiers available in the 2006 IPCC Guidelines for estimating CH₄ emissions from enteric fermentation (vol. 4, chap 10, figure 10.2, p.10.25).

The choice of methods provided by the 2006 IPCC Guidelines primarily depends on data availability:

Tier 1	Tier 2	Tier 3
<p>A simplified approach that relies on default EFs. The tier 1 method is likely to be suitable for most animal species in countries where enteric fermentation is not a key source category, or where enhanced characterization data are not available.</p>	<p>A more complex approach that requires detailed country-specific data on gross energy intake and MCFs for specific livestock categories. The tier 2 method should be used if enteric fermentation is a key source category for the animal category that represents a large (significant) portion of the country's total emissions.</p>	<p>This tier could employ the development of sophisticated models that consider diet composition in detail, seasonal variation in animal population or feed quality and availability. Many of these estimates would be derived from direct experimental measurements.</p>

H. Figure 3-2. The main features of the decision tree to determine which tier to use to estimate CH₄ emissions from enteric fermentation

As a rule of thumb, a livestock species would be **significant** if it accounts for 25–30 per cent or more of emissions from the category.

To learn more about the IPCC tier approaches see below.

<p>Tier 1</p> <p>The tier 1 method is simplified so that only readily available animal population data are needed to estimate emissions. Default EFs are presented for each of the recommended population subgroups (see 2006 IPCC Guidelines, vol. 4, chap. 10, table 10.10). The data used to estimate the default EFs for enteric fermentation of cattle and buffalo are presented in annex 10A.1 to volume 4, chapter 10, of the 2006 IPCC Guidelines.</p> <p>The EFs vary within each region. Animal size and milk production are important determinants of emission rates for dairy cows. Relatively smaller dairy cows with low levels of production are found in Asia, Africa and the</p>
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Indian subcontinent. Relatively larger dairy cows with high levels of production are found in North America and Western Europe.

In its selection of EFs from tables 10.10 and 10.11 of the 2006 IPCC Guidelines, a Party should identify the region most applicable to the country being evaluated. As a reviewer, you must assess whether the Party has demonstrated that any default factors used are applicable to the national circumstances of its livestock populations (e.g. region and milk yield).

Note that using the same tier 1 EFs for the inventories of successive years means that no allowance is being made for changing livestock productivity, such as increasing milk productivity or trend in live weight. If it is important to capture the trend in CH₄ emissions that results from a trend in livestock productivity, then livestock emissions can become a key source category based on trend and a tier 2 calculation should be used.

Tier 2

The differences between tier 1 and tier 2 methods are related to the EFs and the detail of the livestock characterization. As mentioned above, tier 1 is based on the use of IPCC default values, while tier 2 is applied to more disaggregated livestock population categories and uses calculated country-specific EFs requiring detailed data on gross energy intake (GE) and CH₄ conversion rates (Y_m) for each specific livestock and feed combination.

If Y_m are unavailable from country-specific research, the default values of cattle/buffalo Y_m provided in volume 4, chapter 10, table 10.12, of the 2006 IPCC Guidelines can be used for cattle and buffalo. As a reviewer, you must assess whether estimates of gross energy intake are provided, models, animal characteristics and parameters are well documented, whether the bases of these data are reasonable, taking into consideration the livestock characteristics and country management practices, and how they compare with IPCC default values.

In some cases, due to the absence of any AD (e.g. to be used in tier 2 or tier 3), the inventory compiler may rely on expert judgment. Expert judgment on methodological choice and choice of input data to use is ultimately the basis of all inventory development and sector specialists can be of particular use in filling gaps in the available data, selecting data from a range of possible values or making judgments about uncertainty ranges. The goal of expert judgment may be choosing the proper methodology, the parameter value from ranges provided, the most appropriate AD to use, the most appropriate way to apply a methodology or determining the appropriate mix of technologies to use. The subjective nature of expert judgment increases the need for QA/QC procedures to improve comparability of emission and uncertainty estimates between countries. It is recommended that expert judgments are documented as part of the national archiving process. Hence, as a reviewer, you must assess whether expert judgment is transparently documented and archived (for more information, see p.2.21, chapter 2, volume 1 of the 2006 IPCC Guidelines).

Tier 3

Some countries for which livestock emissions are particularly important may go beyond the tier 2 method and incorporate additional country-specific information in their estimates. This approach could employ the development of sophisticated models that consider diet composition in detail, concentration of products arising from ruminant fermentation, seasonal variation in animal population or feed quality and availability, and possible mitigation strategies. Many of these estimates would be derived from direct experimental measurements.

In general, Parties are encouraged to go beyond the tier 2 method when data are available. A tier 3 method should be subjected to a wide degree of international peer review such as that which occurs in peer-reviewed publications to ensure that they improve the accuracy and/or precision of estimates.

Moreover, countries with large populations of domesticated animal species for which there are no IPCC default EFs (e.g. llamas and alpacas) are encouraged to develop national methods (if it is determined that emissions from these livestock are significant).

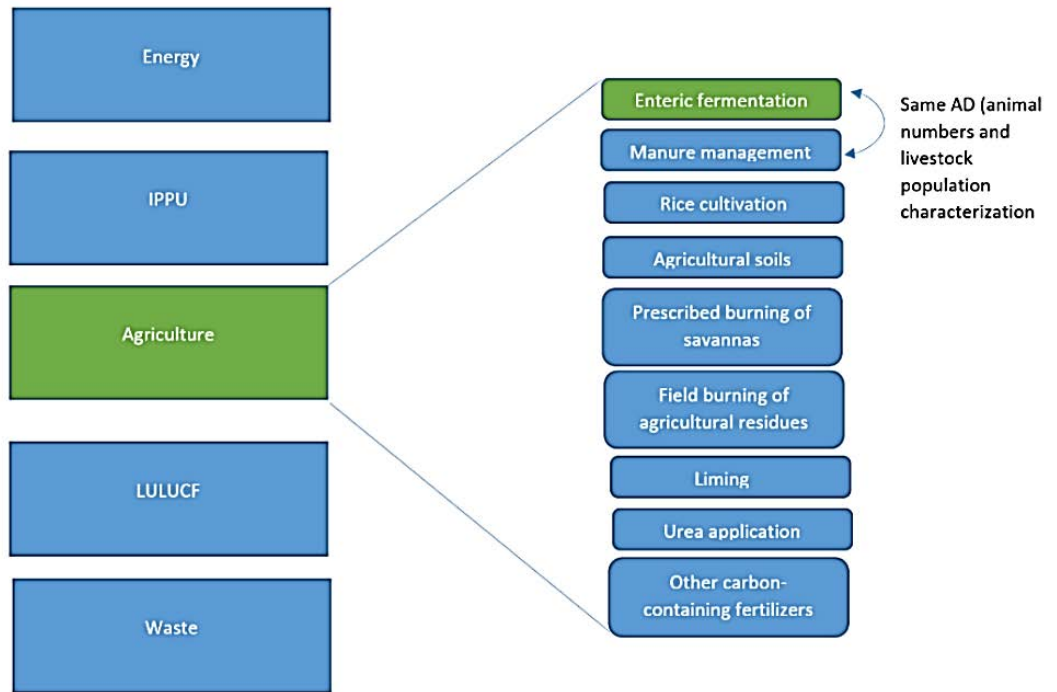
Reviewing tier 3 methods is often challenging because of their complexity and the limited time available for the review, particularly during centralized and desk reviews. However, as a reviewer, you must assess whether the NID includes verification information consistent with the 2006 IPCC Guidelines; and whether the NID includes additional information for improving transparency, such as information on basis and type of model, application and adaptation of the model, main equations/processes, key assumptions, domain of application, how the model parameters were estimated, description of key inputs and outputs, details of calibration and model evaluation, uncertainty and sensitivity analysis, QA/QC procedures adopted and references to peer-reviewed literature. Moreover, there are specific guidance to review the results of a tier 3 estimate (see 2006 IPCC Guidelines, vol. 4, chapter 2.5)

See section 2.6 in lesson 2 (p.28) for:

- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

2.3. Linkages between the enteric fermentation category and other categories

Figure 3-3 summarizes the linkages between the enteric fermentation category and other categories in the agriculture sector and with other sectors.



I. Figure 3-3. Main linkages between the enteric fermentation category and the other categories in the agriculture sector

The data on livestock population characterization, livestock population number and performance parameters used to estimate CH₄ emissions from enteric fermentation should be consistent with the data that were used to estimate CH₄ and N₂O emissions from manure management and the data used to estimate manure nitrogen applied to soils and excreted on pasture (N₂O from agricultural soils).

2.4. Key reporting components

Table 3-1 summarizes the main reporting components and the methodological references related to the enteric fermentation category.

Table 3-1. Summary of key elements relevant to the enteric fermentation category

Overview	Category-specific information	
Category name	Enteric fermentation	
Reference	Section 10.3, volume 4, of the 2006 IPCC Guidelines	
Chapter of the NID	Chapter 5: Agriculture	
Reporting in CRTs	Table 3.A: option A /option B	
Main subcategories and GHGs to be reported	Cattle	CH ₄
	Sheep	CH ₄
	Swine	CH ₄
	Other livestock	CH ₄

In addition to the generic reporting instructions, individual reporting requirements are included in the footnotes of each CRT. Parties may report additional information in the CRT documentation boxes. As an agriculture expert, you must familiarize yourself with the footnotes and the information provided by the Party in the documentation boxes.

The 2006 IPCC Guidelines do not include methodologies to estimate CO₂ from livestock and annual net CO₂ emissions are assumed to be zero – the CO ₂ photosynthesized by plants is returned to the atmosphere as respired CO ₂ .	The CRT allows one of two options to report CH ₄ emissions from enteric fermentation of cattle: Option A is developed to report CH ₄ emissions from cattle enteric fermentation calculated based on a basic livestock characterization and using a tier 1 method; Option B should be used when Parties estimate emissions using enhanced characterization of livestock compared with option A.
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Moreover, you must assess the information reported in summary report tables and in cross-cutting tables.

Summary report tables (3 tables) provide an overview of: <ul style="list-style-type: none"> Aggregate GHG emissions per category and subcategory on a gas-by-gas basis and as CO₂ equivalent for different GHGs; Methods (e.g. tier used) and EFs used for each category and GHG.
Cross-cutting tables (5 tables) provide other complementary information useful to the understanding of the national GHG inventory. These include:

- **CRT table 6:** Cross-sectoral report, in which Parties provide information on indirect emissions of N₂O and CO₂ for each sector;
- **CRT table 7:** A summary overview of key categories, which shows results of the key category analysis based on an approach 1 analysis with the same level of disaggregation of categories as that defined in the 2006 IPCC Guidelines;
- **CRT table 8:** A recalculation table, which allows Parties to report on recalculated emissions on annual GHG inventories;
- **CRT table 9:** A completeness table, which allows Parties to provide further information on the notation keys used (currently “NE”, meaning that emissions for a certain inventory category have not been estimated, and “IE”, meaning that emissions for a certain inventory category are included with the emissions of another category);
- **CRT table(s) 10:** An emissions trends table, which provides an overview of emissions trends per sector and category expressed in terms of both unit of mass (kt) and CO₂ equivalent.

3. Review approach

3.1. Key points to consider when reviewing the enteric fermentation category

There are three common steps determined in the overall review procedure to achieve the tasks: prepare – assess – draft.

The **preparatory** step involves the careful study of all documents that are available to inform your assessments.

The **assessment** step entails the examination of the adherence of the Party's information submitted under Article 13, paragraph 7(a), of the Paris Agreement, MPGs section II of the MPGs, and decision 5/CMA.3. In particular, there are areas to which the TERT must pay attention in assessing the activities the Party has conducted in elaborating the GHG inventory and what it has reported (see below).

Particular attention is to be paid to the '**shall**' requirements and findings that may be considered as **issues**. The TERT should also review whether a Party has implemented the '**should**' and '**may**' elements in the UNFCCC decisions.



FX – when assessing the elements reported by a Party be aware that flexibility may apply for those developing Parties that need flexibility in the light of their capacities. *Paragraph 5 of decision 5/CMA.3 provides options on how Parties may reflect the application of the specific flexibility in the CRTs.*

The outputs of the review consist of a series of documents completed at different stages of your work (**drafting step**).

The information documented on the next slide provides specific guidance to assist in the **assessment** of the key elements relevant to the enteric fermentation category. **Drafting** is covered in the walk-through examples and exercises; you will practice formulating questions to ask a Party under review, translating a finding into an issue and drafting a TERR.



A brief description of three common review steps (prepare – assess - draft) is provided in https://unfccc.int/resource/tet/ba/ba3-01_L_R_Steps.pdf



For more information on the prepare – assess - draft approach see lesson 6 of the "Overview and cross-cutting" course.

The choice of methods, selection of assumptions, development and selection of EFs and collection and selection of AD are the main drivers of inventory quality. Hence, as a reviewer, you must assess and ensure that the selection of these data carried out by a Party are in accordance with the 2006 IPCC Guidelines and its supplements and the requirements in UNFCCC decisions.

Table 3-2 summarizes the possible questions and actions that you can ask yourself when reviewing the emissions reported under the enteric fermentation category. In addition, there are several common elements to be assessed across sectors/categories when reviewing the quality of the Party's submission (i.e. uncertainty analysis, QA/QC, time-series consistency, recalculations and progress in implementing improvements) – lesson 2 above provides a list of relevant guiding questions.

Table 3-2. Possible questions by the review team in its review of CH₄ emissions from the enteric fermentation category

Review element	Possible question/action by the TERT
Choice of method	Which method is applied to estimate the emissions from each livestock (sub)category? Has the Party followed the recommendations and decision trees from the 2006 IPCC Guidelines and its choice of methods and parameters?
Choice of method	If CH ₄ emissions from enteric fermentation have been identified as a key category, have emissions from the significant subcategories been estimated using the tier 2 method based on an enhanced livestock characterization or a tier 3 method?
Use of method	Are country-specific methods and higher-tier methods, EFs and parameters well described in the NID and are they are agreeable? Are the reference documents published in peer-reviewed, accessible journals? Do the estimation methods used for estimating emissions follow good practice guidance?
Use of method / documentation	Does the inventory submission provide a description of the method used to estimate emissions? If the method uses a country-specific methodology or sophisticated model (i.e. tier 3), is the model explained clearly?
Use of method: tier 2	For a tier 2 method, as a reviewer, you must assess whether: <ul style="list-style-type: none"> Disaggregated EFs for subcategories of animal species (e.g. by age and sex subgroups, climatic region, management practice, type of feed, etc.) have been used; Estimates of gross energy intake are provided, in accordance with the characteristics of the livestock population, and models, animal characteristics and parameters are well documented;

Review element	Possible question/action by the TERT
	<ul style="list-style-type: none"> Country-specific Y_m values have been used; The bases of these data are reasonable, considering the livestock characteristics and country management practices, and how they compare with IPCC default values; and Trends in the animal production statistics are the same as the trends of the EFs.
Use of method: tier 1	For a tier 1 method, as a reviewer, you must assess whether the Party has demonstrated that any default factors used are applicable to the national circumstances of their livestock populations (e.g. region and milk yield).
AD	<p>Has the Party followed the recommendations and decision trees from the 2006 IPCC Guidelines in its choice of AD?</p> <p>Is the use of IPCC default AD appropriate? Are data available to enable the Party to move to higher tiers?</p>
AD	What AD have been used? National statistics or other? Is it explained and documented? Are those data collection methods, approaches and data source well documented in the NID?
AD	Has the Party accounted for all livestock numbers, including territories abroad, and for the entire time series?
AD/EFs	How were improvements in management (e.g. cattle types) reflected in the inventory, such as AD (e.g. milk production) or EFs?
AD	Has the Party reported emissions from any new livestock categories? If so, have appropriate methods been selected and has a consistent time series been reported?
AD/EFs	How is the development of feeding practices (e.g. due to availability on the farms or through import) followed in the inventory to update the EFs accordingly?
AD	Are all possible livestock categories covered? Has the country used animal classes and categories in addition to those listed in the 2006 IPCC Guidelines?
AD	Has the Party calculated the annual average population for animal categories with a life cycle of less than one year? Has the calculation approach been documented?
EFs	<p>Has the Party followed the recommendations and decision trees from the 2006 IPCC Guidelines in its choice?</p> <p>Does the Party apply IPCC default values or country-specific EFs?</p> <p>In country-specific EFs are used, are the EFs explained in the NID, with proper references and accessible scientific background? If values, for</p>

Review element	Possible question/action by the TERT
	<p>example, from other Parties or based on expert judgment are used, are they are adequate and explained in the NID?</p> <p>If IPCC default values are used, is it possible for the Party to develop country-specific EFs to move to a higher tier method?</p>

As a reviewer, you must first focus on the observations which have an impact on the level and/or trend of the GHG emissions. Moreover, in the case of issues related to transparency (i.e. the NID does not clearly describe how emissions were estimated), the TERT should specifically determine whether the lack of transparency in the inventory leads it to question the accuracy of the inventory estimates reported.



The intention is not to provide you with an exhaustive list of questions; it is a starting point to stimulate your thinking. You may add or modify the questions as appropriate while conducting a review.



Paragraph 28 of decision 5/CMA.3 notes that Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines. Hence, as a reviewer you must be aware of the improvements undertaken in the 2019 Refinement to the 2006 IPCC Guidelines.

An overview of the changes between the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC Guidelines is provided below:

- A split of the default EFs by high/low productivity systems was introduced in place of the allocation between developing and developed countries used in the 2006 IPCC Guidelines;
- Enteric fermentation default EFs for cattle (both dairy and non-dairy) and buffalo have been revised;
- Tier 2 Y_m values have been updated for cattle and buffalo;
- A simplified tier 2 approach to estimate feed intake has been updated;
- Enteric fermentation default EFs for sheep and goats have been updated;
- An enteric fermentation default EFs for ostriches has been developed;
- A tier 2 approach has been developed to estimate enteric emissions from goats.

3.2. Walk-through examples: assessment of completeness

You are invited to assess the completeness of the information reported by the developed Party EnF in 2026. Review the information reported in CRT 3.A.



Please open the spreadsheet https://unfccc.int/resource/tet/ba/ba3-02_L3_EnF_2026.xlsx and answer the following question:

What is your observation regarding the completeness of the estimates provided by the Party under the enteric fermentation category? To conduct your assessment, you may ask yourself the guiding questions provided in lesson 2 above and those that are relevant for the review of the enteric fermentation category (figure 3-3).

Tip

Check whether emissions are reported for all livestock categories. Has the Party provided estimates of the emissions for all livestock categories for which IPCC tier 1 or 2 emission estimation methods are available? Check international datasets (e.g. FAOSTAT (<https://www.fao.org/faostat/en/#data>)).



You may open the spreadsheet https://unfccc.int/resource/tet/ba/ba3-03_L3_fao_EnF.xlsx with data from FAOSTAT; since a fictional submission has been used, you will not be able to download the data directly from FAOSTAT data sets and fictional data have been developed for your convenience. Are data sets from international statistics as consistent for all livestock categories as those that the Party reports? How do they compare with each other?

You may write your answer here:



If major discrepancies are found between the Party's reported data and those provided by other recognized data sources (e.g. International Energy Agency or FAOSTAT), and they cannot be adequately explained by the Party, you should encourage the Party to explore the reason for these discrepancies.

Assessment of completeness – how to formulate a question

In lesson 2 of the agriculture course, you studied how to formulate questions to be asked to a Party. You can now utilize your knowledge and formulate a clarification question to the Party on the issue you identified.

You may write your answer here:

Assessment of completeness – record in the review report

In the next task, draft and describe your finding in the review report. Explain the TERT finding with references to the CRT and/or NID, summarize any communication with the Party during the review, indicate why the TERT finds that the Party is not meeting applicable reporting requirements of the MPGs and include the TERT recommendation or encouragement in a precise and clear manner.

A hypothetical answer of the Party could be as follows:
Dear TERT, many thanks for the question. We will check with the national statistical authority. Respective estimates will be done and included in the next inventory submission if the existence of buffalo is confirmed by the national statistical authority.

You may write your answer here:

Assessment of completeness – areas of improvement identified the TERT

To facilitate continuous improvement, each Party should, to the extent possible, identify, regularly update and include the information on areas of improvement identified by the Party and the TERT, and on any progress made, including those previously identified as part of the technical expert review (MPGs, para. 7). Moreover, paragraph 146 of the MPGs states that a technical expert review consists of identification of areas of improvement for the Party.

In real reviews, the progress in implementing recommendations identified by you will be assessed by another reviewer in the subsequent review cycle. However, since this is an educational exercise, you are invited to assess the progress of Party EnF towards the implementation of the recommendation posed in the first part of the exercise.



Please open the spreadsheet

https://unfccc.int/resource/tet/ba/ba3-04_L3_EnF_2027.xlsx to review the information reported in the CRT submitted by Party EnF in 2027 and assess whether the Party made progress in implementing the recommendation made within the 2026 review cycle.

You may write your answer here:

3.3. Walk-through examples: methodologies, parameters and data

Examine the submission made by the developing Party EntericLand in 2026.



Please open a PDF copy

https://unfccc.int/resource/tet/ba/ba3-05_L3_Enteriland_NID.pdf of the NID.

What is your assessment of the methodological choice made by the Party in its estimates of CH₄ emissions from enteric fermentation? Check if the appropriate tier has been chosen for estimating emissions from enteric fermentation.

You may write your answer here:

3.4. Answer key to walk-through examples

Assessment of completeness

Party EnF conducted the emission estimates for almost all categories of animals for which IPCC tier 1 or 2 estimation methods are available in the 2006 IPCC Guidelines. Moreover, the Party has applied country-specific EFs to estimate CH₄ emissions from enteric fermentation of fur-bearing animals and rabbits.

However, when comparing the data on livestock representation by category reported in CRT 3.A and those that are provided in the FAOSTAT database, it might be observed that the FAOSTAT data include data on population of buffalo farmed in the country, but the Party has not reported CH₄ emissions from enteric fermentation of buffalo (for which the 2006 IPCC Guidelines provide tier 1 or 2 estimation methods and default EFs).

As the next step, you must consult the NID for any explanatory information (*you will skip this step in this exercise*). If the NID lacks this information, you must raise questions with the Party to clarify all the details on this finding, that is, to explain the reasons for these discrepancies. Moreover, as you might have noted, there are discrepancies in the data on the population number of other livestock categories and poultry, such as sheep and pigs. Studying the reasons for the disparities in the AD on the population number of other livestock categories and poultry might also be a basis for another set of clarification questions. Observed differences do not necessarily mean the Party's estimate is incorrect, but differences should be able to be explained.

Assessment of completeness – how to formulate a question

One possible clarification question might be formulated as follows:

Party EnF did not report CH₄ emissions from enteric fermentation of buffalo under category 3.A.4 (enteric fermentation) in 2024. However, the TERT noted that the FAOSTAT data sets cover the head population of buffalo for 2024 for Party EnF. Could the Party clarify whether the population of buffalo exists in the country? If it does, could the Party explain why CH₄ emissions under category 3.A.4 (enteric fermentation) have not been reported in the current submission?

Assessment of completeness – record in the review report

Below you can see how the TERT could describe the finding in its review report.

Party EnF did not report CH₄ and N₂O emissions for buffalo under categories 3.A.4 (enteric fermentation) and 3.B.4 (manure management). However, the TERT noted that the FAOSTAT data contain the head population of buffalo for 1992–2024 for Party EnF.

In response, the Party explained that the data will be checked with the national statistical office and, if the existence of buffalo in the country is confirmed, the corresponding emission estimates will be included in the next submission.

The TERT recommends that Party EnF clarify whether the population of buffalo exists in the country. If it does, the TERT recommends that the Party estimate CH₄ and N₂O emissions under categories 3.A.4 (enteric fermentation), 3.B.4 (manure management) and 3.D (direct and indirect N₂O emissions from agricultural soils).

Assessment of completeness – areas of improvement identified the TERT

As you may have noted, the Party conducted the estimates and reported CH₄ emissions due to enteric fermentation (category 3.A), CH₄ and N₂O emissions from manure management of buffalo (category 3.B) and direct and indirect N₂O emissions due to application of manure generated by buffalo to the agricultural soils as an organic fertilizer and dropped during the pasture of the animals (category 3.D). Hence, as a reviewer, you may conclude that Party EnF made progress in the implementation of the improvement area identified under the first part of the exercise.

Methodologies, parameters and data

The 2006 IPCC Guidelines often include alternative methods or tiers for each category. In general, a higher-tier method will yield a more accurate estimate of the emissions and is therefore preferred. For the enteric fermentation category, the good practice in applying an appropriate tier is explained in figure 10.2 of the 2006 IPCC Guidelines (vol. 4, chap 10).

Hence, to check whether the appropriate choice of tier has been made for emission estimates, as a reviewer, you must undertake three steps in your review of the information submitted by Party EntericLand for the enteric fermentation category:

Step 1. Assess whether the emissions from enteric fermentation have been identified as a key category and what is an appropriate tier method to be used for estimating the emissions:

- CH₄ emissions from enteric fermentation of livestock has been identified as a key category by level and trend (table 5-4 of the NID of EntericLand);
- According to the decision tree for CH₄ emissions from enteric fermentation in the 2006 IPCC Guidelines, it is good practice to apply a tier 2 approach to estimate CH₄ emissions from enteric fermentation from cattle and sheep. See also paragraphs 21–23 of the MPGs, where the provisions on choice of appropriate method, parameters and data are stipulated.

Step 2. Assess a tier applied to estimate CH₄ emissions for each particular livestock category:

- The Party has used a tier 1 method to estimate the emissions from all livestock categories (table 5-5 of the NID of EntericLand);
- The Party has applied the IPCC default CH₄ EFs elaborated for developing countries (i.e. for sheep, goats, horses, camels and swine) and the IPCC default CH₄ EFs developed for other cattle farmed in Asia (table 5-11 of the NID of EntericLand). Within the category, CH₄ emissions from enteric fermentation from cattle and sheep are deemed significant, as the emissions from these two categories of livestock accounted for 35 and 25 per cent, respectively, in 2024 (table 5-10 and figure 5-5 of the NID of EntericLand);
- Thus, the methodological choice of the Party was not in line with the corresponding decision tree of the 2006 IPCC Guidelines. However, a Party may be unable to adopt a higher-tier method for a particular key category owing to lack of resources. In such cases, the Party may use a tier 1 approach, and should clearly document why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines. The Party should prioritize for future improvement any key categories for which the good practice method elaborated in the 2006 IPCC Guidelines cannot be used (MPGs, para. 23).

Step 3. Assess whether the Party clearly documented why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines and prioritized for future improvement for this category:

- In its NID (chapter 5.1.6), the Party provided the explanation on the current data available to conduct the estimates of CH₄ emissions from enteric fermentation and the further improvement steps to be undertaken by the next submission. However, the Party in its reporting did not specify whether it plans to apply a tier 2 method for estimating CH₄ emissions from enteric fermentation from cattle and sheep, or from all livestock categories;
- As a reviewer, you must get the clarification on this finding and, based on the information received, make a final conclusion on how to reflect the finding in a review report (i.e. recommend the Party to estimate the emissions by using an appropriate tier approach or to explain why it was unable to adopt a recommended tier).

4. Practical exercises

4.1. Practical exercise 1

A Party reported recalculations for CH₄ emissions from enteric fermentation of dairy and non-dairy cattle. Recalculations performed have enhanced the accuracy of the emission estimates for cattle by using disaggregated regional data.

EFs for enteric fermentation of cattle are obtained through regional estimations of the gross energy intake of fodder consumed and fodder digestion factors for 2002–2024.

For 1990–2001, estimates are based on national total data owing to a lack of regional data for these years.

In the NID, the Party reported that the difference between the results based on national and regional data amounts to no more than 1–2 per cent.

After reviewing this information, which statement best describes the possible assessment of the TERT?

Select one:

- A. The TERT welcomes this effort to improve the accuracy of the inventory for the significant livestock categories dairy cattle and non-dairy cattle, and considers that the Party should improve its regional statistics on fodder consumed by cattle in 1990–2001 to ensure time-series consistency
- B. The TERT welcomes this effort to improve the accuracy of the inventory for the significant livestock categories dairy cattle and non-dairy cattle, and recommends that the Party recalculate the 1990–2001 EFs for cattle and use an appropriate method from volume 1, chapter 5, of the 2006 IPCC Guidelines. For example, the Party could choose to recalculate the time series based on its trend and average weighted difference with regional factors for 2002–2024 to ensure time-series consistency or any other approach to fill the gaps in AD and parameters
- C. The TERT welcomes this effort to improve the accuracy of the inventory for the significant livestock categories dairy cattle and non-dairy cattle and concludes that the difference of 1–2 per cent between the results based on national and regional data is negligible and that time-series consistency is ensured
- D. The TERT welcomes this effort to improve the accuracy of the inventory for the significant livestock categories dairy cattle and non-dairy cattle and considers that the Party should use available regional data to estimate EFs for the remaining animal categories
- E. None of the above

Tip

See paragraphs 26–28 and 43 of the MPGs. See also volume 1, chapter 5, of the 2006 IPCC Guidelines on time-series consistency and approaches to fill the gaps in AD and parameters.

The methodologies used to estimate emissions, as well as the methodologies to collect AD, should be consistent across the time series; otherwise, the results of estimates for the earlier and later years of the inventory would not be comparable.

4.2. Practical exercise 2

CH₄ emissions from enteric fermentation is a key category by level assessment. In the respective section of the NID, the Party states:

- The provincial animal population is categorized according to the climate of the province for the selection of appropriate EFs;
- The CH₄ EFs are default IPCC tier 1 factors. Although the 2006 IPCC Guidelines calls for the more detailed tier 2 method to be used in cases in which a Party has listed CH₄ emissions from enteric fermentation as a key category, the detailed data required for applying a tier 2 approach cannot be obtained;
- The country-specific EFs estimation by country experts provides almost the same values as the IPCC tier 1 factors.

Review the information reported in CRT 3.A and answer the question.



Please open CRT 3.A

https://unfccc.int/resource/tet/ba/ba3-06_L3_Exer2_CR.xlsx submitted by the Party.

Which of the following actions by the TERT are correct?

Select one:

- The TERT recommends that the Party perform tier 2 estimations for this key category
- The TERT recommends that the Party perform tier 2 estimations for dairy cattle, non-dairy cattle and sheep using the default parameters provided in the 2006 IPCC Guidelines that are appropriate for national circumstances
- The TERT recommends that the Party perform tier 2 estimations for dairy and non-dairy cattle using the default parameters provided in the 2006 IPCC Guidelines that are appropriate for national circumstances
- The TERT concludes that the Party might wish to use country-specific EFs obtained by expert judgment and provide documentation and comparisons against default EFs, with transparent explanations for any deviations
- The TERT concludes that the Party might wish to use country-specific EFs obtained by expert judgment and provide documentation and comparisons against tier 2 calculations performed for dairy and non-dairy cattle, with transparent explanations for any deviations
- C and E
- B and D

Tip

See the decision tree in figure 10.2 and its footnote 2 in the 2006 IPCC Guidelines (vol. 4, chap. 10), paragraphs 20–24 of the MPGs and annex 2A.1 to volume 1, chapter 2, of the 2006 IPCC Guidelines.

4.3. Practical exercise 3



Please open a PDF copy

https://unfccc.int/resource/tet/ba/ba3-07_L3_exer3_nid.pdf of the NID submitted by a Party.

This is an example of information provided in an NID to describe the method and EFs used to estimate CH₄ emissions from enteric fermentation by dairy cattle. Use this information to review the transparency of the methodology applied by a Party.

Which of the following statements best describes the transparency of the inventory submission with regard to CH₄ emissions from enteric fermentation of dairy cattle?

Select one:

- A. The Party did not provide transparent information on the methodology and EFs used
- B. The Party used a tier 1 methodology and country-specific EFs and supplied basic information on its methodology in its NID
- C. The Party used a tier 2 methodology and country-specific EFs; however, the information provided in the NID is not fully transparent
- D. The Party used a tier 2 methodology and supplied sufficient information on methods and EFs used
- E. None of the above

Tip

See the definition of transparency in the 2006 IPCC Guidelines (vol. 1, chap. 1, p.1.7). To be transparent, a Party's submission (i.e. NID and CRTs) should clearly explain the justification for selecting the methods, the data sources, the assumptions and the methodologies used for an inventory, in order to facilitate replication of the calculation. In other words, transparent reporting should allow you to repeat calculations made by the Party.

4.4. Practical exercise 4



Please open a PDF copy

https://unfccc.int/resource/tet/ba/ba3-08_L3_Exe4.pdf of the document. Note that the submission referred to in the document was made by a Party from the Asian region.

What is your observation regarding the accuracy of the estimates based on the reporting of the Party for enteric fermentation?

Select one:

- A. CH₄ emissions from enteric fermentation of dairy cattle are underestimated for the whole time series
- B. CH₄ emissions from enteric fermentation of dairy cattle are overestimated for the base year and underestimated for the last year of the time series
- C. CH₄ emissions from enteric fermentation of dairy cattle are underestimated for the base year and overestimated for the last year of the time series
- D. CH₄ emissions from enteric fermentation of dairy cattle are overestimated for the base year and the whole time series
- E. It is not possible to form a conclusion

Tip

See the 2006 IPCC Guidelines (vol. 4, chap. 10, table 10.11 and annex 10A.1).





A useful approach for identifying issues in a Party's GHG inventory submission is to examine emission indicators and the trends in these indicators. One such indicator reported in the CRTs is the IEF (emissions/AD). You can use the IEF data to examine the time-series consistency of a Party's inventory submission by examining changes in each element over time. This approach might be a useful instrument in reviewing the consistency of the reporting among correlated categories as well as, for example, CH₄ emissions from enteric fermentation and manure management.

4.5. Practical exercise 5

This exercise is more complex than the first four. You are invited to review the information reported by an Eastern European Party in the NID of its 2026 inventory submission for the category enteric fermentation and to draft the text for the review report based on your findings.

Please open a PDF file
https://unfccc.int/resource/tet/ba/ba3-09_L3_exer5_enteric.pdf of the NID



NID 2026

As the review is likely to be your first experience of preparing an inventory review report for a Party, we will ask six questions to test your knowledge and give useful hints to support your progress through the exercise. Take notes of your findings, as they will be inputs for the review report.



In all cases, you should first attempt to answer the questions before clicking the Tip button. Not doing so will only cause you to be less prepared for your final examination on this training course.

Practical exercise 5 – question 5.1

Which statement best describes the Party's submission for animal population data?

Select one:

- A. The Party uses animal population data based on its numbers as at 1 January of each year
- B. The Party estimates average annual populations only for cattle, swine, sheep, goats, horses and camels. The numbers of donkeys and buffalo are not adjusted to the average annual populations, and no explanations are provided
- C. Only animal populations of cattle, swine, camels, horses and poultry are based on national statistical data; data for donkeys, sheep, goats and buffalo are taken from FAOSTAT data
- D. None of the above
- E. B and C

Tip

See the 2006 IPCC Guidelines, volume 4, chapter 10, section 10.2.2.

Practical exercise 5 – question 5.2

Based on the analysis made for question 5.1, which of the conclusions of the TERT is correct?

Select one:

- A. The TERT recommends that the Party estimate average annual populations for all animal categories or provide evidence that populations of donkeys and buffalo are average annual numbers. The TERT encourages the Party to discover the national source of reporting to FAOSTAT on animal populations and use national statistical data on donkey, sheep, goat and buffalo populations
- B. The TERT recommends that the Party estimate average annual populations for all animal categories and use national statistical data on donkey, sheep, goat, and buffalo populations
- C. The TERT commends the Party for the improved reporting on average annual populations of major animal categories and encourages the Party to continue its efforts in the estimation of average annual populations of other animals
- D. None of the above

Tip

The recommendation is related to good practice in the 2006 IPCC Guidelines, which requires the use of average annual populations. The encouragement is to use, if possible, population data from official national statistics or industry sources. FAOSTAT data can be used if national data are unavailable (2006 IPCC Guidelines, vol. 4, chap. 10, p.10.8).

Practical exercise 5 – question 5.3

Which statement best describes the TERT assessment of the completeness of the inventory and methodological choice of the Party?

Select one:

- A. The inventory is complete; however, the category of sheep is significant and tier 2 methodology should be used
- B. The inventory is not complete, as emissions from rabbits are not estimated
- C. The inventory is complete. The methodological choice is correct
- D. The inventory is complete. The methodological choice is correct. However, the Party must investigate the possibility of estimating emissions from rabbits and make efforts to apply a tier 2 methodology for sheep
- E. The inventory is not complete, as emissions from rabbits are not estimated. However, the methodological choice of tier 1 is correct as the category of sheep is not significant

Tip

See the 2006 IPCC Guidelines (vol. 4, chap. 10, table 10.10) on the tier 1 default EFs for enteric fermentation; and the decision tree for CH₄ emissions from enteric fermentation (vol. 4, chap. 10, figure 10.2).

Practical exercise 5 – question 5.4

Carefully review the information provided in tables 5.8, 5.12 and 5.14 of the NID and respective default values from chapter 10 of volume 4 of the 2006 IPCC Guidelines for Eastern Europe. What would be the conclusion based on your expertise?

Select one:

- A. EFs provided in table 5.14 are lower than the default parameters from the 2006 IPCC Guidelines; however, they are within the uncertainty ranges
- B. The live weights of dairy and non-dairy cattle are lower than the default values. Milk productivity is also lower than in the data used to develop the default EFs
- C. The milk yields show a clear increasing trend since 2010; however, the Party uses constant live weight and feed digestibility data for dairy cattle during the whole time series. This could lead to either overestimation or underestimation of emissions
- D. The Party should provide comparisons of its EFs against default values and explain any differences
- E. All of the above

Tip

Default values could be taken from tables 10A.1 and 10A.2 in chapter 10, volume 4, of the 2006 IPCC Guidelines. In accordance with the QA/QC section 10.3.5 in the same chapter, if using the tier 2/tier 3 method, the inventory compiler should cross-check country-specific EFs against the IPCC defaults. Significant differences between country-specific EFs and default EFs should be explained and documented.

Practical exercise 5 – question 5.5

Review the transparency and accuracy of tier 2 calculations of EFs for dairy and non-dairy cattle. Which statement best describes the TERT assessment?

Select one:

- A. From the information provided in the NID, it is not clear how the net energy for growth has been estimated, and the data on average daily weight gain of cattle (kg/day) are not presented. If net energy for growth has not been included in the calculations, the EFs might be underestimated for non-dairy cattle
- B. From the information provided in the NID, it is not clear how the net energy for growth has been estimated, and the data on average daily weight gain of cattle (kg/day) are not presented. If net energy for growth has not been included in the calculations, the EFs might be overestimated for non-dairy cattle
- C. The default calculations of the TERT based on the data provided and the default values result in higher estimations of gross energy for non-dairy cattle
- D. The default calculations of the TERT based on data provided and default values result in lower estimations of gross energy for both dairy and non-dairy cattle
- E. A and C
- F. B and C
- G. A and D

Tip

See section 10.2.2 and tables 10A.1–10A.2, chapter 10, volume 4 of the 2006 IPCC Guidelines.

Practical exercise 5 – question 5.6

Carefully review the information provided on the uncertainty assessment. What would be the conclusion based on your expertise?

Select one:

- A. The uncertainty assessment is correct. The default values of uncertainties for EFs are used. The uncertainty rates for AD are reported within the NID
- B. The default values of EF uncertainties are correct; however, the uncertainty of the AD is not provided
- C. The lower limits of uncertainty for default values of tier 1 EFs are used and the uncertainty of AD is not provided
- D. The default values of EF uncertainties are correct; however, the uncertainty of AD is not provided. The overall uncertainty of emission estimations is not assessed
- E. None of the above

Tip

The methodology to estimate the uncertainty of emission estimates is presented in chapter 3 of volume 1 and section 10.3.4, chapter 10, volume 4 of the 2006 IPCC Guidelines.

Practical exercise 5 – review report

In the box below, draft the text for the review report on CH₄ emissions from enteric fermentation using the findings from questions 1-6 above.

Remember that you have to describe the problem identified, provide your assessment and give a clear recommendation or encouragement addressing the issue identified. Try to keep the text as short and concise as possible but ensure that there is no trade-off in transparency. Include in the review report only those findings that you consider to be major. Note that during a real review, you will also have to describe the response received from the Party before making any recommendation or encouragement.

You may draft your text here.

4.6. Answer key to practical exercises

Practical exercise 1

The correct answer is B.

Although the difference between the results based on the national total and regional data is not large, consistency in time series should be ensured (option C is incorrect). The problem relates to the past, and, in practical terms, it is not possible to collect necessary regional data at present (option A is incorrect). One of the simplest approaches to improving consistency in the time series could be the use of correction factors (average weighted differences between the results based on the national total and regional data for 2002–2024). The value obtained could be applied to the EFs for 1990–2001 without any impact on its trend. Other alternative methods to fill the gaps in AD and parameters are provided in chapter 5 of volume 1 of the 2006 IPCC Guidelines.

Regarding option D, the text does not provide any additional information on the emission level of significance of other livestock categories in the total value of CH₄ emissions from enteric fermentation. However, it is less likely that the emissions from enteric fermentation of other livestock categories might be defined as significant (see the 2006 IPCC Guidelines, vol. 4, chap. 10, footnote 2 to figure 10.2); hence, the Party may apply use a tier 1 approach to calculate the emissions, and therefore the regional data on fodder consumed and fodder digestion factors would not be needed.

Practical exercise 2

The correct answer is G.

In this example, significant animal species are dairy and non-dairy cattle (2006 IPCC Guidelines, vol. 4, chap. 10, foot note 2 to figure 10.2), and their contributions to the total CH₄ emissions from enteric fermentation are 62.9 per cent and 28.6 per cent, respectively. Hence, a tier 2 approach should be used to calculate the emissions. CH₄ emissions from sheep enteric fermentation contribute only 7.7 per cent, and this species should not be considered as significant; therefore, the use of a tier 2 approach is not compulsory.

Moreover, if country-specific EFs are used by a Party, their derivations must be transparently documented; for example, by being published in peer-reviewed journals. Expert judgments should be clearly documented. Any deviations from default values should be clearly explained in the NID. In this example for dairy and non-dairy cattle, comparison of country-specific EFs should be conducted with tier 2 calculations.

Practical exercise 3

The correct answer is C.

The key considerations for the tier 2 method are the development of EFs and the collection of detailed AD. The Party reported a formula and provided the background AD (with a reference to a scientific paper) used to evaluate EFs, which is an inherent part of the tier 2 approach. The 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.30) state “The emission factors for each category of livestock are estimated based on the gross energy intake and methane conversion factor for the category.” Thus, options A and B might be considered as incorrect options.

Moreover, in its NID the Party did not transparently clarify (i) whether the values on weight and diets of dairy cattle reported in table 4 correspond to the national circumstances; and (ii) how the gross energy intake values reported in table 5 have been evaluated. Hence, option D might also be considered as incorrect.

Practical exercise 4

The correct answer is B.

When compared with default EFs for dairy cattle provided in table 10.11 and taking into account underlying data from annex 10A.1 to chapter 10, volume 4, of the 2006 IPCC Guidelines, it is possible to conclude that the IEF used by the Party (66.21 kg CH₄/head/year) corresponds to approximately 1,650 kg milk/head/year. For the 1990 milk yield, the Party estimated about 1,309 kg milk/head/year and for 2025 this value was 2,983 kg milk/head/year. Thus, the current reporting of the Party is likely to lead to overestimation of CH₄ emissions from enteric fermentation of dairy cattle for 1990 and underestimation for 2025.

Practical exercise 5 question 5.1

The correct answer is E (both B and C).

In its NID (p.3), the Party clearly stated that it uses data on animal populations of cattle, swine, camels, horses and poultry from the national statistical data and that data for donkeys, sheep, goats and buffalo are taken from FAOSTAT (option C is correct). These data are reported as the number of animals as at the end of each year (see table 5.5 of the Party's NID). Moreover, the Party has described how it estimates average annual populations for cattle, swine, sheep, goats, horses and camels and reported the data on average annual populations in table 5.7 of its NID (hence, you may consider option A as incorrect). However, the Party has not provided any information regarding how or whether the data on the numbers of donkeys and buffalo have been adjusted. Hence, option B must be indicated as correct.

Practical exercise 5 question 5.2

The correct answer is A.

The 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.8) state: "If possible, inventory compilers should use population data from official national statistics or industry sources. Food and Agriculture Organisation (FAO) data can be used if national data are unavailable."

Moreover, paragraph 24 of the MPGs indicates "Each Party is encouraged to use country-specific and regional emission factors and activity data, where available, or to propose plans to develop them, in accordance with the good practice elaborated in the IPCC guidelines."

Hence, the TERT may only encourage (not recommend, as indicated in option B) the Party to discover the national institution responsible for reporting animal populations to FAOSTAT and use national statistical data on donkey, sheep, goat and buffalo populations for estimating its emissions.

Moreover, the 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.8) specify that seasonal births or slaughters may cause the population size to expand or contract at different times of the year, which will require

the population numbers to be adjusted accordingly. However, the NID does not explicitly specify whether or how the changes in population number of donkeys and buffalo have been captured by the Party. Therefore, the Party can either (i) conduct the estimates of average annual populations for all animal categories (including buffalo and donkeys); or (ii) provide evidence that populations of donkeys and buffalo are average annual numbers (as indicated in option A).

Option C is not correct because the use of average annual populations is required as per the 2006 IPCC Guidelines. Therefore, the TERT should raise a recommendation, not an encouragement, for the Party to estimate annual populations of other animals.

Practical exercise 5 question 5.3

The correct answer is C.

In its NID, the Party specified that rabbits are kept in the country. However, as you may have noticed, there is no default EF for CH₄, emissions from enteric fermentation of rabbits. Moreover, the Party reported (section 5.2.5) that "the population in the country is not significant". Therefore, CH₄ emissions from enteric fermentation of rabbits would not be significant enough to justify developing a country-specific EF (see the 2006 IPCC Guidelines, vol. 4, chap. 10, section 10.2.4).

The Party cannot conduct the estimates of CH₄ emissions from enteric fermentation of rabbits (i.e. options B and D are incorrect) as the IPCC default EFs are neither developed nor reported in the 2006 IPCC Guidelines.

Option A is not correct because sheep is not a significant subcategory (its contribution is less than 25 per cent of the total emissions from enteric fermentation in 1990–2024). The Party's choice of tier 1 to estimate emissions from sheep is fully in line with the decision tree for the choice of method (2006 IPCC Guidelines, vol. 4, chap. 10, figure 10.2).

Practical exercise 5 question 5.4

The correct answer is E.

The data reported in the NID have been combined into one single table and replicated below; the relevant default IPCC EFs and performance parameters have been reported within table 5.4 in the NID.

Year	Dairy cattle, kg/head per year	Non-dairy cattle, kg/head per year	Milk yield per dairy cow, kg/day	Weight of dairy cattle, kg/head	Weight of non-dairy cattle, kg/head
1990	90.81	54.05	5.35	475	352
1995	90.18	52.77	5.20	475	341
2000	88.06	49.61	4.70	475	314
2005	87.81	49.96	4.64	475	317
2006	86.83	44.91	4.41	475	275
2007	86.15	45.28	4.25	475	278
2008	85.18	43.93	4.02	475	267
2009	84.25	45.52	3.80	475	280
2010	86.20	46.62	4.26	475	289
2011	89.08	51.14	4.94	475	327
2012	90.98	50.20	5.39	475	319
2013	91.28	47.10	5.46	475	293

Year	Dairy cattle, kg/head per year	Non-dairy cattle, kg/head per year	Milk yield per dairy cow, kg/day	Weight of dairy cattle, kg/head	Weight of non-dairy cattle, kg/head
2014	92.30	46.98	5.70	475	292
2015	92.59	48.06	5.77	475	301
2020	93.48	47.82	5.98	475	299
2021	93.91	48.54	6.08	475	305
2022	94.67	48.42	6.26	475	304
2023	95.22	48.66	6.39	475	306
2024	95.98	48.30	6.57	475	303
IPCC defaults	99 (table 10.10)	58 (table 10.10)	6.85 2,550 kg head ⁻¹ yr ⁻¹ (table 10.10)	550 (table 10A.1)	392.4 (table 10A.2)

As you may have noted, the parameters provided in the table above are all lower than the default parameters from the 2006 IPCC Guidelines; however, they are within the uncertainty ranges ($\pm 50\%$) (option A is correct).

Moreover, the live weights of dairy and non-dairy cattle are lower than the default values. Milk productivity (or milk yield per head of dairy cow) is also lower than the data used to develop the default EFs (option B is correct).

In table 5.12 of the NID (or from the aggregated overview table reported here), the milk yields show a clear increasing trend since 2010. However, the Party used the constant live weight (table 5.8 of the NID) and feed digestibility data for dairy cattle during the whole time series. In its NID the Party stated that “Feed digestibility coefficient (DE%) in local conditions is about 60%.” However, the changes in milk productivity of dairy cows are a response to the intensification of the sector – for example, optimization of diets or breed structure of the herd. Hence, the use of the constant values could lead to either overestimation or underestimation of emissions (option C is correct).

Nevertheless, despite the differences in its EFs against the IPCC default values, the Party has not provided any information to explain the differences. Inventory compilers should compare country-specific factors with relevant IPCC default EFs, taking into consideration the characteristics and properties on which the default factors are based (2006 IPCC Guidelines, vol. 1, chap. 6, section 6.7, and vol. 4, chap. 10, section 10.3.5). The intent of this comparison is to determine whether country-specific factors are reasonable, given similarities or differences between the national source/sink category and the ‘average’ category represented by the defaults. Large differences between country-specific factors and default factors do not necessarily indicate problems, but nevertheless may point to quality issues if the differences cannot be explained. Hence, the Party should provide comparisons of its EFs against default values and explain any differences (option D is correct).

Practical exercise 5 question 5.5

The correct answer is E.

In accordance with equation 10.16 in chapter 10 of volume 4 of the 2006 IPCC Guidelines, gross energy calculations should include estimates of the net energy needed for growth (NE_g). For adult animals, NE_g could be equal to zero – mature animals are generally assumed to have no net weight gain or loss over an entire year (2006 IPCC Guidelines, vol. 4, chap. 10, p.10.13); however, the category of non-dairy cattle includes growing animals (see default parameters in tables 10A.1 and 10A.2).

The calculations performed by the TERT with data from table 5.9 in the NID (for 2024) for dairy cattle (assuming no dairy heifers are included) resulted in the following:⁷

- NE_m (net energy required by the animal for maintenance. Equation 10.3) = 39.27 MJ/day;
- NE_a (net energy for animal activity. Equations 10.4 and 10.5) = 4.24 MJ/day;
- NE_l (net energy for lactation. Equations 10.8, 10.9, and 10.10) = 19.38 MJ/day;
- NE_p (net energy required for pregnancy. Equation 10.13) = 3.93 MJ/day;
- REM (ratio of net energy available in a diet for maintenance to digestible energy consumed. Equation 10.14) = 0.49;
- GE (gross energy) = 225.14 MJ/day.

The Party reported a value of GE = 225.14 MJ/day for 2024 (table 5.13). The results of the estimates are consistent.

For non-dairy cattle (for NE_g , the default parameters for Eastern European countries were used):

- NE_m = 23.39 MJ/day;
- NE_a = 5.89 MJ/day;
- NE_g (net energy needed for growth. Equations 10.6 and 10.7) = 5.15 MJ/day;
- REM = 0.49;
- REG = 0.28;
- GE = 116.00 MJ/day.

However, the Party reported a value of GE = 113.29 MJ/day for 2024 (table 5.13).

Practical exercise 5 question 5.6

The correct answer is C.

The Party has not provided any information on the uncertainty related to the AD applied in the estimates (option A is incorrect).

The Party provided the information on the uncertainty rates associated with the EFs. It stated that “accuracy of the estimation of EFs for cattle using the tier 2 approach is within +/-20 per cent (IPCC, 2006)”. The 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.33) specify that EF estimates using the tier 2

⁷ All references to equations are contained in chapter 10 of volume 4 of the 2006 IPCC Guidelines.

method are likely to be in the order of +/-20 per cent. Inventory compilers using the tier 2 method should undertake an analysis of uncertainties reflecting their particular situation, and in the absence of this analysis the uncertainty under the tier 2 method should be assumed to be similar to the uncertainty under the tier 1 method. Therefore, on the one hand the Party provided the uncertainty rates that are relevant to those described in the 2006 IPCC Guidelines, that is, for a tier 2; however, on the other hand, the Party has not undertaken any analysis and shown that the uncertainty reflects its national situation. Hence, the uncertainty relevant for the tier 1 method should be used (± 30 –50 per cent) (option B and D are incorrect).

The Party stated that “for other categories of animals, the accuracy of the emission factors was assumed to be $\pm 30\%$ ”. As you noted, the Party used the IPCC default EFs to estimate CH₄ emissions from other livestock categories (table 5.15 of the NID). However, default values of uncertainties for tier 1 EFs are ± 30 –50 per cent (2006 IPCC Guidelines, vol. 4, chap. 10, table 10.10). Hence, the choice of the lower limit should be clearly explained by the Party; otherwise, the upper limit should be used (i.e. to apply a conservative approach by using the upper range of uncertainty so that it is not underestimated).

Practical exercise 5 – review report

Exemplary text:

In the 2026 GHG inventory submission, the Party has developed the adjustment factors to estimate average annual populations of cattle, swine, sheep, goats, horses and camels based on the available animal population national statistics. The TERT noted that numbers of donkeys and buffalo are not adjusted to the average annual population, and no explanations are provided in the NID. The TERT further noted that only animal populations of cattle, swine, camels, horses and birds are based on the national statistics, and data for donkeys, sheep, goats and buffalo are taken from FAOSTAT. The TERT recommends that the Party estimate average annual populations for all animal species in this category or provide evidence that populations of donkeys and buffalo are average annual numbers. The TERT encourages the Party to discover the national source of reporting to FAOSTAT on animal populations and use national statistical data on donkey, sheep, goat and buffalo populations in its next GHG inventory submission.

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The Party applied a tier 2 methodology to estimate CH₄ emissions from enteric fermentation of significant animal categories (dairy and non-dairy cattle). From the NID, it is not clear if the net energy for growth has been taken into consideration in the estimates of gross energy intakes of non-dairy cattle, as neither the data on average daily weight gain of cattle (kg/day) nor the explanation on this issue are provided. The TERT noted that exclusion of net energy for growth from calculations might lead to underestimations of EFs for non-dairy cattle.

The TERT recommends that the Party estimate a net energy for growth of non-dairy cattle and/or provide explanatory information on its exclusion in the national inventory report of its next GHG inventory submission.

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The TERT noted that the milk yields have increased since 2010; however, the Party used constant live weight data for dairy cattle (475 kg/head) during the whole time series. This could lead to an underestimation of emissions for later years or an overestimation for earlier years.

The TERT recommends that the Party develop annual data on live weight of dairy cattle to improve the accuracy of the estimates.

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The TERT noted that the uncertainty of AD and total CH₄ emissions from enteric fermentation is not reported.

The TERT recommends that the Party estimate the uncertainty for this category using the methodology provided in the 2006 IPCC Guidelines and report the results in its next GHG inventory submission.

5. Self-check quiz

Question 1

A Party from Western Europe used default EFs for enteric fermentation from sheep intended to be used by developing countries (see 2006 IPCC Guidelines, vol. 4, chap. 10, table 10.10). In its NID, the Party had comprehensively justified applying the default EF intended to be used by developing countries.

As a reviewer, would you agree with the approach used by the Party?

Select one:

- A. Yes, I would agree
- B. No, I would not agree

Question 2

A developing country applying flexibility uses the notation key “NE” to report CH₄ emissions from enteric fermentation of goats.

Would you agree with the following possible action?

As a reviewer, you must verify that the emissions from enteric fermentation of goats are insignificant. In other words, it must be below the level of significance or emissions from enteric fermentation of goats must be below 0.05 per cent of the national total GHG emissions, excluding LULUCF, or 500 kt CO₂ eq, whichever is lower. In addition, the total national aggregate of estimated emissions for all gases and categories considered insignificant must remain below 0.1 per cent of the national total GHG emissions, excluding LULUCF.

Select one:

- A. Yes, I would agree
- B. No, I would not agree

Question 3:

To estimate CH₄ emissions from enteric fermentation of dairy cattle, a Party from Eastern Europe used a CH₄ conversion factor (Y_m) of 6 per cent. However, neither a reference to the Y_m value used nor justification is provided in the NID. Therefore, the TERT considers that the use of a Y_m of 6 per cent may lead to an overestimation of CH₄ emissions from enteric fermentation of cattle and must recommend that the Party provide a justification for the current Y_m value used.

As a reviewer, would you agree with the decision made by the TERT?

Select one:

- A. Yes, I would agree
- B. No, I would not agree

Question 4

The NID of a developing country contains the following information on the methodological choice applied to estimate CH₄ emissions from livestock enteric fermentation and the uncertainty assessment performed for these estimates:

The simplified IPCC tier 1 method and default EFs to estimate the amount of CH₄ emissions from enteric fermentation were used, except for cattle, where IPCC default values were adapted as follows to reflect the country's conditions more realistically:

An interpolated CH₄ EF of 43 kg CH₄/head/year, based on IPCC values reported for Africa and Asia was used for non-dairy cattle, and an EF of 72 kg CH₄/head/year (double the IPCC default value) for dairy cattle.

The CH₄ emissions from enteric fermentation in livestock, mainly cattle and sheep, are the dominant source of CH₄ emissions for the agriculture sector, contributing about 70 per cent to the total national CH₄ emissions.

The emission estimates from this category are incomplete and have a high level of uncertainty associated with them. There is a lack of data on uncertainty rates associated with AD for livestock population number.

As a reviewer, would you recommend that the Party make efforts and conduct a quantitative uncertainty assessment for the livestock enteric fermentation category and estimate the trend uncertainty of emissions between the starting year and the latest reporting year?

Select one:

- A. Yes, I would recommend
- B. No, I would not recommend

Question 5

Read through the description of the finding recorded by the TERT in the TERR and classify it into one of the TACCC principles:

“CH₄ emissions from enteric fermentation is identified as a key category, in which cattle and sheep are significant (accounting for 44.3 and 31.4 per cent of the emissions from enteric fermentation, respectively). However, a developed Party applied a tier 1 method for the estimation of emissions from all livestock species.

In response to questions raised by the TERT during the review, the Party informed it that the necessary data for using a tier 2 method for estimating emissions from the enteric fermentation of dairy cattle have been collected and will be used for the next inventory submission.

The TERT welcomes this planned improvement and recommends that the Party estimate emissions for all significant livestock categories using an enhanced livestock characterization and a tier 2 method in accordance with the 2006 IPCC Guidelines.”

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness



For more information, see page 1.8 in chapter 1 of volume 1 of the 2006 IPCC Guidelines.

Question 6

A Party from Eastern Europe used a tier 1 method for estimating CH₄ emissions from enteric fermentation of buffalo for the whole time series. In its NID, the Party reported an average live weight of buffalo equal to 380 kg. However, as a reviewer, you noted that the default EF from the 2006 IPCC Guidelines is 55 kg CH₄/head/year corresponding to a live weight of 300 kg. Hence, the corresponding CH₄ EF used by the Party to estimate the emissions from enteric fermentation of buffalo should be as follows:

Select one:

- A. 55 CH₄/head/year, as that is the default EF that has been developed for the Eastern European region
- B. 69.67 CH₄/head/year
- C. 65.67 CH₄/head/year

Question 7

Read through the description of the finding recorded by the TERT in the TERR and classify it into one of the TACCC principles:

“In its NID and CRT 3.A, the Party reported CH₄ emissions from enteric fermentation of bulls used for breeding purpose under ‘growing young cattle’ category.

The TERT notes that according to the classification of livestock categories listed in table 10.1, chapter 10, volume 4 of the 2006 IPCC Guidelines, the population and relevant emissions must be reported under ‘other mature cattle’ category.

The TERT recommends that the Party report the AD and emissions for bulls used for breeding purpose under other mature cattle” in CRT 3.As1 and 3.B(a)s1, respectively.”

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness



For more information, see page 1.8 in chapter 1 of volume 1 of the 2006 IPCC Guidelines.

Question 8

Read through the description of the finding recorded by the TERT in the TERR and classify it into one of TACCC principles:

“Recalculations to the reported CH₄ emissions from enteric fermentation of cattle since the 2026 submission changed the emission estimates for the time series by more than 2 per cent since 2010 (e.g., for 2015, the decrease in the reported emissions was 5.3 per cent in the 2022 submission). The recalculations were not justified in the NID.

During the review, the Party explained that the CH₄ emission estimates for this category were updated for the 2021 submission and a new spreadsheet was created for the calculations.

The TERT recommends that the Party improve its reporting on recalculations by clearly documenting and justifying all recalculations in the NID.”

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness
- F. None of above, as the issue relates to the assessment of recalculations

5.1. Answer key to the self-check quiz

Question 1

The correct answer is A.

The default factors for a tier 1 method may not be representative of a Party's national circumstances. Hence, the Parties may use the default factors developed for other regions if they better reflect its national circumstances. However, in this case, the Party should transparently explain the rationale of the use of the default EFs selected.

Question 2

The correct answer is B.

Developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to consider emissions insignificant if their likely level is below **0.1** per cent of the national total GHG emissions, excluding LULUCF, or **1,000** kt CO₂ eq, whichever is lower. The total national aggregate of estimated emissions for all gases from categories considered insignificant, in this case, should remain below 0.2 per cent of the national total GHG emissions, excluding LULUCF (MPGs, para. 32).

Question 3

The correct answer is B.

The default Y_m value reported in the 2006 IPCC Guidelines is 6.5 per cent. Hence, the use of the Y_m at the value of 6 per cent might lead to an underestimation of CH₄ emissions from enteric fermentation of cattle. The TERT must recommend that the Party investigate the appropriateness of the value used for Y_m for cattle and provide a justification for the current value or recalculate CH₄ emissions from enteric fermentation of cattle for the entire time series using the Y_m factor from the 2006 IPCC Guidelines to address the accuracy issue resulting from the use of an incorrect Y_m .

Question 4

The correct answer is B.

Paragraph 29 of the MPGs states:

- i) Each Party shall quantitatively estimate and qualitatively discuss the uncertainty of the emission and removal estimates for all source and sink categories, including inventory totals, for at least the starting year and the latest reporting year of the inventory time series;
- ii) Each Party shall also estimate the trend uncertainty of emission and removal estimates for all source and sink categories, including totals, between the starting year and the latest reporting year of the inventory time series.

However, the same paragraph indicates that those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead provide, at a minimum, a qualitative discussion of uncertainty for key categories, where quantitative input data are unavailable to quantitatively estimate uncertainties, and are encouraged to provide a quantitative estimate of uncertainty for all source and sink categories of the GHG inventory.

Question 5

The correct answer is B.

Moving from a tier 1 (approach with the lowest accepted accuracy) to a tier 2 approach, which relies on country-specific data on performance parameters of each livestock category within the enhanced livestock characterization, can improve the accuracy of livestock emission estimates in the sense that they are systematically neither over nor under the true emissions level and that uncertainties are reduced as far as practicable.

Question 6

The correct answer is C.

The 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.23) indicates an approach for scaling the EF using the ratio between the live weight of the animal of interest and the live weight of a reference animal (in this case, 380/300) raised to the power of 0.75. Hence, the Party must use the EF value of 65.67 CH₄/head/year to estimate the emissions from enteric fermentation of buffalo.

Question 7

The correct answer is D.

According to the classification principles of livestock populations into subcategories for each species according to age, type of production, and sex established in the 2006 IPCC Guidelines (vol. 4, chap. 10, table 10.1), the population of bulls used for breeding purposes should be presented under other mature cattle. Hence, the reporting of the emissions from enteric fermentation of bulls used for breeding purposes under growing young cattle can be identified as failure to follow general IPCC good practice for enteric fermentation and can be further defined as an issue of comparability.

Question 8

The correct answer is A.

The issues should be classified as a transparency issue. The Party did not provide any documentation illustrating the reasons for performing the recalculations, meaning that Hence, it is not possible for a reviewer to have understandable information and reproduce the calculations.

6. Key points to remember

- Section 10.3, in volume 4 of the 2006 IPCC Guidelines provides the methodology to estimate CH₄ emissions from livestock enteric fermentation.
- Paragraph 28 of decision 5/CMA.3 notes that the Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines.
- Annex I to decision 5/CMA.3 provides the template of CRTs for the electronic reporting of the information in the national inventory reports of anthropogenic GHG emissions by sources and removals by sinks:
 - CRT 3.A contains information on the tier method used, AD and EFs applied and assumptions made in the estimates of CH₄ emissions from enteric fermentation.
- Annex V to decision 5/CMA.3 outlines the NID, pursuant to the MPGs :
 - Chapter 5 of the NID includes information on methods, AD, EFs, parameters and GHG emissions reported under the categories of the agriculture sector.
- The tier 2 method is a complex approach that requires detailed country-specific data on nutrient requirements, feed intake and CH₄ conversion rates for specific feed types, which are used to develop EFs for country-defined livestock categories.
- The enteric fermentation category interlinks with the manure management category: the data on livestock population characterization, livestock population number and performance parameters used to estimate CH₄ emissions from enteric fermentation should be consistent with data that are used to estimate CH₄ and N₂O emissions from manure management.
- As a reviewer, you must assess the following elements:
 - *Choice and use of methods*: whether a Party has followed the route reflected in the decision tree (2006 IPCC Guidelines, vol. 4, chap. 10, figure 10.2) and whether the estimation methods used to estimate CH₄ emissions follow the good practice guidance, and whether a Party has transparently explained the rationale for its selection of AD, parameters and assumptions applied in its calculations;
 - *AD*: whether all livestock species/subcategories are covered for the entire reporting period and whether reference sources for AD are documented in the NID (you may consult the international data sets to check completeness of the inventory and to ensure that all the livestock categories for which the IPCC default EFs are evaluated have been covered by the estimates);
 - *EFs*: whether all parameters used in the estimates are documented and cited in the NID; whether calculated EFs are compared with the IPCC defaults; and if a tier 1 approach was used, whether a Party demonstrated that the default factors used are applicable to the national circumstances.
- As a reviewer, you should document any questions you have to the Party during the review; The review report is the written record of the key issues that the TERT concludes need to be resolved by the Party in order for the Party to be fully in compliance with the reporting requirements of the MPGs.

- As a reviewer, you do not jump to conclusions without a consultation with the Party to obtain further clarifications of the findings you identified; therefore, it is essential that you make the necessary effort to ensure that the communications are clear and concise, as effective communication between the TERT and the Party is one key to a successful review process.

Lesson 4: Manure management

1. Introduction

1.1. Learning objectives and time needed to complete the lesson

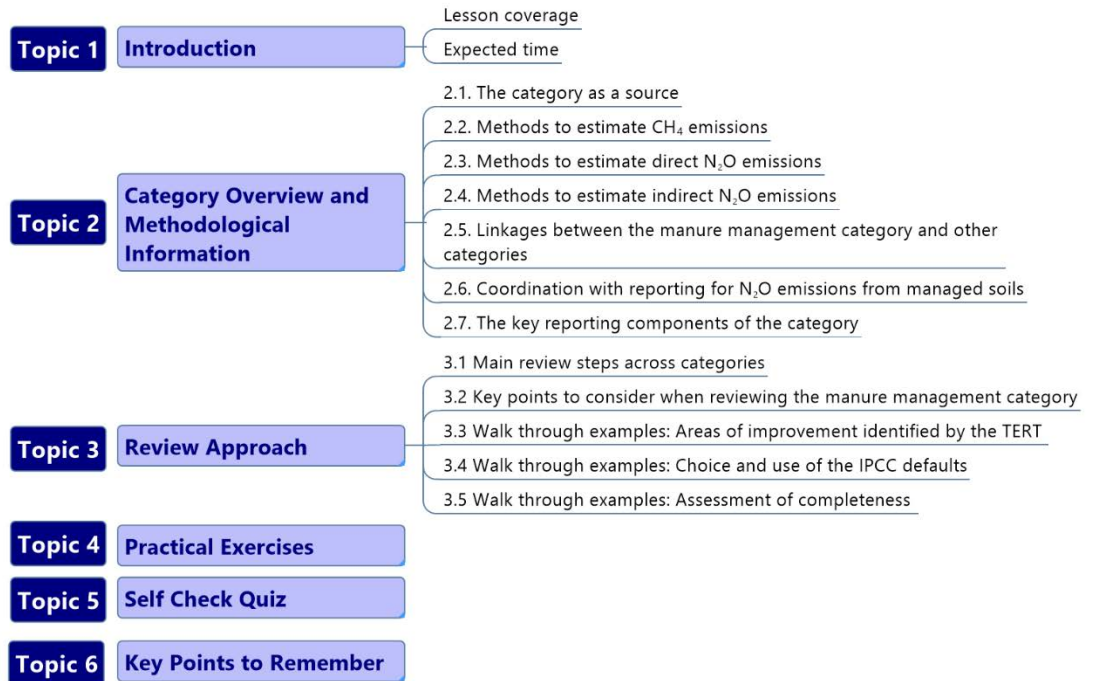
Lesson 4 describes the methodological basis underlying the estimates of CH₄ and N₂O emissions from manure management and addresses the steps the TERT should undertake in reviewing this agriculture sector category.

At the end of this lesson, you will be able to:

- Identify methodological references and reporting components relevant to the manure management category;
- Understand how the manure management category interlinks with other categories within the agriculture sector and the categories of other sectors of the inventory;
- Focus on the key review components and be aware of possible actions by the TERT in its review of CH₄ and N₂O emissions for the manure management category;
- Understand how to formulate clarification questions to a Party;
- Identify findings or issues, draft relevant encouragements or recommendations in a TERR;
- Understand issues on the basis of the TACCC principles.

Expected time needed to complete lesson 4: 60 minutes

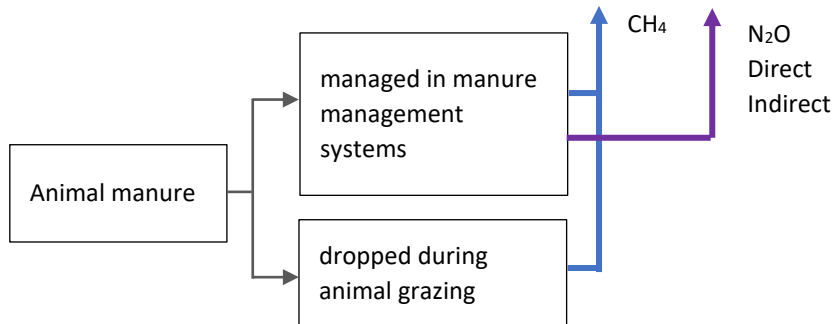
1.2. Structure of the lesson



2. Category overview and methodological information

2.1. The category as a source

The **manure management** category involves the reporting of CH₄ and N₂O emissions (figure 4-1).



J. Figure 4-1. Reporting of greenhouse gas emissions under the animal manure management category

The term “**manure**” is used in the 2006 IPCC Guidelines collectively to include both dung and urine (i.e. the solid and liquid manure) produced by livestock.

GHG emissions from animal manure are reported under the following categories:

- N₂O emissions from the land's surface due to the application of *manure to soils* are accounted for under the direct and indirect N₂O emissions from managed soils category;
- N₂O emissions generated by manure in the system *pasture, range and paddock* occur directly and indirectly from the soil, and are therefore reported under the category N₂O emissions from managed soils.

The emissions associated with the burning of dung *for fuel* are to be reported under the energy sector, or under the waste sector if burned *without* energy recovery.

To learn more about CH₄ and N₂O emissions see below.

CH₄ is produced from the decomposition of manure under anaerobic conditions (i.e. in the absence of oxygen) during storage and treatment. These conditions occur most readily when large numbers of animals are managed in a confined area (e.g. dairy farms, beef feedlots and swine and poultry farms) and where manure is disposed of in liquid-based systems.

The main factors affecting CH₄ emissions are the amount of manure produced and the proportion of manure that decomposes anaerobically. The former depends on the rate of waste production per animal and the number of animals, and the latter on how the manure is managed. When manure is stored or treated as a liquid (e.g. in lagoons, ponds, tanks or pits), it decomposes anaerobically and can produce a significant quantity of CH₄. The temperature and retention time of the storage unit greatly affect the amount of CH₄ produced. When manure is handled as a solid (e.g. in stacks or piles) or when it is deposited on pastures and rangelands, it tends to decompose under more aerobic conditions and, therefore, less CH₄ is produced.

N₂O is also produced **directly** and **indirectly** during the storage and treatment of manure before it is applied to land or otherwise used for feed, fuel or construction purposes.

Direct N₂O emissions occur via combined nitrification and denitrification of nitrogen contained in the manure. N₂O emissions from manure during storage and treatment depends on the nitrogen and carbon content of the manure, on the duration of storage and on the type of treatment. N₂O emissions from managed manure requires the presence of either nitrites or nitrates in an anaerobic environment preceded by the aerobic conditions necessary for the formation of these oxidized forms of nitrogen. In addition, conditions preventing the reduction of N₂O to N₂, such as a low potential of hydrogen or limited moisture, must be present.

Indirect emissions result from volatile nitrogen losses, which occur primarily in the form of NH₃ and NO_x.

The fraction of excreted organic nitrogen that is mineralized to ammonia nitrogen during manure collection and storage depends mainly on time and, to a lesser degree, temperature. Nitrogen losses begin at the point of excretion in livestock houses and other animal production areas (e.g. milking parlours) and continue through on-site management in storage and treatment systems (i.e. manure management systems).

Indirect emissions also occur from nitrogen which is lost through run-off and leaching into soils from the solid storage of manure in outdoor areas, in feedlots and where animals are grazing on pastures.



For more information, see page 10.35 in chapter 10 of volume 4 of the 2006 IPCC Guidelines.

2.2. Methods to estimate CH₄ emissions from manure management systems

A general approach to estimate CH₄ emissions from manure management of domesticated animals (organized by animal species/subcategory) is expressed as follows:

$$\text{total CH}_4 \text{ emissions} = \sum N_i \times EF_i$$

where N_i is the number of animals by category/subcategory *i* and EF_i is the EF per animal of category/subcategory *i*, where the EF is highly temperature dependent.

There are three different methodological tiers available in the 2006 IPCC Guidelines (vol. 4, chap. 10, figure 10.3, p.10.36) for estimating CH₄ emissions from manure management:

Tier 1	Tier 2	Tier 3
For animal species defined as not significant , it is acceptable to use a basic livestock characterization and a tier 1 method, if no country-specific EFs are available.	The tier 2 method is applicable when manure management is a key category or data on enhanced livestock population characterization, country-specific VS rates, MCF values, B ₀ values, and management system usage data are available.	If there is a country-specific tier 3 methodology or measurement-based approaches, estimates should be carried out using a tier 3 approach.

K. Figure 4-2. The main features of the decision tree to determine which tier to use to estimate CH₄ emissions from manure management



See section 2.6 in lesson 2 (p.28) for:

- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

To learn more about the tier methods, see below.

Tier 1

The tier 1 method is a simplified method that only requires livestock population data by animal species/category and climatic region (i.e. cool, temperate or warm) or temperature, in combination with the IPCC default EFs, to estimate emissions. As some emissions from manure management systems are highly temperature dependent, it is good practice to estimate the average annual temperature associated with the manure management system locations.

For animal species defined as not significant (normally sheep, goats, horses, mules, asses, camels, and poultry), it is acceptable to use a basic livestock characterization and a tier 1 method, if no country-specific EFs are available.

Default EFs by average annual temperature are presented in tables 10.14, 10.15 and 10.16 of the 2006 IPCC Guidelines for each of the recommended population subcategories. These EFs represent the range in manure volatile solids content and in the manure management practices used in each region, as well as the difference in emissions due to temperature. Tables 10A-4 to 10A-9 in annex 10A.2 to chapter 10 of volume 4 of the 2006 IPCC Guidelines present the underlying assumptions used for each region.

See page 10.35 in chapter 10 of volume 4 of the 2006 IPCC Guidelines for more information.



As a reviewer, you must assess whether a Party provided the bases on how well the default VS excretion rates, B_0 values and manure management practices are applicable to the national circumstances and whether the EFs selected are appropriate to the region and the annual average temperature of the country.

Tier 2

The tier 2 method is applicable when manure management is a key category and requires detailed information on animal characteristics and manure management practices, which is used to develop EFs specific to the conditions of the country.

The method chosen should depend on data availability and national circumstances. Good practice in estimating CH_4 emissions from manure management systems entails making every effort to use the tier 2 method, including calculating EFs using country-specific information. The tier 1 method should only be used if all possible avenues to use the tier 2 method have been exhausted and/or it is determined that the source is not a key category or subcategory.

If country-specific EFs are not available, tier 2 EFs can be estimated from:

- **VS excretion rates.** Country-specific published sources should be used. Otherwise, country-specific VS values may be calculated based on estimated daily average gross energy intake, digestible energy of the feed and ash content of the manure, and urinary energy (UE) expressed as fraction of GE;
- **Bedding materials.** Straw, sawdust, chippings, etc., are not included in the VS modelled under the tier 2 method. The type and use of these materials is highly variable from country to country. Since they are typically associated with solid storage systems, their contribution would not add significantly to overall CH_4 production;
- **B_0 .** If country-specific B_0 measurement values are not available, default values are provided in tables 10A-4 to 10A-9 in chapter 10 of volume 4 of the 2006 IPCC Guidelines;
- **MCF,** which is a function of the climatic conditions of the region and of the share of manure handling systems. Default MCFs are provided in the 2006 IPCC Guidelines (vol. 4, chap. 10, table 10.17) for different manure management systems and by annual average temperatures. As liquid-based systems are very sensitive to temperature effects, where possible, default MCF values for these systems have been presented in table 10.17 of the 2006 IPCC Guidelines for specific annual average temperatures in each climatic range. For specific management systems used in particular countries or regions, country-specific MCFs should be developed if possible.

If country-specific data are available for only a portion of these variables, countries are encouraged to calculate country-specific EFs using the data in tables 10A-4 to 10A-9 to fill gaps.

See page 10.41 in chapter 10 of volume 4 of the 2006 IPCC Guidelines for more information.

As a reviewer, you should check:



- Whether country-specific EFs and parameters (MCFs, B_0 and the share of manure management systems) have been utilized, and whether the bases of these data are provided and how well they compare with IPCC default values;
- If the values of gross energy intake and digestible energy used for calculations of CH_4 emissions from manure management are the same as those used in the estimations of CH_4 emissions from enteric fermentation for the respective species;
- How annual average temperatures have been considered to estimate MCFs for liquid-based manure management systems.

Tier 3

Some countries for which livestock emissions are particularly important may wish to go beyond the tier 2 method and develop tier 3 models for country-specific methodologies or use measurement-based approaches to quantify EFs.

Reviewing tier 3 methods is often challenging because of their complexity and the limited time available for the review, particularly during centralized and desk reviews. However, as a reviewer, you must assess:

- Whether the NID includes verification information consistent with the 2006 IPCC Guidelines;
- Whether the NID includes additional information for improving transparency, such as information on basis and type of model, application and adaptation of the model, main equations/processes, key assumptions, domain of application, how the model parameters were estimated, description of key inputs and outputs, details of calibration and model evaluation, uncertainty and sensitivity analysis, QA/QC procedures adopted and references to peer-reviewed literature.

Moreover, there are specific guidance to review the results of a tier 3 estimate See page 10.35 in chapter 10 of volume 4 of the 2006 IPCC Guidelines for more information.

2.3. Methods to estimate direct N₂O emissions from manure management systems

The level of detail and methods chosen for estimating **direct** N₂O emissions from manure management systems will depend upon national circumstances. The decision tree in the 2006 IPCC Guidelines (vol. 4, chap. 10, figure 10.4) describes *good practice* in choosing a method accordingly.

N₂O emissions from manure management systems include both direct and indirect sources.

The following sections describe the different tiers referenced in the decision tree for calculating direct N₂O emissions from manure management systems.

Tier 1	Tier 2	Tier 3
For animal species defined as not significant (normally goats, horses, camels, mules, asses and poultry), it is acceptable to use a basic livestock characterization , IPCC default parameters (i.e. Nex rates and typical animal weight) and a tier 1 approach.	If N ₂ O from manure management is a key category , or data on enhanced livestock population characterization, country-specific Nex rates, fractions of nitrogen losses, EFs and management system usage data are available.	A tier 3 method utilizes alternative estimation procedures based on a country-specific methodology. For example, a process-based, mass balance approach which tracks nitrogen throughout the system starting with feed input through final use/disposal.

L. Figure 4-3. The main features of the decision tree to determine which tier to use to estimate direct N₂O emissions from manure management



See section 2.6 in lesson 2 (p.28) for:

- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

Tier 1

A tier 1 method entails multiplying the total amount of Nex (from all livestock species/categories) in each type of manure management system by an EF for that type of manure management system. The tier 1 method is

applied using IPCC default N₂O EFs, default Nex data and default manure management system data (for default management system allocations, see tables 10A-4 to 10A-8 in annex 10A.2 to chapter 10 of volume 4 of the 2006 IPCC Guidelines). Default daily Nex rates are given in volume 4 of the 2006 IPCC Guidelines in kg nitrogen per 1000 kg of animal mass, which allows adjustment of Nex rates by different livestock subcategories of varying ages and growth stages.

Data on average animal weight by each subcategory are collected for enhanced characterization of livestock species. For basic characterization, default values of animal mass could be used (see 2006 IPCC Guidelines tables 10A-4 to 10A-8).

For animal species defined as not significant (normally goats, horses, camels, mules, asses and poultry), it is acceptable to use a basic livestock characterization, IPCC defaults and a tier 1 approach.

See pages 10.53 and 10.57 in chapter 10 of volume 4 of the 2006 IPCC Guidelines for more information.



When reviewing reporting by a Party using a tier 1 method, as a reviewer, you must assess whether the default values (e.g. for Nex rates and average animal mass) used for some or all species are applicable to the national circumstances.

Tier 2

A tier 2 method follows the same calculation equation as tier 1 – that is, it entails multiplying the total amount of Nex (from all livestock species/categories) in each type of manure management system by an EF for that type of manure management system (see equation 10.25 in chapter 10 of volume 4 of the 2006 IPCC Guidelines) – but would include the use of country-specific data for some or all of the variables in the equation (e.g. country-specific Nex rates and distribution of manure management systems).

Country-specific Nex rates may be either taken directly from documents or reports in the agricultural industry and scientific literature or derived from information on animal nitrogen intake and retention in accordance with the 2006 IPCC Guidelines. References for country-specific Nex rates should be provided in the NID, along with a summary explaining the nature of any significant differences to 2006 IPCC default Nex rates or to rates in those Parties with similar national circumstances.

See pages 10.53 and 10.58 in chapter 10 of volume 4 of the 2006 IPCC Guidelines for more information.

As a reviewer, you should check that calculations of Nex rates are based on the same gross energy values as those used in the estimations of CH₄ emissions from enteric fermentation and CH₄ emissions from manure management, and percentage of crude protein in the diet. Moreover, as a reviewer, you must assess whether:



- The NID includes descriptions, references and sources of information for AD, methods and EFs as well as the rationale for their selection;
- The development or selection of EFs and their documentation is in line with the general guidance in the 2006 IPCC Guidelines and its supplements and with the guidance for the specific category;
- Country-specific EFs are periodically reviewed and updated to ensure accuracy if underlying conditions change.

Tier 3

A tier 3 method utilizes alternative estimation procedures based on a country-specific methodology. For example, a process-based mass balance approach that tracks nitrogen throughout the system, starting with feed input through to final use/disposal, could be utilized as a tier 3 procedure. Tier 3 methods should be well documented to clearly describe estimation procedures.

For more information on how to review a tier 3 method, see the tier 3 box in the section “CH₄ emissions from manure management” in the current lesson (section 2.2).

2.4. Methods to estimate indirect N₂O emissions from manure management systems

The decision route to select a method to estimate **indirect** N₂O emissions from manure management systems is the same as for direct N₂O emissions from manure management systems (2006 IPCC Guidelines, vol. 4, chap. 10, figure 10.4). The key principles are outlined in figure 4-4.

Tier 1	Tier 2	Tier 3
<p>The tier 1 method is applied using default Nex data, default manure management system data and default fractions of nitrogen losses from manure management systems due to volatilization.</p>	<p>The tier 2 method is applied for better consideration of national circumstances and to reduce uncertainty of estimates as much as possible. National NH₃ emission inventories developed by some countries could be used for tier 2 estimation of N volatilization from manure management systems. Estimation of N losses from leaching and runoff from manure management should be considered part of a Tier 2</p>	<p>A tier 3 method could be developed with country-specific EFs for volatilization and nitrogen leaching and run-off based on actual measurements.</p>

M. Figure 4-4. The main features of the decision tree to estimate indirect N₂O emissions from manure management



All losses of nitrogen through manure management systems (both direct and indirect) need to be excluded from the amount of manure nitrogen that is available for application to soils, which is reported under N₂O emissions from managed soils in CRT 3.D (for more information navigate to section “Ensuring consistency with reporting for N₂O emissions from managed soils” in the current lesson (section 2.6)).



See section 2.6 in lesson 2 (p.28) for:

- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

To learn more about the tier methods to estimate indirect N₂O emissions, see below.

Tier 1
<p>A tier 1 calculation of nitrogen volatilization in the form of NH₃ and NO_x from manure management systems is based on multiplication of the amount of nitrogen excreted (from all livestock categories) and managed in each manure management system by the fraction of volatilized nitrogen. Losses are then summed over all manure management systems.</p> <p>The tier 1 method is applied using default Nex data, default manure management system data (tables 10A-4 to 10A-8 in annex 10A.2 to chap. 10 in vol. 4 of the 2006 IPCC Guidelines) and default fractions of nitrogen losses from manure management systems due to volatilization (see table 10.22 in chap. 10 of vol. 4 of the 2006 IPCC Guidelines).</p>

Default values for EF₄ (nitrogen volatilization and redeposition) and EF₅ (nitrogen leaching/run-off) are given in table 11.3 (Default emissions, volatilization and leaching factors for indirect soil N₂O emissions) in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

See page 10.54 in chapter 10 of volume 4 of the 2006 IPCC Guidelines for more information.

The fraction of manure nitrogen that leaches from manure management systems (Frac_{leachMS}) is highly uncertain and should be developed as a country-specific value applied in a tier 2 or tier 3 method.



As a reviewer, you must assess if a Party has reported indirect N₂O emissions from leaching/run-off during manure management. If emissions are not estimated, the TERT should work with the Party to determine whether it would be a key category and therefore to be estimated. It is important to note that failure to report indirect N₂O emissions from leaching/run-off does not lead to an underestimate of N₂O emissions.

Tier 2

A tier 2 method would follow the same calculation procedure as that of tier 1 – that is, it entails multiplying the total amount of Nex (from all livestock species/categories) in each type of manure management system by an EF for that type of manure management system (see equation 10.25 in chapter 10 of volume 4 of the 2006 IPCC Guidelines), but includes the use of country-specific data for some or all of these variables.

National NH₃ emission inventories developed by some countries could be used for tier 2 estimation of nitrogen volatilization from manure management systems. A tier 2 method would require a more detailed characterization of the flow of nitrogen throughout the animal housing and manure management systems used in the country. For example, detailed methodologies for estimating NH₃ and other nitrogen losses using mass balance/mass flow procedures are described in the EMEP/EEA air pollutant emission inventory guidebook.⁸ Estimation of N losses from leaching and run-off from manure management should be considered part of a tier 2 or tier 3 method.

See page 10.56 in chapter 10 of volume 4 of the 2006 IPCC Guidelines for more information.

Double counting of emissions associated with the application of managed manure should be avoided, as well as manure associated with pasture and grazing operations, which should be calculated and reported under N₂O emissions from managed soils. As a reviewer, you must assess whether:



- The NID include descriptions, references and sources of information for AD, methods and EFs as well as the rationale for their selection;
- The development or selection of EFs and their documentation is in line with the general guidance in the 2006 IPCC Guidelines and its supplements and with the guidance for the specific category;
- Country-specific EFs are periodically reviewed and updated to ensure accuracy if underlying conditions change.

Tier 3

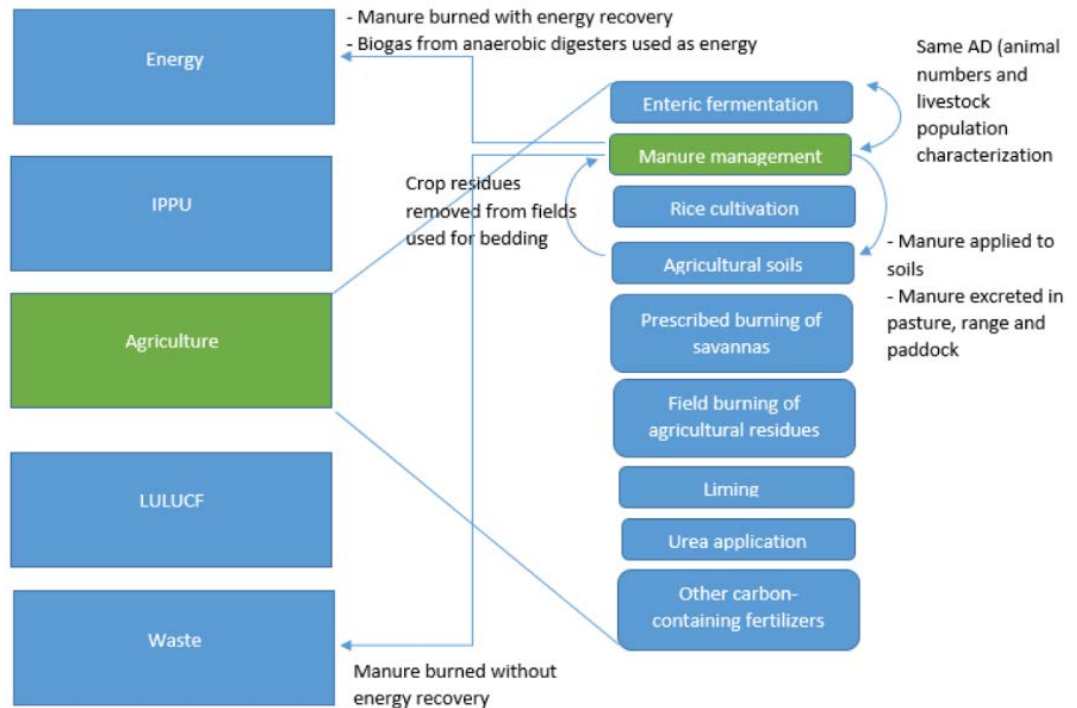
A tier 3 method could be developed with country-specific EFs for volatilization and nitrogen leaching and run-off based on actual measurements.

⁸EMEP/EEA air pollutant emission inventory guidebook 2019. Available at <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019>

For more information on how to review a tier 3 method, navigate to “CH₄ emissions from manure management” in this lesson.

2.5. Linkages between the manure management category and other categories

Figure 4-5 demonstrates the main linkages between the manure management category and other categories of the inventory.



N. Figure 4-5. Main linkages between the manure management category and the other categories in the agriculture sector and other sectors

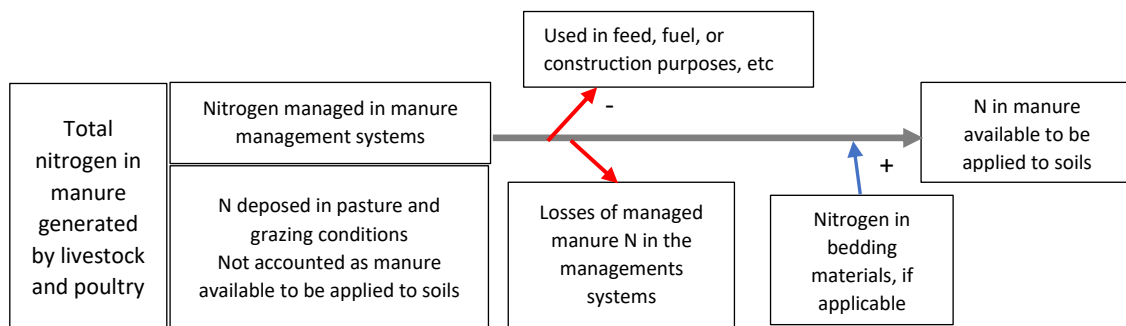
For more information refer to:

- Enteric fermentation: lesson 3;
- Agricultural soils:
 - Section “Coordination with reporting for N₂O emissions from managed soils” in the current lesson;
 - Lesson 5;
- Waste and energy sectors:
 - Section “Manure management category as a source” in the current lesson.

2.6. Ensuring consistency with reporting for N₂O emissions from managed soils

Following storage or treatment in any system of manure management, nearly all the manure will be applied to land. The emissions that subsequently arise from the application of the manure to soil are to be reported under category *N₂O emissions from managed soils (CRT 3.D)*.

A schematic flowchart developed to demonstrate the algorithm to calculate the amount of **animal manure nitrogen that is applied to soils** is presented below.



O. Figure 4-6. Ensuring consistency with reporting for N₂O emissions from managed soils

The detailed methodology is presented on page 10.64 in chapter 10 of volume 4 of the 2006 IPCC Guidelines.

Please open PDF file https://unfccc.int/resource/tet/ba/ba4-01_L4_N_flows.pdf to learn more about an IPCC approach developed to calculate the amount of animal manure nitrogen that is directly applied to soils and a diagram that indicates the equations to be used to estimate nitrogen flows and N₂O emissions and flags relevant CRTs to be filled out with the corresponding data.

2.7. The key reporting components of the category

Table 4-1 summarizes the main reporting components and the references related to the manure management category.

Table 4-1. Summary of key elements of the manure management category

Overview	Category-specific information	
Category name	Manure management	
General reference	2006 IPCC Guidelines, volume 4, chapters 10.4 and 10.5	
Chapter of the NID	Chapter 5: Agriculture	
Reported in CRT	CRT 3.B(a) and 3.B(b): option A/option B	
Main subcategories and GHGs to be reported	Cattle	CH ₄ , N ₂ O
	Sheep	CH ₄ , N ₂ O
	Swine	CH ₄ , N ₂ O
	Other livestock	CH ₄ , N ₂ O
	Indirect N ₂ O emissions	N ₂ O

The CRT allows one of two options to report CH₄ and N₂O emissions from manure management of cattle:

- **Option A** is developed to report the emissions from cattle manure management calculated based on a basic livestock characterization and using a tier 1 method;
- **Option B** should be used when Parties estimate emissions using enhanced characterization of livestock compared with option A.

In addition to the generic reporting instructions, individual reporting requirements are included in the footnotes of each CRT. Parties may report additional information in the documentation boxes in the CRT. As an agriculture expert, you must familiarize yourself with the footnotes and the information provided by the Party in the documentation boxes. Moreover, you must assess the information reported in **summary report tables** and in **cross-cutting tables**.

3. Review approach

3.1. Key points to consider when reviewing the manure management category



A brief description of three common review steps (prepare – assess - draft) is provided in https://unfccc.int/resource/tet/ba/ba4-02_L_R_steps.pdf. Please read carefully before continuing with the key points to consider when reviewing emissions from manure management, if you have not yet done so.

The choice of methods, selection of assumptions, development and selection of EFs and collection and selection of AD are the main drivers of inventory quality. Hence, as a reviewer, you must assess and ensure that the selection of these data carried out by a Party are in accordance with the 2006 IPCC Guidelines and its supplements and the requirements in the UNFCCC decisions.

Table 4-2 summarizes the possible questions and actions that you can ask yourself when reviewing the emissions reported under the manure management category. In addition, there are several common elements to be assessed across sectors/categories when reviewing the quality of the Party's submission (i.e. uncertainty analysis, QA/QC, time-series consistency, recalculations and progress in implementing improvements); lesson 2 above provides a list of guiding questions.



The intention is not to provide you with an exhaustive list of questions; it is a starting point to stimulate your thinking. You may add or modify the questions as appropriate while conducting a review.

Table 4-2. Possible questions by the review team in its review of CH₄ and N₂O emissions from the manure management category

Review element	Possible question/action by the ERT
	CH₄ emissions from manure management
Choice of method	If CH ₄ emissions from manure management have been identified as a key category and whether these emissions have been estimated for significant animal types using an enhanced characterization and a tier 2 or tier 3 method.
	CH₄ emissions from manure management/tier 1
EFs	Are the the IPCC default EFs appropriate to the region and annual average temperature in the country.
EFs	Is there support to justify that the default IPCC EF used are applicable to the national circumstances?
AD	Did the Party has reported any changes in the types of manure management systems used over time, and were such changes are reflected in the emission time series?
	CH₄ emissions from manure management/tier 2
AD	Is the information on the distribution of manure management systems based on statistics or other information? Is the distribution periodically updated to reflect changing practices?
AD	Was actual data on the usage of each type of manure management system collected or was that data based on assumptions or expert judgment, and whether such data are reasonable, available and presented in a transparent manner?
Consistency	Is the manure management system distribution consistently used for estimation of CH ₄ and N ₂ O emissions?
EFs and parameters	If there are multiple climate zones in the country, has the Party estimated CH ₄ emissions regionally, applying appropriate parameters?
EFs/AD	Were country-specific EFs and parameters (MCFs, B ₀ and the share of manure management systems) have been utilized, and were the bases of these data are provided and how well they compare with IPCC default values?
EFs and parameters	Are data on GE and DE are the same as those used in estimations of CH ₄ emissions from enteric fermentation for the respective species?
EFs and parameters	How annual average temperatures have been considered to estimate MCFs for liquid-based manure management systems
	N₂O emissions from manure management
Choice of method	Are N ₂ O emissions from manure management identified as a key category, and are emissions from significant animal species have been estimated using an enhanced livestock characterization and tier 2 or tier 3 methods?
AD	Were changes in livestock population categories and in the types of manure management systems used over time have been addressed? These changes should also be reflected in the emissions time series.
AD	Were manure emissions from all livestock populations and all types of manure management systems existing in the country (e.g. liquid/slurry with or without

	natural cover) accounted for, and if the distribution of manure by management systems was that the same as that used in CH ₄ emissions from manure management?
AD	Were default values (e.g. for Nex rates and average animal mass) used for some or all species, and are these values applicable to the national circumstances?
AD and parameters	For a tier 2 method, are values for gross energy intake and digestible energy of the feed the same as those used in estimations of CH ₄ emissions from enteric fermentation and manure management for the respective species.
AD and parameters	Is the total amount of nitrogen produced by manure management systems, per animal species consistent with the value obtained by multiplying the population by typical Nex rates? Any differences in these values should be explained by the use of specific livestock practices.
AD	Are direct N ₂ O emissions estimated based on total nitrogen excreted without subtracting the amount of nitrogen lost through leaching and/or volatilization?
Indirect N₂O emissions	
Indirect N ₂ O emissions	Has the Party reported indirect N ₂ O emissions from volatilization of ammonia and NO _x during manure management?
Indirect N ₂ O emissions	Has the Party reported indirect N ₂ O emissions from leaching/run-off during manure management?
Indirect N ₂ O emissions	If indirect emissions are estimated, are these emissions included in the national total? (Indirect N ₂ O emissions from agriculture and LULUCF must be included in the national total, whereas those from other sectors should not)
Use of method	Are the assumptions on emissions from bedding in line with the 2006 IPCC Guidelines (assumed no emissions from bedding during manure management, while emissions from bedding materials are assumed to occur during manure application to soils)?
Cross-cutting issues	
Cross-cutting issues	Has the Party correctly allocated indirect emissions from manure excreted in pasture, range and paddock into the agricultural soils category?
Cross-cutting issues	If the Party reports treatment of manure in anaerobic digesters, is the amount subdivided into different categories considering the amount of biogas recovery, flaring and storage after digestion? If biogas is used for energy production, is it included in the energy sector?
Cross-cutting issues	If the Party reports that manure is burned with or without energy recovery, is this included in the energy or waste sector, respectively?
Cross-cutting issues	Is the amount of manure nitrogen that available for application to soils is estimated to exclude all losses of nitrogen in animal houses and manure management systems and exclude the nitrogen deposited by grazing animals?
Cross-cutting issues	Is the nitrogen content in organic bedding materials (applicable for solid storage and deep bedding) available and used in the estimations of the amount of manure nitrogen that is available for application to soils?
Cross-cutting issues	Is or not the total quantity of nitrogen produced in manure larger than (if nitrogen from bedding material is considered) or equal to (if nitrogen from bedding is not

	included) the sum of the nitrogen reported as urine and dung from grazing animals (F_{PRP}), managed animal manure (F_{AM}) applied to soils, nitrogen manure used for other purposes (e.g. energy sources, construction and animal fodder) and total nitrogen losses from manure management systems?
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As a reviewer, you must first focus on the observations which have an impact on the level and/or trend of the GHG emissions. Moreover, in the case of issues related to transparency (i.e. the NID does not clearly describe how emissions were estimated), the TERT should specifically determine whether the lack of transparency in the inventory leads it to question the accuracy of the inventory estimates reported.



Paragraph 28 of decision 5/CMA.3 notes that Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines. Hence, as a reviewer you must be aware of the improvements undertaken in the 2019 Refinement to the 2006 IPCC Guidelines.

An overview of the changes between the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC Guidelines is provided below:

- A split of the default EFs by high/low productivity systems has been introduced instead of the allocation between developing and developed countries as in the 2006 IPCC Guidelines;
- Default values for VS excretion rates have been introduced in terms of kg VS/1000 kg animal mass/day;
- Default values for CH₄ EFs by animal category, manure management system and climate zone have been updated and provided as g CH₄ per VS;
- Default values for B₀ have been updated;
- Default values for MCF_s for manure management systems have been updated;
- A tier 2 approach to calculate a country- or region-specific MCF has been introduced;
- A tier 2 approach to calculate MCF for biogas systems has been introduced;
- Definitions of manure management systems have been updated;
- Default values for animal waste management system have been updated for all categories of livestock and poultry;
- Default values for Nex rates have been updated;
- Default values for liveweight for animal categories have been updated;
- Default values of crude protein contained in the diet of cattle and buffalo (by subcategory) have been introduced;
- Default values for the fraction of nitrogen in feed intake of livestock that is retained by cattle and buffalo (by subcategory) have been updated;
- A tier 2 method for swine and poultry has been introduced;
- Default EFs for direct N₂O emissions from manure management have been updated;

- Default values for nitrogen loss fractions due to volatilization of NH₃ and NO_x and leaching of nitrogen from manure management have been updated;
- Ensuring consistency with reporting for N₂O emissions from managed soils has been updated;

3.2. Walk-through examples: areas of improvement identified by the technical expert review team

Please examine the issue identified by a TERT in the 2027 review cycle:

3.B.3 swine – CH₄ and N₂O – transparency

The percentage allocations to manure management systems and climate regions for market swine in CRT 3.B(a)s2 do not sum to 100 per cent but to 90 per cent in 2025. During the review, the MM-Party confirmed that an error had been made when completing CRT 3.B(a)s2 and that the correct allocation for digesters is 55 per cent, not 45 per cent, bringing the total allocation to 100 per cent. The ERT confirmed that the error in CRF table 3.B(a)s2 does not affect the emission estimates.



Please open CRT 3.B(a)s2

https://unfccc.int/resource/tet/ba/ba4-03_L4_CS1_MM_27s..xlsx submitted in 2027 and CRT 3.B(a)s2

https://unfccc.int/resource/tet/ba/ba4-04_L4_CS1_MM_28s.xlsx submitted in 2028

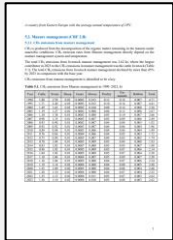
Now assess whether the MM-Party has made any improvement in the subsequent submission.


You may write your assessment here:

3.3. Walk-through examples: choice and use of the IPCC defaults

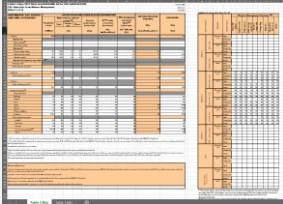
Now you are invited to review the estimates of GHG emissions from manure management. Please assess the inventory submitted by MMSland from Western Europe in 2026.

Please open PDF file https://unfccc.int/resource/tet/ba/ba4-05_L4_CS2_NID.pdf for the NID



 NID 2026

and XLSX file https://unfccc.int/resource/tet/ba/ba4-06_L4_CS2_CRT.xls.xlsx for the CRTs



CRT 2026

Please also study section 5.1 of the NID on enteric fermentation.

What would be your assessment regarding the transparency of the information submitted by the Party on the estimates of CH₄ emissions from manure management and the appropriateness of choice and use of the IPCC default EFs to estimate CH₄ emissions from manure management systems for other livestock categories?

You may write your assessment here:

Choice and use of the IPCC defaults – how to formulate questions

Effective communication between the TERT and the Party is one key to a successful review process. Hence, the TERT must make the necessary effort to ensure that the communications are clear and concise. Now it is your turn to practice; try to draft a clarification question regarding the finding you identified.

Please formulate one question on non-transparent reporting of tier 2 estimates of CH₄ emissions from cattle and sheep manure management and another on the appropriate default EF employed to calculate emissions from goat manure management.

You may write your assessment here:

Choice and use of the IPCC defaults – reporting in the review report

Here you are invited to describe and reflect your finding as a part of the review report. Please explain the TERT finding with references to the CRT and/or NID, summarize any communication with the Party during the review, indicate why the TERT finds that the Party is not meeting applicable reporting requirements of the MPGs and include the TERT recommendation or encouragement in a precise and clear manner.

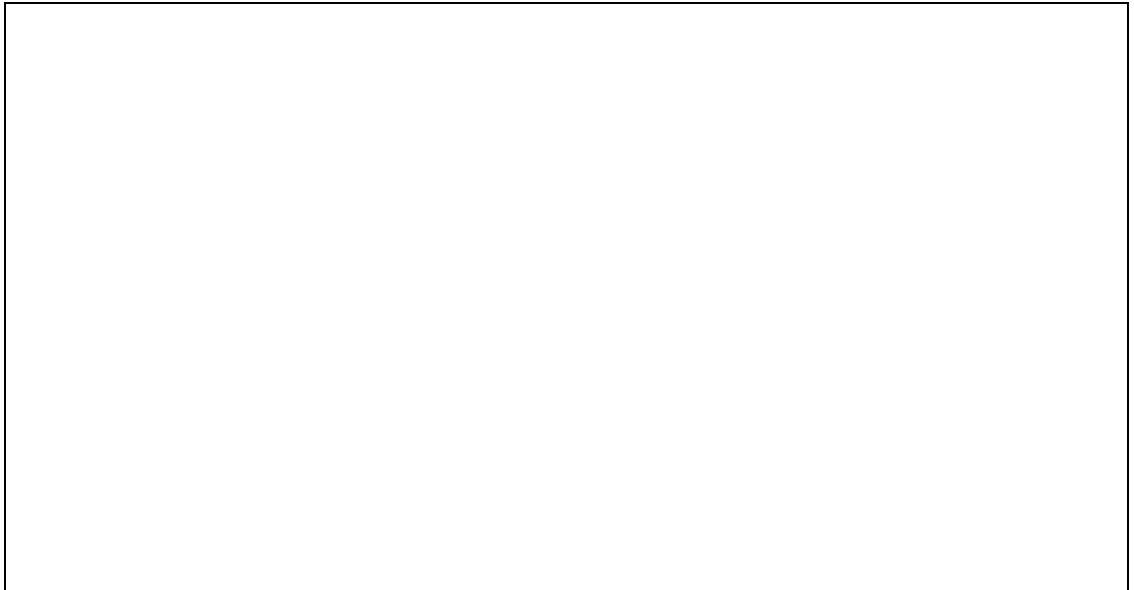
Hypothetical answers of the Party could be as follows:

Dear TERT, many thanks for the questions:

1) The values of VS and B₀ employed to estimate CH₄ emissions from each subcategory of cattle and sheep are reported in Table 3.B(a)s1;

2) We applied the EF developed for sheep (by using a tier 2 approach) to estimate CH₄ emissions from manure management of goats as we consider that these two livestock categories are close to each other in terms of animal weight and habits. Moreover, we argue that the same conclusion is reached by the 2006 IPCC Guidelines, where similar values are proposed (0.20 kg CH₄/head/year for goats and 0.28 kg CH₄/head/ year for sheep).

You may write your assessment here:



3.4. Walk-through examples: assessment of completeness

Now you are invited to review the submission made by a developing country Party.



Please open a PDF document https://unfccc.int/resource/tet/ba/ba4-07_L4_CS3_NID.pdf on indirect N₂O emissions from manure management of the NID.

Examine the information reported by the Party. What would be your assessment in terms of the completeness of the estimates conducted for indirect N₂O emissions from manure management?

You may write your assessment here:



3.5. Answer key to walk-through examples

Areas of improvement identified by the TERT

As you may have noted, the MM-Party did not correct the percentage allocation for digesters and still reported 45 per cent instead of 55 per cent. Therefore, the percentage allocations to manure management systems and climate regions for market swine in CRT 3.B(a)s2 do not sum to 100 per cent, but to 90 per cent in 2025. Hence, as a reviewer, you may conclude that the MM-Party has not addressed the issue from the previous TERT.

Choice and use of the IPCC defaults

As you may have noted, the Party presented the detailed information on the calculation of CH₄ emissions from cattle and sheep enteric fermentation – that is, the country reported the background information on the performance parameters employed to estimate the emissions from each cattle and sheep subcategory. However, the manure management section of the NID covers limited information regarding the parameters used in calculating CH₄ emissions from cattle and sheep manure management, that is, daily VS manure excreted by cattle and sheep; B₀ for animal waste. Moreover, the relevant CRT reflects the aggregate information on these parameters. Hence, it is impossible to assess and replicate the calculation steps conducted by the Party. Thus, as a reviewer, you must raise clarification questions and ask the Party to clarify the values of the parameters used in the estimates.



As a reviewer, please be aware that in some cases, the lack of transparency might lead to accuracy issues, since after seeking and receiving clarification for all (non-transparently reported) details, it might become apparent that some values/parameters have been used inadequately, and the Party had underestimated (or overestimated) its emissions from one or another category.

In table 5.2 of the NID (page 10), the Party clarified that a tier 1 approach and the IPCC default EFs had been used to estimate CH₄ emissions from manure management of other livestock. The Party has provided the values of the default EFs in CRT 3.B(a). However, in its NID, the Party has not provided any reference source (a relevant table of the 2006 IPCC Guidelines) and has not specified the region/annual average temperature underlying CH₄ default EFs for manure management. The table below presents the comparable results on the EFs reported in the NID by the Party and those provided within the 2006 IPCC Guidelines; a brief comment is given with regard to each livestock category.

Livestock category	IEF reported in CRT 3B(a), kg CH ₄ /head/year	The IPCC EF provided within the 2006 IPCC Guidelines, kg CH ₄ /head/year	Reference / note
Swine	16.00		The default EFs are provided in table 10.14 of the 2006 IPCC Guidelines and the annex tables: table 10A-7 (for market swine) and table 10A-8 (for breeding swine). However, as the Party did not report any information on an average annual temperature and how the IEF was selected, it is impossible to assess the appropriateness of use of the CH ₄ EF. Therefore, further clarification from the Party is needed.
Buffalo	9.00		The default EFs are provided in table 10.14 of the 2006 IPCC Guidelines and the annex table (table 10A-6). However, as the Party did not report any information on an average annual temperature and how the IEF was selected, it is impossible to assess the appropriateness of use of the CH ₄ EF. Therefore, further clarification from the Party is needed.
Goats	1.03	0.20	The EF used by the Party is higher than those reported in the 2006 IPCC Guidelines (table 10.15 in chapter 10). However, the Party has not provided any supplemental information to explain and justify the choice and use of the EF for goat. Therefore, further clarification from the Party is needed.
Horses	2.34	2.34	The value used by the Party is the same as those reported in the 2006 IPCC Guidelines (table 10.15 in chapter 10) so no further clarification by the Party is needed.
Mules and asses	1.10	1.10	The value used by the Party is the same as those reported in the 2006 IPCC Guidelines (table 10.15 in chapter 10) so no further clarification by the Party is needed.
Poultry	0.03	Different for various poultry species	Values were used from table 10.15 in chapter 10 of the 2006 IPCC Guidelines. However, as the Party did not report the data on disaggregated poultry population numbers, it is not clear from the NID how the IEF was evaluated and applied. Therefore, further clarification from the Party is needed.

Choice and use of the IPCC defaults – how to formulate questions

- 1) MMSland applied a tier 2 method to estimate CH₄ emissions from cattle and sheep manure management. However, the ERT noted that MMSland has not reported any information in its NID to enable the TERT to assess a tier 2 method applied and replicate the calculations of the CH₄ emissions. Namely, the Party has not provided values for daily VS of manure excreted by each subcategory of cattle and sheep, B₀, etc.
Could MMSland specify the values of VS and B₀ employed to estimate CH₄ emissions from each subcategory of cattle and sheep and list reference sources for the parameters?
- 2) In its NID, MMSland reported using a tier 1 method to estimate CH₄ emissions from manure management from goats. However, the TERT noted from CRT 3.B(a)s1 that MMSland used the IEF for goats at a value of 1.03 kg CH₄/head/year, which is higher than the default EF (0.20 kg

CH₄/head/year) presented in table 10.15 of the 2006 IPCC Guidelines for developed countries. The TERT also noted that the NID does not include any information on a reference source for this factor and any explanation of how the EF had been evaluated.

Could MMSland further clarify the finding by providing a reference source for the EF used to estimate CH₄ emissions from manure management of goats?

Choice and use of the IPCC defaults – reporting in the review report

Examine how the issues have been described in the review report.

3.B Manure management – CH₄ – transparency

MMSland explained in the NID that a tier 2 approach was used to estimate CH₄ emissions for cattle and sheep. The TERT commends the Party for this improvement. However, the TERT noted that MMSland has not included the following information in its NID, which would enable the TERT to understand the tier 2 approach applied: daily VS of manure excreted by cattle and sheep; and B₀ for manure produced by cattle and sheep.

During the review week, MMSland explained that these parameters have been reported in the CRT.

The ERT recommends that MMSland improve the transparency of the reporting by including in its NID all parameters used to estimate its country-specific EFs, for example in a tabular format, and provide an in-depth explanation of the methodology used.

3.B.4 Other livestock – CH₄ – accuracy

MMSland explained in its NID that a tier 1 approach was used to estimate CH₄ emissions for the category other livestock. The TERT noted that the IEF reported in CRT 3.B(a)s1 for goats (1.03 kg CH₄/head/year) is higher than the default EF (0.20 kg CH₄/head/year) presented in table 10.15 of the 2006 IPCC Guidelines for temperate developed countries.

During the review week, MMSland explained that the EF developed for sheep was used for goats because of the similar animal weight and habits. Moreover, the Party argued that the same conclusion is reached by the 2006 IPCC Guidelines, where similar values are proposed (0.20 kg CH₄/head/year for goats and 0.28 kg CH₄/head/year for sheep). The TERT notes that the default EF for goats is 28.6 per cent lower than the default EF for sheep. In addition, the typical animal mass of goats for developed countries (38.5 kg) used by MMSland, obtained from the 2006 IPCC Guidelines, is 15.2 per cent lower than the average typical animal mass of sheep (45.4 kg) estimated by MMSland. Also, the TERT could not ensure the reliability of similar habits in sheep and goats because the default feed intake value for developed countries for goats (0.75 kg/day) from the 2006 IPCC Guidelines is 29.6 per cent lower than the value for sheep (1.03 kg/day). The TERT considers that the use of this country-specific EF for sheep might lead to an overestimation of CH₄ emissions from manure management of goats.

The TERT recommends that the Party provide a revised estimate of CH₄ emissions from manure management of goats for the entire time series using the default EF (0.20 kg CH₄/head/year) from the 2006 IPCC Guidelines in order to avoid an overestimation. Moreover, the TERT recommends that MMSland explain the estimates for CH₄ emissions from manure management of goats in its NID.

Walk-through examples: assessment of completeness

In your assessment of indirect N₂O emissions from manure management systems, you may ask yourself two following questions:

- Has the Party reported indirect N₂O emissions from volatilization of NH₃ and NO_x during manure management?
- Has the Party reported indirect N₂O emissions from leaching/run-off during manure management?

The Party provided the information on a method applied to estimate the emissions and reported an exemplary calculation algorithm developed to estimate indirect N₂O emissions from dairy and non-dairy manure management systems (table 5.87 of the NID). It can be seen that the country has performed the estimates of indirect N₂O emissions released from volatilization of NH₃ and NO_x during manure management. Indirect N₂O emissions that occurred due to leaching/run-off during manure management have been marked as “NE” and the emissions have been identified as not a key category. Hence, the Party could apply a tier 1 approach. Moreover, with regard to tier 1, the 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.56) provide the following information:

There are extremely limited measurement data on leaching and run-off losses from various manure management systems. The greatest nitrogen losses due to run-off and leaching typically occur where animals are on a dry lot. In drier climates, run-off losses are smaller than in high rainfall areas and have been estimated in the range of 3 to 6 per cent of nitrogen excreted. Other studies illustrated that nitrogen lost in run-off was 5 to 19 per cent of nitrogen excreted and 10 to 16 per cent leached into soil, while other data show relatively low loss of nitrogen through leaching in solid storage (less than 5 per cent of nitrogen excreted) but greater loss could also occur. Further research is needed in this area to improve the estimated losses and the conditions and practices under which such losses occur. Equation 10.28 should only be used where there is country-specific information on the fraction of nitrogen loss due to leaching and run-off from manure management systems available. Therefore, estimation of nitrogen losses from leaching and run-off from manure management should be considered part of a tier 2 or tier 3 method.

In other words, the 2006 IPCC Guidelines do not provide a tier 1 approach to estimate indirect N₂O emissions through leaching and run-off from manure management. Hence, if emissions are not estimated, as a reviewer, you must work with the Party to determine whether it would be a key category and therefore to be estimated. It is important to note that failure to report indirect N₂O emissions from leaching/run-off does not lead to an underestimate of N₂O emissions. However, as a reviewer, you may encourage the Party to report indirect N₂O emissions from nitrogen leaching from manure management applying equations 10.28 and 10.29 of the 2006 IPCC Guidelines (vol. 4, chap. 10), including reporting the underlying information in CRT 3.B(b) and in the NID.

4. Practical exercises

4.1. Practical exercise 1



Please open PDF file https://unfccc.int/resource/tet/ba/ba4-08_L4_EX1.pdf with information on manure management.

Using the information provided in the table, how would you assess the completeness of the inventory for manure management?

Select one:

- A. The reporting for manure management is complete because all sources for which methodologies and EFs exist are covered
- B. The reporting for manure management is not complete because emissions from mules and asses are not reported separately
- C. The reporting for manure management is not complete because emissions from rabbits are not estimated, although the methodology is provided in the 2006 IPCC Guidelines
- D. The reporting for manure management is not complete because emissions from rabbits and alpaca are not estimated
- E. The reporting for manure management is complete, with the condition that emissions from rabbits reported as "NE" are considered as insignificant and the NID provide justifications for the exclusion of these emissions in terms of their likely level
- F. B and C
- G. B and D

Tip

See tables 10.14–10.16, table 10.19 and table 10A-9 in chapter 10 of volume 4 of the 2006 IPCC Guidelines. See paragraph 32 of the MPGs for the definition of insignificant emissions.

4.2. Practical exercise 2

Using the data in CRT 3.B(b), for which animal species are there inconsistencies in the reporting of total nitrogen excreted?



Please open spreadsheet https://unfccc.int/resource/tet/ba/ba4-09_L4_EX2.xlsx to access CRT 3.B(b).

Select one:

- A. All animal species
- B. Dairy cattle, non-dairy cattle, sheep, horses, and mules and asses
- C. Sheep, horses, and mules and asses
- D. Sheep, and mules and asses
- E. None of the animal species

Tip

You may use the data from CRT 3B(b) to calculate the numbers for each of these animal species. Total nitrogen excreted for each animal species can be estimated by two methods:

- 1) As the product of the animal's population size and the value of Nex per head;
- 2) As the sum of total nitrogen excreted across all manure management systems for each animal species. These two values should match.

4.3. Practical exercise 3

In its 2026 submission, a Party reported that:

- A tier 3 method (based on direct measurements) was used to estimate country-specific EFs and report CH₄ emissions from anaerobic lagoons for the whole time series (i.e. 1990–2024);
- In 1990–2024, the share of anaerobic lagoons in manure management systems increased from 15 to 45 per cent;
- The direct measurements were performed only for 2007–2017 and covered only a few modern facilities.

During the review, the TERT noted that the country-specific EFs are among the lowest among reporting Parties and are lower than the IPCC default value (obtained for the national annual average temperature).

After reviewing this information, which statement best describes the possible assessment of the TERT?

Select one:

- A. The TERT noted that the country-specific EFs are among the lowest among reporting Parties and lower than the IPCC default value, and considers that the Party should provide detailed explanations on this difference in its next NID
- B. The TERT noted that country-specific EFs have been obtained only for 2007–2017 and are not representative for the whole time series. The TERT considers that the Party should apply tier 3 country-specific EFs only for 2017 and onward, while for 1990–2016, tier 2 calculations should be performed

- C. As the measurements have been performed for only a few modern facilities, the TERT considers that the country-specific EFs might not be representative of the older facilities. Hence, the TERT recommends that the Party obtain more evidence that measurements are representative for the whole time series and all anaerobic lagoons in the country and provide this information in its next NID
- D. As the measurements have been performed only for the modern facilities, the TERT considers that the country-specific EFs might not be representative of the older facilities. Hence, the TERT recommends that the Party perform tier 2 calculations for the whole time series and use the available direct measurements as a QA/QC procedure of emission estimates, or provide evidence that measurements are representative for the whole time series and all anaerobic lagoons in the country

Tip

See paragraph 26 of the MPGs and section 5.2.1, chapter 5, and section 6.7.1.2, chapter 6, of volume 1 of the 2006 IPCC Guidelines.

4.4. Practical exercise 4

This exercise is more complex than the first ones. You are invited to review the information reported by a Party in the NID of its 2025 GHG emission inventory submission on the manure management category and draft the text for the review report based on your findings.

As the review is likely to be your first experience of preparing an inventory review report for a Party, seven questions have been prepared to test your knowledge and provide useful hints to support your progress through the exercise. Take notes of your findings, as they will be inputs for the review report.

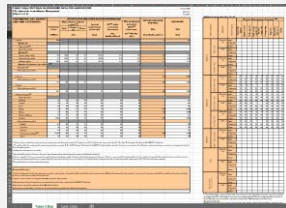
Please open a PDF file https://unfccc.int/resource/tet/ba/ba4-10_L4_EX4_NID.pdf of the NID



NID 2025



and a spreadsheet https://unfccc.int/resource/tet/ba/ba4-11_L4_EX4_CRT.xlsx of the CRTs



CRT 2025

You should first attempt to answer the questions before clicking the Tip button. Not doing so will only cause you to be less prepared for your final examination on this training course.

Practical exercise 4 – question 4.1

Review the information provided in section 5.3.1. and 5.3.1.1. of the NID and in CRT 3.B(a). Which statement best describes the possible assessment of the TERT regarding the consistency of the AD (i.e. performance parameters) used to calculate the emissions from the enteric fermentation (CH₄) and manure management (CH₄ and N₂O) categories?

Select one:

- A. The Party employed the same data set to estimate CH₄ emissions from enteric fermentation and manure management of cattle. The data on manure characteristics (i.e. B₀, urinary energy expressed as a fraction of gross energy and ash content of manure (percentage)) employed to estimate CH₄ emissions from manure management were transparently documented in the NID
- B. The Party employed the same data set to estimate CH₄ emissions from enteric fermentation and manure management of cattle. Nevertheless, the Party has not transparently detailed the information on manure characteristics employed to estimate CH₄ emissions from manure management; no references were provided to support the choice of the values used
- C. In its NID, the Party did not provide any information on the VS values applied in the estimates of CH₄ emissions from cattle manure management systems. Nevertheless, CRT 3.B.(a) reports the average VS values relevant for each cattle subcategory
- D. In its NID, the Party did not report any information on the VS applied in the estimates of CH₄ emissions from cattle manure management (i.e. by subcategory: dairy, mature non-dairy cattle and growing animals). Nevertheless, the Party clarified that equation 10.24 of the 2006 IPCC Guidelines were used to evaluate the VS values reflected in CRT 3.B.(a). However, the TERT noted that the VS values reported the same value for all cattle subcategories, that is, 6.5 kg dm/head/day
- E. B and D
- F. A and C

Tip

Section 10.4 of volume 4 of the 2006 IPCC Guidelines;
Paragraphs 21–23 and 39 of the MPGs.

Practical exercise 4 – question 4.2

Review the information provided in section 5.3.1.1, “Cattle manure management systems”, of the NID. Which statement best describes the TERT assessment on time-series consistency of the allocation data for manure management system usage and whether information on AD and EFs has been transparently reported in the NID?

Select one:

- A. In its NID, the Party provided the data on manure management systems established in the country to store and treat dairy cattle manure. In addition, the Party explained key drivers for the changes that occurred in management practices (i.e. the transition from tie-stall technology to loose technology with slatted floors) over the whole reporting period. Moreover, the Party provided references in the NID to support its use of data on manure management system allocation
- B. The Party used the constant data on manure management allocation by system type for non-dairy cattle for the entire reporting period. No references were provided in the NID to support the data
- C. In its NID, the Party provided information on manure management systems in the country to store and treat dairy cattle manure. In addition, the Party explained key drivers for the changes in management (i.e. the transition from tie-stall technology to loose technology with slatted floors) over the whole reporting period. However, the Party has not provided any reference to support the information provided in the NID
- D. In its NID, the Party transparently explained the rationale for the choice and use of MCFs to estimate CH₄ emissions from cattle manure management
- E. In its NID, the Party provided the information on MCFs used to estimate CH₄ emissions from cattle manure management; however, the rationale for the choice and use of MCFs has not been provided
- F. The data on the manure management systems used to store and treat animal waste produced by dairy and non-dairy cattle and MCFs relevant to each manure management system reported in the NID are consistent with those reported in CRT 3.B(a)
- G. The data on the manure management systems used to store and treat animal waste produced by dairy and non-dairy cattle and MCFs relevant to each manure management system reported in the NID is not consistent with those reported in CRT 3.B(a)
- H. B, C, E and F
- I. A, B, E and F
- J. B, C, D and F.

Tip

Table 10.17 in chapter 10 of volume 4 of the 2006 IPCC Guidelines;

Practical exercise 4 – question 4.3

Review the information provided in section 5.3.1.2 of the NID and CRT 3.B(a). Which statement best describes the TERT assessment regarding the choice and use of the method used by the Party to estimate CH₄ emissions from manure management of swine, sheep and other livestock categories?

Select one:

- A. The tier method applied to estimate CH₄ emissions from manure management practices implemented to store and treat animal waste generated by livestock categories (swine, sheep, goats, horses, fur-bearing animals, rabbits) is in line with the route provided in the decision tree for CH₄ emissions from manure management
- B. The Party provided the background information on a method employed to estimate CH₄ emissions from manure management practices of other livestock categories. The choice of AD and EFs was not supported by references
- C. A rationale for the choice of CH₄ EFs for all livestock categories is well documented in the Party's NID
- D. All the above
- E. None of the above

Tip

Paragraphs 21–23 and 30–31 of MPGs.

Chapter 10 (in particular, figure 10.3 and tables 10.14 –10.16) of volume 4 of the 2006 IPCC Guidelines;

Practical exercise 4 – question 4.4

Review the information provided in section 5.3.2.1 of the NID and CRT 3.B(b).

Which statement best describes the TERT assessment on the consistency of AD employed to estimate CH₄ and N₂O emissions from cattle manure management?

Select one:

- A. The data on manure management system allocation used to estimate N₂O emissions are consistent with those used to estimate CH₄ emissions from cattle manure management
- B. The data on manure management system allocation used to estimate N₂O emissions are not consistent with those used to estimate CH₄ emissions from cattle manure management

Tip

Section 10.5 of volume 4 of the 2006 IPCC Guidelines.

Practical exercise 4 – question 4.5

Carefully review the information provided in tables 5.11 and 5.12 and CRT 3.B(b).

Which statement best describes the TERT assessment on transparency of the information reported by the Party and on the accuracy of the estimates of the amount of nitrogen in manure produced by other livestock?

Select one:

- A. The Party reported the Nex rates employed to estimate N₂O emissions from manure management of other livestock categories and poultry in its NID. The references have been provided in footnote 6 to table 5.11
- B. The Party transparently reported the Nex rates employed to estimate N₂O emissions from manure management of other livestock categories and poultry. However, the Party has not provided any rationale for the choice of Nex rates for swine
- C. The background information used to derive the total amounts of nitrogen in manure, reported in table 5.12 of the NID, have been transparently described by the Party
- D. The background information used to derive the total amounts of nitrogen in manure, reported in table 5.12 of the NID, have not been transparently described by the Party
- E. A and C
- F. B and D
- G. A and D

Tip

Tables 10.19, 10.A-7 and 10.A-8 in chapter 10 of volume 4 of the 2006 IPCC Guidelines.

Practical exercise 4 – question 4.6

Review the information provided in section 5.3.2.3 of the NID.

Which statement best describes the TERT assessment on the appropriateness of N₂O EFs employed by the Party in its estimates of direct N₂O emissions from manure management?

Select one:

- A. The references that support the N₂O EF used in the estimations are provided in the NID. The rationale for the choice of the EFs is transparently documented in the NID
- B. The references that support the N₂O EF used in the estimations are provided in the NID. However, the Party has not provided any rationale for the choice of the EFs

Tip

Table 10.21 in chapter 10 of volume 4 of the 2006 IPCC Guidelines.

Practical exercise 4 – question 4.7

Review the information provided in section 5.3.3 of the NID.

What would be the conclusion based on your expertise?

Select one:

- A. The methodological choice is in line with the decision tree of the 2006 IPCC Guidelines (figure 10.4). The EFs and the fractions of managed manure nitrogen losses due to run-off, leaching and volatilization are transparently documented in the NID and supported by references
- B. The references that support the choice and use of EFs, and the fractions of managed manure nitrogen losses due to volatilization have not been reported in the NID. The Party has not provided any background information used to evaluate the country-specific value of nitrogen losses due to leaching from manure management systems
- C. The methodological choice is not in line with the relevant decision tree of the 2006 IPCC Guidelines (figure 10.4)
- D. B and C

Tip

Section 10.5 of volume 4 of the 2006 IPCC Guidelines.

Practical exercise 4 – question 4.8

In the box below, draft the text for the review report on CH₄ and N₂O emissions from the manure management category using the findings from questions 4.1 to 4.7.

Remember that you have to describe the problem identified, provide your assessment and give a clear recommendation or encouragement addressing the issue identified. Try to keep the text as short and concise as possible but ensure that there is no trade-off in transparency. Include in the review report only those findings that you consider to be major. Note that during a real review, you will also have to describe the response received from the Party before making any recommendation or encouragement.

You may draft your text here.

4.5. Answer key to practical exercises

Practical exercise 1

The correct answer is E.

The 2006 IPCC Guidelines (vol. 4. chap. 10, annex 10A.2, tables 10.14, 10.15, 10.16 and 10.19) provide the default EFs and Nex to estimate CH₄ and N₂O emissions from manure management systems of all categories listed in the NID table. For alpaca, there are no EFs provided in the 2006 IPCC Guidelines; therefore, these emissions may not be estimated (hence, option D is incorrect). As a reviewer, you may conclude that the reporting for manure management is complete even if emissions from alpacas are not estimated.

As you may have noted, the Party used the notation key "IE" for mules and asses. The use of "IE" is consistent with the MPGs and decision 5.CMA.3 (para. 27) which notes that "when information on emission factors, activity data and/or emissions by sources and removals by sinks of greenhouse gases are not available at the most disaggregated level, the notation key "IE" may be used to indicate the data are included elsewhere in the inventory instead of under the expected source or sink category"; therefore, there is no problem with completeness for reporting emissions from mules and asses together with horses (however, the accuracy of such estimates should be examined further) (option B is incorrect).

The Party used the notation key "NE" to report CH₄ and N₂O emissions from manure management of rabbits. Reporting of emissions from rabbits as "NE" could be in line with the MPGs, if these emissions are considered insignificant in accordance with the conditions set out in paragraph 32 of MPGs (option C is incorrect). As a reviewer, please note that those developing country Parties that need flexibility in the light of their capacities have flexibility with respect to this provision.

Practical exercise 2

The correct answer is C.

Total nitrogen excreted for each animal species can be estimated by two methods:

- 1) As the product of the animal's population size and the value of Nex per head;
- 2) As the sum of total nitrogen excreted across all manure management systems for each animal species. These two values should match.

The differences of total nitrogen excretion values for dairy cattle and buffalo when summed across the manure management systems are 0.004 and 0.02 per cent, respectively, higher than the product resulting from multiplying population by Nex per head. Such differences are not a consistency problem of data reported; rather, they are just due to rounding off of numbers.

The differences of total Nex values for non-dairy cattle and swine when summed across the manure management systems are 0.0006 and 0.0001 per cent, respectively, lower than the product of the population and the Nex per head. This is due to rounding off of numbers.

There are no differences in the values of Nex for goats, poultry and rabbits.

The difference of total Nex values for sheep when summed across the manure management system is 17.8 per cent lower than the population multiplied by the Nex per head. This is a potential case of inconsistency.

The difference of total Nex values for horses when summed across the manure management system is 10.2 per cent higher than the population multiplied by the Nex per head. This is a potential case of inconsistency.

The difference of total Nex values for mules and asses when summed across the manure management system is 64.5 per cent higher than the population multiplied by the Nex per head. This is a potential case of inconsistency.



Please open XLS file https://unfccc.int/resource/tet/ba/ba4-12_L4_EX2_key.xlsx to cross-check your calculations.

Practical exercise 3

The correct answer is D.

In its NID, the Party reported that tier 3 direct measurements were used to estimate country-specific EFs and report CH₄ emissions from anaerobic lagoons for the whole time series. It also reported that the measurements have been conducted on only a few modern facilities, which raises a question about the representativeness of country-specific EFs to all anaerobic lagoons in the country and to all years.

Paragraph 26 of the MPGs, states that “to ensure time-series consistency, each Party should use the same methods and a consistent approach to underlying activity data and emission factors for each reported year.” Option B is incorrect because it recommends that the Party apply tier 3 country-specific EFs only from 2017 onward, and tier 2 for 1990–2016.

However, the utilization of the updated (i.e. the results of direct measurements on a few modern facilities in 2007–2017) and disaggregated data could trigger a methodological refinement for this category. The 2006 IPCC Guidelines (vol. 1, chap. 5, p.5.5) explicitly clarifies that “a *methodological refinement* occurs when an inventory compiler uses the same tier to estimate emissions but applies it using a different data source or a different level of aggregation. An example of a refinement would be if new data permit further disaggregation of a livestock enteric fermentation model, so that resulting animal categories are more homogenous or applies a more accurate emission factor. In this case, the estimate is still being developed using a Tier 2 method, but it is applied at a more detailed level of disaggregation. Another possibility is that data of a similar level of aggregation but higher quality data could be introduced, due to improved data collection methods.” In other words, as the measurements are representative only for a few modern farms, the Party should split farms into modern and old facilities and apply country-specific EFs to only part of them, consistently for all years. Moreover, as a reviewer, you must give the Party the opportunity to provide detailed information on the representativeness of country-specific EFs to all years and all anaerobic lagoons in the country. In this case, the Party could reflect and capture the historical changeover or modification of the manure management systems in the time series of emissions.

Option A suggests that the Party provide detailed explanations on the differences between the country-specific EFs used in its calculations and the default IPCC EFs and those used by other Parties, as if this would be sufficient to consider the issue resolved. As a reviewer you should understand that providing this information would not solve the inconsistency issue. Note that section 6.7.1.2 in chapter 6 of volume 1 of the 2006 IPCC Guidelines states that country-specific factors should be compared “with relevant IPCC default emission factors, taking into consideration the characteristics and properties on which the default factors are based...Large differences between country-specific factors

and default factors do not necessarily indicate problems, but nevertheless may point to quality issues if the differences can not be explained.” In addition, the 2006 IPCC Guidelines stipulate in the same section that between-country emission factor comparisons should be performed. “This type of comparison may enable outlier detection based on the statistical distribution of values from the sample of countries considered. When using between-country emission factor comparisons as a QC check, it is important to investigate similarities and differences in national circumstances for the relevant category. If source/sink category characteristics are dissimilar between countries, this diminishes the effectiveness of this check.”

Options B and C provide only a partial solution to the finding identified by the TERT.

Practical exercise 4 question 4.1

The correct answer is E.

In its NID, the Party clarified that the gross energy intake values were estimated and reported under the enteric fermentation section. It also confirmed that the gross energy intake values calculated within the enteric fermentation category were used to estimate CH₄ emissions from manure management of dairy cattle and non-dairy cattle for the whole reporting period. Hence, the Party ensured the consistency in the AD on performance parameters across two categories (i.e. CH₄ emissions from enteric fermentation and CH₄ emissions from manure management).

In its NID, the Party provided the information on B₀ values employed in the estimates and presented the reference sources for these data. However, the calculation steps of equation 10.24 require the utilization of the data on urinary energy expressed as a fraction of gross energy and ash content of manure (percentage). Nevertheless, the Party has not clarified which values were applied in the estimates and has not provided any reference sources (option B).

CRT 3.B(a) includes the information on cattle weight for each subcategory (i.e. dairy, mature non-dairy cattle, and growing animals) and the relevant B₀ values. However, in CRT 3(a), the Party reported the same VS value (i.e. 6.5 kg dm/head/day) for all cattle subcategories (option D). Hence, as a reviewer, you may preliminarily consider that if the VS values reported by the Party in its CRT 3(a) have been applied in the estimations, then CH₄ emissions from manure management systems of mature non-dairy cattle and growing cattle animals might be overestimated. However, the Party might have made a typographical error in copying the VS values from calculation files and pasting them to CRT 3(a).

Therefore, as a reviewer, you must communicate with the Party and work out the nature of the error. You should then draft a recommendation on this finding based on the response received from the Party.

Practical exercise 4 question 4.2

The correct answer is H.

In its NID, the Party provided the data on manure management systems in the country to store and treat animal waste generated by dairy and non-dairy cattle. However, it has not provided any reference to explain how the data were obtained (e.g. how many farms were covered by analysis or survey, the data of which years were investigated, etc.) (options B and C).

Table 10.17 in the 2006 IPCC Guidelines (vol. 4) classifies the liquid/slurry manure management system as two subsystems, with natural crust cover and without natural crust cover, and provides an MCF relevant for each subsystem. However, as you noted, the Party applied the MCF that is appropriate for liquid/slurry systems with natural crust cover, but has not provide any rationale for its decision in its NID (option E). Hence, as a reviewer, you must further clarify this finding and ask the Party to provide evidence that the liquid/slurry management system without natural crust cover does not exist in the country.

As a reviewer, to assess the consistency of the information provided in CRT 3.B(a) and the NID you must cross-check the data on manure management practices described in table 5.5 of the NID with those reported in CRT 3.B(a) (under additional information for tier 2). As you might have noted, the Party reported the data across two sources (i.e. the NID and the CRT) in a consistent manner (option F).

Practical exercise 4 question 4.3

The correct answer is E.

Figure 10.3 in the 2006 IPCC Guidelines (vol. 4, chap. 10) indicates that a tier 2 should be used if CH₄ emissions from manure management is a key category and for species that contribute a significant share to CH₄ emissions within this category (footnote 2 states “as a rule of thumb, a livestock species would be significant if it accounts for 25-30% or more of emissions from the source category”).

Table 5.1 of the Party’s NID illustrates that CH₄ emissions from manure management from swine contributed about 42 per cent to the total CH₄ emissions. However, the Party indicated that a tier 1 approach and the IPCC default EFs were used to estimate CH₄ emissions from swine manure management without explaining why it did not use the recommended method in accordance with the decision trees in the 2006 IPCC Guidelines. For other livestock categories (i.e. sheep, goats, horses, fur-bearing animals, rabbits) the use of the tier 1 method to estimate CH₄ emissions from manure management is in line with the 2006 IPCC Guidelines. Hence, you may conclude that option A is partially incorrect.

The allocation data for manure management systems established in the country to store and treat animal waste generated by swine, sheep and other livestock are reported in table 5.7 of the NID. The Party clarified that the data were used to estimate direct and indirect N₂O emissions from manure management. However, the Party did not provide any references for the data recorded in table 5.7. In addition, no explanation has been provided in the NID on the approach employed to derive the data.

The Party transparently reported the EFs used to calculate CH₄ emissions from poultry manure management for the whole time series. However, the Party reported aggregated annual average poultry population numbers in its NID (table 5.2), which makes it impossible to replicate the calculations and assess the accuracy of the estimates (option B is incorrect).

In footnote 5 to table 5.7, the Party indicated that it applied the IPCC default EF of 3 kg CH₄/head/year. This corresponds to market swine of Eastern Europe with an average annual temperature of less than 10 °C (2006 IPCC Guidelines, vol. 4, table 10A-7). However, the Party has not clarified whether and how it adjusted the share of breeding swine in the total swine population. As a reviewer, you may preliminarily conclude that this may lead to an underestimation of CH₄ emissions from swine manure management as the IPCC default EF that is representative for breeding swine of Eastern Europe is 4 kg CH₄/head/year (option C is incorrect).

Practical exercise 4 question 4.4

The correct answer is (B).

In its estimates of CH₄ emissions and direct N₂O emissions from cattle manure management, the Party has not ensured consistency in manure management system allocation data. A cross-check might have been made using the data reported in CRT 3.B(a) and CRT 3.B(b) and in the NID (table 5.5) by dividing the amount of nitrogen handled per each manure management system by the total nitrogen excreted:

- Mature dairy cattle:
 - Liquid system: $2,590,225/10,753,806 = 24$ per cent;
 - Solid storage: $3,577,304/10,753,806 = 33.3$ per cent;
 - Pasture, range and paddock: $4,586,277/10,753,806 = 42.6$ per cent.

As you might have noted, the calculated shares (expressed in percentage) of nitrogen stored in the liquid and solid manure management systems and dropped during animal grazing are not consistent with those reported for 2023 in table 5.5 and CRT 3.B(a): 24 per cent, 36 per cent, and 40 per cent, respectively (option B).

Hence, as a reviewer, you must communicate with the Party to clarify the inconsistencies identified.

The data on percentage allocation for other mature cattle and growing cattle reported in the NID (p.4) are consistent with those calculated by you:

- Other mature cattle:
 - Solid storage: $422,733/845,465 = 50$ per cent;
 - Pasture, range and paddock: $422,733/845,465 = 50$ per cent;
- Growing cattle:
 - Solid storage: $1,954,057/3,489,388 = 56$ per cent;
 - Pasture, range and paddock: $1,535,331/3,489,388 = 44$ per cent.

Practical exercise 4 question 4.5

The correct answer is F.

Table 10.19 in chapter 10 of volume 4 of the 2006 IPCC Guidelines provides two Nex rates to be used by countries, namely for market and breeding swine:

- 10.0 kg N/head/day for market swine;
- 32.2 kg N/head/day for breeding swine of Eastern Europe (calculated based on the information reported in tables 10.19, 10.A-7 and 10.A-8).

However, in table 5.11 of the NID, the Party stated that a Nex rate of 10 kg N/head/day (corresponding to market swine) was applied to calculate the amount of nitrogen in manure generated by swine over the whole reporting period. It is not clear in the NID whether and how the Party has accounted for a share of breeding swine in the total swine population for the whole time series (option B).

Moreover, in table 5.11 of the NID, the Party reported Nex rates for each species of poultry and fur-bearing animals. However, table 5.2 provides aggregated data on population numbers of poultry and fur-bearing animals,, which makes it impossible to replicate the calculations and assess the accuracy of the estimates reported in table 5.12 of the NID (option D).

Practical exercise 4 question 4.6

The correct answer is B.

Table 10.21 in chapter 10 of volume 4 of the of the 2006 IPCC Guidelines classify the liquid/slurry manure management systems into two subsystems and provides an N₂O EF (EF₃) relevant for each subsystem:

- With natural crust cover: EF₃ of 0.005 kg N₂O-N/kg Nitrogen excreted;
- Without natural crust cover: EF₃ of 0 kg N₂O-N/kg Nitrogen excreted.

However, as you might have noted, the Party applied the EF₃ of 0, which is appropriate for the liquid/slurry system with natural crust cover, not for the liquid system without natural cover as reported in table 5.13 of the NID. Moreover, no information on the rationale for choosing this factor has been documented in the NID (option B). Hence, as a reviewer, you must further clarify this finding with the Party.

Practical exercise 4 question 4.7

The correct answer is D.

The Party has not followed the methodological route described in the decision tree of the 2006 IPCC Guidelines (figure 10.4). The NID (section 5.3.3) states that indirect N₂O emissions from manure management have been identified as a key category by level and trend.

The Party applied a tier 1 approach to estimate indirect N₂O emissions through volatilization of nitrogen from manure management (contributing 94 per cent of the total indirect N₂O emissions from manure management in 2023) and a tier 2 approach to estimate indirect N₂O emissions due to losses of nitrogen through leaching and run-off (option C).

In general, all fractions and EFs that have been applied in the estimates of indirect N₂O emissions from manure management systems are supported by references and transparently documented in the NID. Furthermore, the Party used the country-specific value of N losses due to leaching from manure management systems (Fra_{CLeachMS}), which corresponds to the typical range of 1–20 per cent provided by the 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.56). However, the Party has not provided any background information to explain how this fraction has been derived (option B).

As a reviewer, you must ask the Party for additional information to be provided and to clarify how the value has been evaluated; for example, how many manure storage facilities were covered by the study carried out by the Party, whether measurements were performed on modern facilities or older ones and what the proportion was of modern to older facilities. Thus, based on responses provided by the Party, you may conclude whether or not the country-specific Fra_{CLeachMS} used for the entire reporting period is representative for the whole time series.

Practical exercise 4 question 4.8

Exemplary response

The TERT noted that the Party has not provided any information on urinary energy expressed as a fraction of gross energy (GE) and manure ash content values (percentage) used to evaluate the VS for each cattle subcategory (i.e. dairy cattle, mature non-dairy cattle and growing animals). Moreover, the TERT noted that in its CRT 3.B(a) the Party reported the same VS value (i.e. 6.5 kg dm/head/day) for all cattle subcategories. The TERT considers that the use of the constant VS value at 6.5 kg dm/head/day to estimate CH₄ emissions from manure storage produced by other cattle subcategories may lead to an overestimation of emissions, as the gross energy intake values of mature non-dairy cattle and growing animals presented in table 5.3 of the NID are significantly lower than those calculated for dairy cattle.

The TERT recommends that the Party revise its CH₄ emissions from manure management by using appropriate VS values for mature non-dairy cattle and growing bovine animals. The TERT also recommends that the Party provide background information (i.e. urinary energy expressed as a fraction of gross energy and manure ash content (percentage)) used to evaluate the VS for each cattle subcategory (i.e. dairy cattle, mature non-dairy cattle and growing animals) in the NID. In addition, the TERT believes that future TERTs should consider this issue further to ensure that appropriate VS values for mature non-dairy cattle and growing bovine animals are applied and there is no overestimation of CH₄ emissions from manure management of non-dairy cattle and growing animals.

In its NID, the Party reported the information on management practices established to store and treat dairy cattle manure. In addition, the Party reported that important changes occurred in its manure treatment practices, such as the transition from tie-stall technology to loose technology with slatted floors. However, the TERT noted that the Party had not provided any references to support the information reported on management practices such as the number of farms or the time period covered. The TERT recommends that the Party provide reference sources and explain how the data on manure management practices were obtained over the reporting period (e.g. how many farms were covered by analysis or survey, the data of which years investigated).

The TERT noted that the Party applied an MCF appropriate for liquid/slurry systems with natural crust cover but did not provide any rationale to support the choice of MCF used or any information to justify its assertion that the manure management practice for liquid/slurry systems without natural crust cover does not exist in the country.

The TERT recommends that the Party justify its assertion that manure management practice for liquid/slurry systems without natural crust cover does not exist in the country and revise its estimates accordingly.

The Party estimated CH₄ emissions from manure management of swine using a tier 1 methodology and the default EFs. However, the TERT concludes that this is not in accordance with the 2006 IPCC Guidelines, as the CH₄ emissions from manure management have been identified as a key category, with the emissions from swine being the most significant contributor within the category (e.g. 42 per cent for 2023).

The TERT recommends that the Party estimate CH₄ emissions from manure management of swine using a tier 2 methodology, including country-specific EFs or, if unable to adopt a tier 2 method, clearly

document in the NID why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines.

In its NID (table 5.7), the Party indicated that a CH₄ EF at a value of 3 kg CH₄/head/year was applied to estimate CH₄ emissions from swine manure management practices. In footnote 5 to table 5.7, the Party clarified that the value was taken from table 10A-7 in chapter 10 of volume 4 of the 2006 IPCC Guidelines. However, the TERT noted that the CH₄ EF value is representative only for the market swine of Eastern Europe. The TERT also noted that the Party had not specified whether the population of breeding swine were considered in the estimates of CH₄ emissions reported in the current inventory submission.

The TERT recommends that the Party revise the estimates of CH₄ emissions from swine manure management by taking into consideration the emissions from breeding swine manure management and provide the information on the share of breeding swine of the total swine population for the entire time series.

The TERT noted that the Party's data on the allocation of dairy cattle manure management used to estimate CH₄ emissions (reported in table 5.5 of the NID and CRT 3.B(a)) in 2023 are not consistent with those used to calculate N₂O emissions from manure management systems for the same livestock category, which were calculated as the amount of nitrogen produced by dairy cattle and handled per each manure management system divided by total nitrogen excreted by dairy cattle (information reported in CRT 3.B(b)). The TERT considers that the approach employed by the Party is not consistent with the 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.61), which states that "the manure management system usage data used to estimate N₂O emissions from manure management should be the same as those that are used to estimate CH₄ emissions from manure management."

The TERT recommends that the Party justify the approach employed to estimate CH₄ and N₂O emissions from manure management of dairy cattle or ensure consistency in the data on the allocation of dairy cattle manure management systems and apply the same data set on dairy cattle manure management system usage to estimate CH₄ and N₂O emissions in accordance with the 2006 IPCC Guidelines.

Please note that since this is an educational exercise, you were not able to communicate with the Party and further clarify this finding, as sometimes it might happen that a Party mistakenly reported the data on the allocation of manure management systems in the NID/or CRT 3.B(a)) rather than applying the different data sets on the distribution of dairy cattle manure management to estimate CH₄ and N₂O emissions. The information provided by the Party in response to your further clarification questions would help you to determine the nature of the issue (i.e. accuracy or transparency) and the consequent recommendation. However, as you might have noted, the Party used inconsistent data sets on the allocation of manure management systems to estimate CH₄ and N₂O emissions from manure management.

In its NIR (table 5.11), the Party indicated that a Nex value of 10.0 kg N/head/day was applied to estimate N₂O emissions from swine manure management system. In footnote 6 to table 5.11, the Party clarified that the value had been obtained from tables 10.19 and 10A-7 in chapter 10 of volume 4 of the 2006 IPCC Guidelines. However, the TERT noted that the Nex is representative only for the market swine of Eastern Europe. The TERT also noted that the Party had not specified whether the population of breeding swine were considered in the estimates of N₂O emissions reported in the current inventory submission.

The TERT recommends that the Party revise the estimates of N₂O emissions from swine manure management by taking into consideration the emissions from breeding swine manure management and provide the information on the share of breeding swine of the total swine population for the entire time series.

The ERT noted that the Party used the N₂O EF (EF₃) appropriate for liquid/slurry systems with natural crust cover to estimate N₂O emissions from swine manure management. Furthermore, the TERT noted that the Party had not provided any information to justify its assertion that the manure management practice for liquid/slurry systems without natural crust cover does not exist in the country.

The TERT recommends that the Party justify its assertion that manure management practice for liquid/slurry systems without natural crust cover exists in the country and revise its estimates accordingly.

Indirect N₂O emissions from manure management have been identified as a key category. However, the Party used an IPCC tier 1 methodology to estimate indirect N₂O emissions through nitrogen volatilization from manure management without providing any information in its NID explaining why it was unable to adopt a higher-tier method.

The TERT recommends that the Party estimate indirect N₂O emissions from manure management using a tier 2 methodology, including country-specific data on the percentage of managed manure nitrogen that volatilizes as NH₃ and NO_x in the manure management system or, if unable to adopt a tier 2 method, clearly document in the NID why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines. Moreover, the TERT encourages the Party to incorporate the newly available research from the 2019 EMEP/EEA air pollutant emission inventory guidebook.

The Party used a tier 2 approach and country-specific data on Fra_{CLeachMS} (i.e., percent of managed manure nitrogen losses due to run-off and leaching during solid and liquid manure storage). However, the TERT noted that the Party had not provided any background information specifying how the value had been obtained.

The TERT recommends the Party provide information in the NID indicating how the country-specific Fra_{CLeachMS} value was obtained; for example, how many manure storage facilities were covered by the study carried out by the Party, whether measurements were performed on modern facilities or older ones, and what the proportion was of modern to older facilities.

5. Self-check quiz

Question 1

A Party uses a tier 2 method to estimate CH₄ emissions from manure management of cattle.

As a reviewer, you must ensure that the Party applied the same performance parameters to derivate VS rates of cattle and CH₄ enteric fermentation EFs for cattle.

Select one:

- A. True
- B. False

Question 2

The manure management system usage data used to estimate N₂O emissions from manure management should be the same as those used to estimate CH₄ emissions from manure management.

Select one:

- A. True
- B. False

Question 3

CH₄ emissions and N₂O emissions from manure dropped during grazing of animals must be reported under the agricultural soils category.

Select one:

- A. True
- B. False

Question 4

The amount of bedding materials (straw, sawdust, chippings, etc.) should be included in the amount of VS modelled under a tier 2 method to estimate CH₄ emissions from manure management systems.

Select one:

- A. True
- B. False

Question 5

Read through the description of the finding recorded by the TERT in a review report and classify it into one of the TACCC principles:

“A Party reported in CRT 3.B(b) IEFs per animal for N₂O emissions from manure management. The increase in the N₂O IEF for swine between 1990 and 2022 is significant: the 2018 value (0.0787 kg N₂O/head/year) is 220.5 per cent higher than the 1990 value (0.0246 kg N₂O/head/year).

During the review, the Party clarified that the increase could be attributable to the intensification of the swine industry, and it noted that there has also been a change in the allocation of N to MMS, with a downward trend in the use of anaerobic lagoons.

The TERT recommends that the Party provide an explanation in the NID for the trend in the N₂O IEF from manure management of swine.”

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness

Question 6

Read through the description of the finding recorded by the TERT in a review report and classify it into one of the TACCC principles:

“A Party reported in its NID a $F_{\text{raCLEACH-MS}}$ of 0.24 kt N/kt N applied for N leaching from solid storage manure management system, referring to the 2019 IPCC Refinement to the 2006 IPCC Guidelines. However, the TERT noted that the values for $F_{\text{raCLEACH-MS}}$ provided in table 10.22 of the 2019 IPCC Refinement (chapter 10, volume 4) are much lower (e.g., 0.02 for solid storage for all livestock types). The TERT considers that an overestimation of N losses from manure management may lead to an underestimation of total N₂O emissions since, according to equation 3DA.3 in the NID, less manure N would be transferred to agricultural soils and accounted for under category 3.D.a.2.a (animal manure applied to soils).

During the review, the Party clarified that it had applied the $F_{\text{raCLEACH-MS}}$ in annex 10B.7 of the 2019 IPCC Refinement and that it was not aware of the more specific default values in table 10.22 of the 2019 IPCC Refinement. The Party estimated that, by using a lower value of 0.02 (from table 10.22 of the 2019 IPCC Refinement) for leaching from solid manure storage, overall estimated N₂O emissions from the agriculture sector would increase by approximately 2 kt CO₂ eq.

The TERT recommends that the Party revise the estimation of N losses from manure management by updating $F_{\text{raCLEACH-MS}}$ to an appropriately justified value within the range provided in the 2006 IPCC Guidelines (equation 10.28, chapter 10, volume 4) (i.e., 0.01-0.20), or provide a justification for using a specific value in the calculation model.”

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness

Question 7

Read through the description of the finding recorded by the TERT in a review report and classify it into one of the TACCC principles:

“In CRT 3.B(a)s2 on emissions from manure management for volatile solids for feedlot cattle (temperate climate), swine (cool and temperate climate) and poultry (cool and temperate climate), the total shares allocated across the manure management systems exceed 100 per cent.

During the review, the Party informed the TERT that the value exceeding 100 per cent reflects the fact that manure from intensive livestock industries may pass through multiple treatment stages. The same manure is therefore allocated to multiple categories of manure management systems in such cases. For example, 100 per cent of volatile solids will first pass through a primary system (feedpad – dry lot) before passing through secondary treatment (composting, solid storage or direct application) and tertiary treatment (effluent pond).

The TERT recommends that the Party explain in the NID why the total shares allocated across all manure management systems exceed 100 per cent.”

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness

Question 8

Assume that as a reviewer, you noted that several changes were introduced for the first time in the 2024 inventory submission for the agriculture sector, including: the new country-specific EF for enteric fermentation; the use of a mass flow approach for manure management; new EFs for inorganic fertilizers based on the analysis of measurement data from the Nitrous Oxide Research Program; and the new stratification of savannah into three broad vegetation zones. The Party has listed all of these changes in the NID and has made the necessary recalculations, but no information is provided on the qualitative impact of each individual change in the overall recalculations.

As a reviewer, would you:

- A. Conclude that the reporting of the Party is in line with the MPGs and not raise the finding as an issue
- B. Conclude that the reporting of the Party is not in line with the MPGs and raise the finding as an issue

Question 9

Assume that during the review week, a developing country Party clarified that the total CH₄ emissions from manure management of other livestock categories (i.e. sheep, goats, horses, mules and asses) does not include CH₄ emissions from pasture, range and paddock for the entire reporting period. However, the Party reported in CRT 3.B(a)s1 that the manure of these livestock categories is handled in pasture management practices.

As a reviewer, you concluded that this reporting is not in line with the 2006 IPCC Guidelines (vol. 4), specifically equations 10.22 and 10.23 for estimating CH₄ emissions from manure management (including pasture, range and paddock).

During the review, the Party clarified that CH₄ emissions from pasture, range and paddock of other livestock categories amounted to 20.3 kt CH₄ in 2023 (507.5 kt CO₂ eq), which is about 0.06 per cent of the national total CO₂ eq emissions for 2023 without LULUCF.

As a reviewer, what would you conclude?

- A. That the emissions from the category are insignificant and there is no need to raise the finding as an issue
- B. That the emissions from the category are significant and the finding should be raised as an issue

Question 10

Assume that a Party did not estimate CH₄ emissions from ostrich manure management in CRT 3.B(a). In response to a question raised by the TERT during the review week, the Party indicated that according to data collected, the ostrich population was 5,246 in 2015, 5,568 in 2018 and 3,159 in 2021.

As a reviewer, you must recommend that the Party submit the calculations under the appropriate emission category. Select one:

- A. CH₄ emissions from enteric fermentation of ostrich
- B. CH₄ emissions from ostrich manure management
- C. N₂O emissions from ostrich manure management
- D. A and B
- E. B and C
- F. A, B and C

Question 11

Assume that in its submission, a Party used the default Nex for all animal categories from the Revised 1996 IPCC Guidelines.

During the review, the Party acknowledged the situation and provided information that the updated estimates would be included in the next submission thanks to new information collected allowing the Party to use the methodology from the 2006 IPCC Guidelines.

As a reviewer, would you:

- A. Recommend that the Party update its Nex according to the newest knowledge in the Party. This can be done, preferably, by using either equations 10.30 to 10.32 in the 2006 IPCC Guidelines, where national data on crude protein content in the feed are used, or the methodology in the EMEP/EEA air pollutant emission inventory guidebook provided that coordination with the Convention on Long-Range Transboundary Air Pollution reporting is taking place
- B. Encourage the Party to update its Nex according to the newest knowledge in the Party. This can be done, preferably, by using either equations 10.30 to 10.32 in the 2006 IPCC Guidelines, where national data on crude protein content in the feed are used, or the methodology in the EMEP/EEA air pollutant emission inventory guidebook provided that coordination with the Convention on Long-Range Transboundary Air Pollution reporting is taking place

5.1. Answer key to self-check quiz

Question 1

The correct answer is A.

The 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.51) state that, if using the tier 2 method, derivation of VS rates should be compared with background assumptions used for the enteric fermentation tier 2 inventory where applicable. For example, the gross energy and digestible energy components used in the enteric fermentation inventory can be used to cross-check independently derived VS rates.

Question 2

The correct answer is A.

The 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.61) state that the manure management system usage data used to estimate N₂O emissions from manure management should be the same as those used to estimate CH₄ emissions. The portion of manure managed in each manure management system must be collected for each representative livestock category.

Question 3

The correct answer is B.

CH₄ emissions from manure dropped during grazing (i.e. pasture/range and paddock manure management systems) must be reported under the manure management category (CRT 3.B(a)). However, N₂O emissions from pasture/range and paddock system are to be reported under the agricultural soils category (CRT 3.D).

Question 4

The correct answer is B.

Bedding materials (straw, sawdust, chippings, etc.) are not included in the modelling of VS under the tier 2 method. The type and use of these materials is highly variable from country to country. Since they are typically associated with solid storage systems, their contribution would not add significantly to overall CH₄ production (2006 IPCC Guidelines, vol. 4, chap. 10, p.10.41).

Question 5

The correct answer is A.

The TERT observed a significant increase in the IEFs per animal for N₂O emissions from manure management over 1990–2022 and noted that the Party had not included any information to explain the trend and specify the driving forces behind it.

In its response, the Party assured the TERT that the estimates do not incur any underestimation or overestimation of N₂O emissions from swine manure management. The TERT was satisfied with this response but concluded that the finding must be classified as a transparency issue.

Question 6

The correct answer is B.

Paragraph 20 of the MPGs states that each Party must use the 2006 IPCC Guidelines and any subsequent version or refinement of the 2006 IPCC Guidelines agreed upon by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement. Paragraph 28 of decision 5/CMA.3 notes that Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines. Hence, if a Party applies any EF or any other parameter from the 2019 Refinement to the 2006 IPCC Guidelines, it should provide justification for this action.

However, the issue must be defined as an accuracy issue. As the use of unjustified $F_{\text{raCLEACH-MS}}$ impacted the final value of N_2O emissions, that is, it led to an overestimation of nitrogen losses from manure management and, consequently, an underestimation of total N_2O emissions. Moreover, you might have noted that the TERT recommended that the Party revise the estimation of nitrogen losses from manure management by updating the $F_{\text{raCLEACH-MS}}$ to an appropriately justified value within the range provided in the 2006 IPCC Guidelines, as the latest are considered to be a mandatory requirement (“shall”).

Question 7

The correct answer is A.

The 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.61) states that in some cases, manure may be managed in several types of manure management systems. For example, manure flushed from a dairy free-stall barn to an anaerobic lagoon may first pass through a solid separation unit where some of the manure solids are removed and managed as a solid. Therefore, it is important to carefully consider the fraction of manure that is managed in each type of system.

The 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.5.6) also clarify that it is good practice to document and archive all information required to produce the national emissions inventory estimates as outlined in chapter 6 of volume 1. When country-specific data (e.g. EFs, manure management practices and manure characteristics such as VS and B_0) have been used, the derivation of or references for these data should be clearly documented and reported along with the inventory results under the appropriate IPCC source category. To improve transparency, the emission estimates from this source category should be reported along with the AD and EFs used to determine the estimates.

In its CRT 3.B(a)s2, the Party reported the data on shares allocated across the manure management systems; however, it has not provided any information to clarify why the shares allocated across the manure management systems exceed 100 per cent.

Question 8

The correct answer is B.

Please see paragraphs 26–28 and 43 of the MPGs.

As you noted, the Party has not met the requirements established in paragraph 43 of the MPGs, which indicate that each Party must report recalculations together with explanatory information and justifications for recalculations with an indication of relevant changes and their impact on the emission trends.

Question 9

The correct answer is A.

Paragraph 32 of the MPGs indicates the following: “Those **developing** country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead consider emissions insignificant if the likely level of emissions is below **0.1** per cent of the national total GHG emissions, excluding LULUCF, or **1,000** kt CO₂eq, whichever is lower. The total national aggregate of estimated emissions for all gases from categories considered insignificant, in this case, shall remain below 0.2 per cent of the national total GHG emissions, excluding LULUCF.”

Question 10

The correct answer is B.

The 2006 IPCC Guidelines only provide the default manure management CH₄ EFs for ostrich (vol. 4, chap. 10, table 10A-9). Therefore, as a reviewer, you should recommend that the Party conduct and report CH₄ emission estimates from manure management from ostrich, or use notation key “NE” and provide justification that CH₄ emissions from ostrich manure management are lower than the likely level of significance (MPGs, para. 32).

As the 2006 IPCC Guidelines do not provide default factors (i.e. enteric fermentation EF and Nex rate for ostrich) to estimate CH₄ and N₂O emissions from ostrich enteric fermentation, the Party may choose not to conduct the estimates.

Question 11

The correct answer is A.

Paragraph 20 of the MPGs stipulates that each Party must use the 2006 IPCC Guidelines and any subsequent version or refinement of the 2006 IPCC Guidelines agreed upon by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement.

Parties must use the latest available IPCC guidelines agreed upon by the Conference of the Parties (i.e. the 2006 IPCC Guidelines). However, in the latest submissions, most (developed) Parties have used the methodologies described in the EMEP/EEA air pollutant emission inventory guidebook (elaborated to estimate CO, NO_x, NH₃, NMVOCs and SO₂ emissions) to evaluate indirect nitrogen emissions from agricultural activities, as the Parties have been proceeding to harmonize both the inventory on GHG emissions and the inventory on air pollutants. Hence, using the data on crude protein content in the feed or applying the methodology in the EMEP/EEA guidebook has been proposed as one of the solutions to derive the country-specific information on Nex rates for animal categories. Nevertheless, the TERT has established one prerequisite for use of the guidebook, namely, Ensuring consistency with reporting under the Convention on Long-Range Transboundary Air Pollution.

6. Key points to remember

- The reporting of emissions under the manure management category includes:
 - a. CH₄ emissions from manure stored and treated in manure management systems and manure dropped at grazing (i.e. pasture/range and paddock);
 - b. Direct and indirect N₂O emissions from manure management systems.
- The manure management category closely links with other categories of the GHG emission inventory, namely, the enteric fermentation and the agricultural soils categories and categories of the energy and waste sectors.
- Chapters 10.4 and 10.5 of the 2006 IPCC Guidelines provide the methodologies and the default EFs to be applied to estimate CH₄ and direct and indirect N₂O emissions from manure management.
- Paragraph 28 of decision 5/CMA.3 notes that Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines.
- Annex I to decision 5/CMA.3 provides the template of CRTs for the electronic reporting of the information in the national inventory reports of anthropogenic GHG emissions by sources and removals by sinks:
 - CRT 3.B(a) contains the data on CH₄ emissions from the manure management practices established in a country and the background information employed to estimate the emissions;
 - CRT 3.B(b) contains the data on direct and indirect N₂O emissions from the manure management practices established in a country and the background information employed to estimate the emissions;
 - N₂O emissions generated by manure in the system pasture, range and paddock occur directly and indirectly from the soil and are therefore reported under the category N₂O emissions from managed soils (CRT 3.D).
- Annex V to decision 5/CMA.3 outlines the NID, pursuant to the MPGs:
 - Chapter 5 of the NID includes the information on methods, AD, EFs, parameters and GHG emissions for the categories of the agriculture sector;
- As a reviewer, you must assess whether a Party ensured consistency:
 - a. In the AD on livestock population to estimate CH₄ emissions from enteric fermentation, CH₄ emissions from manure management and N₂O emissions from manure management;
 - b. In the values of gross energy intake applied to calculate CH₄ emissions from enteric fermentation, and CH₄ and N₂O emissions from livestock manure management;
 - c. In the data on manure management system allocation to estimate CH₄ emissions and N₂O emissions from manure management.
- As a reviewer, you must assess the following review elements:
 - **Choice of method**, for example, if CH₄ or N₂O emissions from manure management have been identified as a key category and whether these emissions have been

- estimated for significant animal types using an enhanced characterization and a tier 2 or tier 3 method;
- **Use of method**, for example, whether the calculation steps conducted to estimate CH₄, and direct and indirect N₂O emissions follow good practice guidance, and whether a Party has transparently explained the rationale for the selection of AD, parameters and assumptions applied in its calculations;
 - **Activity data**, for example, whether the information on the distribution of manure management systems is based on statistics or other information (e.g. on assumptions or expert judgment), and whether such data are reasonable, available and presented in a transparent manner;
 - **Emission factors**, for example, if the IPCC default values were used, and whether these values are applicable to the national circumstances (e.g. whether a Party selected an MCF that is appropriate for climatic conditions of the country);
 - **Emission factors**, for example, if country-specific EFs and other parameters have been utilized, and whether the bases of these data are provided and how well they compare with IPCC default values.
- As a reviewer, you must assess whether any possible double counting or omissions of emissions has occurred:
 - a. Has the Party correctly allocated indirect emissions from manure excreted in pasture, range and paddock in the agricultural soils category?
 - b. If a Party reports treatment of manure in anaerobic digesters, is the amount subdivided into different categories taking into consideration the amount of biogas recovery, flaring and storage after digestion? If biogas is used for energy production, is it included in the energy sector?
 - c. Is the amount of manure nitrogen available for application to soils estimated to exclude all losses of nitrogen in animal houses and manure management systems and exclude the nitrogen deposited by grazing animals?
 - d. Is the nitrogen content in organic bedding materials (applicable for solid storage and deep bedding) available and used in the estimations of the amount of manure nitrogen that is available for application to soils?
 - e. Is the total quantity of nitrogen produced in manure not larger than (if nitrogen from bedding material is considered) or equal to (if nitrogen from bedding is not included) the sum of the nitrogen reported as urine and dung from grazing animals, managed animal manure applied to soils, nitrogen manure used for other purposes and total nitrogen losses from manure management systems?
 - As a reviewer, you must record any finding identified by you; the review report is the written record of the key issues that the TERT concludes needs to be resolved by the Party in order for the Party to be fully in compliance with the reporting requirements of the MPGs.
 - As a reviewer, do not jump to conclusions without consultation with a Party and further clarifying the identified findings. Therefore, it is essential that you make the necessary efforts

to ensure that the communications are clear and concise. Effective communication between the TERT and the Party is one key to a successful review process.

Lesson 5: Agricultural soils

7. Introduction

7.1. Lesson coverage

This lesson describes the methodological basis underlying the estimates of direct and indirect N₂O emissions for the agricultural soils category and addresses the approaches that the TERT should apply in reviewing this category.

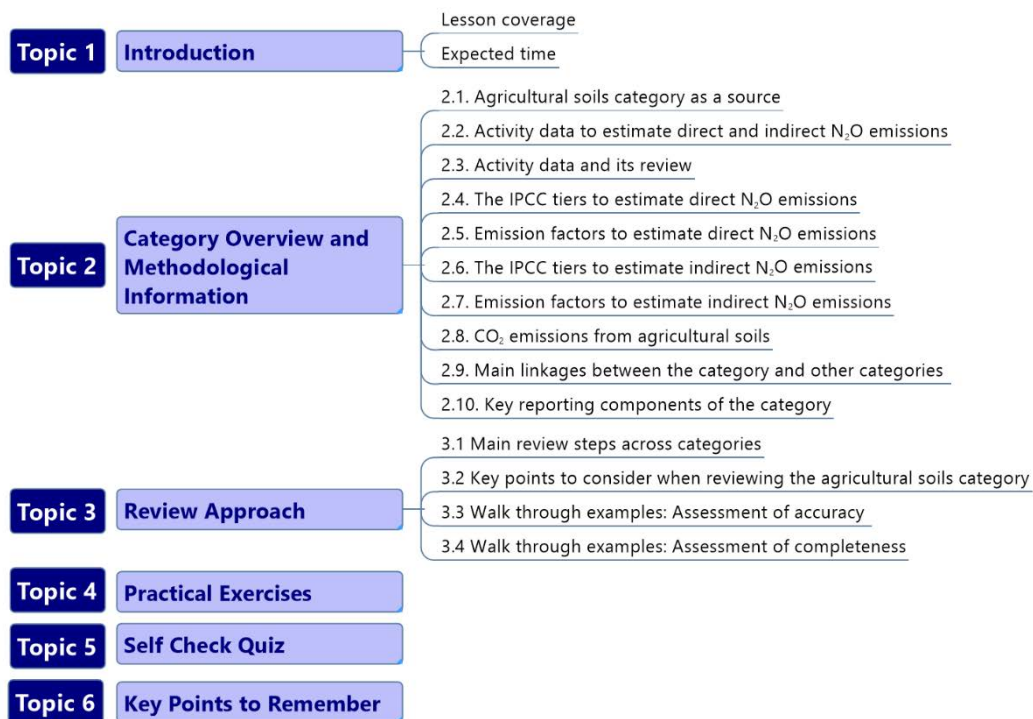
At the end of this lesson, you will be able to:

- Identify methodological references and reporting components relevant to the agricultural soils category;
- Understand how the agricultural soils category interlinks with other categories within the agriculture sector and other sectors of the inventory;
- Focus on the key review points and be aware of possible actions by the TERT in its review of direct and indirect N₂O emissions for the agricultural soils category;
- Understand how to formulate clarification questions to a Party in the context of the review;
- Identify and describe findings and issues, and draft relevant encouragements and recommendations in a review report;
- Classify issues into one of the TACCC principles.

7.2. Expected time

Expected time needed to complete lesson 5: ~60 minutes

7.3. Structure of the lesson



8. Category overview and methodological information

8.1. Agricultural soils category as a source

N₂O is produced naturally in soils through the processes of nitrification and denitrification.

- Nitrification is the aerobic microbial oxidation of ammonium (NH₄⁺) to nitrate (NO₃⁻),
- Denitrification is the anaerobic microbial reduction of NO₃⁻ to dinitrogen (N₂).

N₂O is a gaseous intermediate in the reaction sequence of denitrification and a by-product of nitrification that leaks from microbial cells into the soil and ultimately into the atmosphere. One of the main controlling factors in this reaction is the availability of inorganic nitrogen in the soil.



P. Figure 5-1.
Harvesting of crops

However, an increase in available nitrogen enhances nitrification and denitrification rates, which then increase the production of N₂O. Increases in available nitrogen can occur through:

- Human-induced net nitrogen additions to soils (e.g. synthetic or organic fertilizers);
- Mineralization of nitrogen in soil organic matter following drainage/management of organic soils;
- Cultivation/land-use change on mineral soils (e.g. forest land/grassland/settlements converted to cropland).

The emissions of N₂O that result from anthropogenic nitrogen inputs or nitrogen mineralization occur through both:

- A **direct** pathway (i.e. directly from the soils to which the nitrogen is added/released); and
- Two **indirect** pathways (i.e. volatilization of NH₃ and NO_x and the subsequent redeposition, and through leaching and run-off of nitrogen).

The principal pathways are illustrated in figure 11.1 in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

8.2. Activity data to estimate direct and indirect N₂O emissions from managed soils

Direct emissions of N₂O from managed soils are estimated separately from indirect emissions, although using a common set of AD.

The following nitrogen sources are included in the methodology for estimating direct N₂O emissions from managed soils:

1. Synthetic nitrogen fertilizers (F_{SN});
2. Organic nitrogen applied as fertilizer (F_{ON});
3. Urine and dung nitrogen deposited on pasture, range and paddock by grazing animals (F_{PRP});
4. Nitrogen in crop residues (F_{CR});

Biological nitrogen fixation has not been considered as a direct source of N₂O because of the lack of evidence of significant emissions arising from the fixation process itself.

5. Nitrogen mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils (F_{SOM}); and
6. Drainage/management of organic soils (i.e. histosols, F_{OS}).

Note that enhanced emissions of CO₂ from cultivation of histosols should be reported under the LULUCF sector in CRT 4(II) or CRT 4.B and 4.C.



Nitrogen sources marked 1 to 5 in the list above are included in the methodology for estimating **indirect N₂O emissions** from managed soils**.

Nitrogen from the components marked 4 and 5 is only included in the leaching/run-off component of indirect N₂O emission and excluded as a nitrogen source for atmospheric deposition.

Nitrogen source labelled as 6 is only considered in the estimates of direct N₂O emissions.

***Only atmospheric deposition of nitrogen volatilized from agricultural inputs of nitrogen are to be accounted for here, not including NO_x associated with the burning of savannahs and crop residues.*

8.3. Activity data and their review

- **Synthetic fertilizers, F_{SN}**

Activity data:

- The term F_{SN} refers to the annual amount of synthetic nitrogen fertilizer applied to soils;
- Annual fertilizer consumption data may be collected from official country statistics. If country-specific data are not available, data on total fertilizer use by type and by crop from the International Fertilizer Industry Association (IFIA), or data on synthetic fertilizer consumption from FAOSTAT can be used;
- Note that for the tier 1 approach, in accordance with the 2006 IPCC Guidelines, the amounts of applied mineral nitrogen fertilizers (F_{SN}) and of applied organic nitrogen fertilizers (F_{ON}) are no longer adjusted for the amounts of NH_3 and NO_x volatilization after application to the soil. This is a change from the methodology described in the Revised 1996 IPCC Guidelines. The reason for this change is that N_2O EF for applied N were not adjusted for volatilization when they were estimated: EF were determined from fertilizer-induced N_2O-N emitted / total amount of N applied, and not from fertilizer-induced N_2O-N emitted / (total amount of N applied – NH_3 and NO_x volatilized).

As a reviewer:

- You must ensure that there is no double counting or omission of emissions due to potential reporting of inorganic nitrogen applied to land-use categories other than agricultural soils (e.g. forest land);
- You may compare national statistics to international databases such as those of the International Fertilizer Industry Association and FAOSTAT and contact the Party for clarification in case of discrepancies in the AD.

International Fertilizer Industry Association: <http://www.fertilizer.org>

FAOSTAT: <http://faostat.fao.org/>

- **Organic nitrogen fertilizers, F_{ON}**

Activity data:

- The term F_{ON} refers to the amount of organic nitrogen inputs applied to soils other than by grazing animals and is calculated using equation 11.3 in chapter 11 of volume 4 of the 2006 IPCC Guidelines;
- The term F_{AM} (animal manure applied to soils) refers to the annual amount of animal manure nitrogen applied to soils; this might be calculated using equation 10.34 or determined based on a manure mass balance;
Volatilization and subsequent deposition of nitrogen from the manure in manure management systems should be reported as indirect N_2O emissions from manure management under category (CRT 3.B(b)).
- Other organic nitrogen additions (e.g. compost (F_{COMP}), sewage sludge (F_{SEW}), rendering waste (F_{OOA})) can be included in this calculation if sufficient information is available. The waste input is measured in units of nitrogen and added as an additional source sub-term under F_{ON} .

If sewage sludge is accounted under the agricultural soils category, a cross-check with the waste sector is needed to ensure that there is no double counting of N₂O emissions from the nitrogen in sewage sludge.

If compost is accounted under the agricultural soils category, it must be ensured that manure nitrogen in compost is not double counted.

- The application of organic fertilizers on cropland and grassland should be reported under the agriculture sector. The application of fertilizers to other land categories should be reported in CRT 4(I), in the category “Direct and indirect nitrous oxide (N₂O) emissions from nitrogen (N) inputs to managed soils”.

However, if it is not possible to identify the application of fertilizers to other land categories separately, then the resulting emissions should be included under the agriculture sector. This should be explicitly indicated in the documentation box of the respective CRT and in the NID.

As a reviewer:

- You must check that there is no double counting among organic fertilizers defined as compost and a manure management system with composting. All nitrogen from manure should be included under F_{AM}. However, under F_{ON}, only other types of organic composts should be included.

- **Urine and dung deposited on pasture, F_{PRP}**

Activity data:

- The term F_{PRP} refers to the annual amount of nitrogen deposited on pasture, range and paddock soils by grazing animals;
- The calculation algorithm developed to estimate the amount of manure nitrogen deposited on pasture is explained in lesson 4 above;

As a reviewer:

- You must assess that AD on animal manure are consistent with the Party's livestock characterization and appropriate Nex rates. You should check that:
- The nitrogen quantity and emissions from animal manure produced by grazing animals have been excluded from the managed animal manure (F_{AM}) applied to soils;
- The total nitrogen produced from livestock is not larger than (if nitrogen from bedding material is considered) or is equal (if nitrogen from bedding is not included) to the sum of the nitrogen reported as urine and dung from grazing animals (F_{PRP}), managed animal manure (F_{AM}) applied to soils, nitrogen manure used for fuel, food or construction and total nitrogen losses from manure management systems (for more information, please refer to lesson 4).

- **Crop residues, F_{CR}**

Activity data:

- The term F_{CR} refers to the amount of nitrogen in crop residues, including nitrogen -fixing crops, returned to soils annually. It also includes the nitrogen from nitrogen -fixing and non-nitrogen -fixing forages mineralized during forage or pasture renewal;

The nitrogen residue from perennial forage crops is only accounted for during periodic pasture renewal, not necessarily on an annual basis as is the case of annual crops.

- The method developed to estimate N₂O emissions is described on page 11.14 in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

As a reviewer:

- It may be useful to compare national AD on crop species, the yields and areas harvested with data published by FAOSTAT;
- Since yield statistics for many crops are reported as fresh weight, a correction factor can be applied to estimate dry matter yields (Crop_(T)) where appropriate. Hence, you must check whether a Party has employed the relevant correction factor;

An improvement on this approach for determining FCR (i.e. tier 2) would be the use of country-specific data rather than the values provided in table 11.2 in chapter 11 of volume 4 of the 2006 IPCC Guidelines, as well as country-specific values for the fraction of above-ground residue burned.

- Note that area burned for each crop and values for crop production, residue/crop ratios, dry matter fraction of residues and fraction residues burned on fields are also to be reported in CRT 3.F. You should use this information to check the consistency in the estimates among emissions from managed soils and field burning of residues and ensure that there is no double counting or omission of crop residues in the agriculture sector. The mass balance of crop residues (e.g. fractions burned, grazed or removed annually for purposes such as feed, bedding and construction, and retained in the soil) should be checked.



Please open PDF file https://unfccc.int/resource/tet/ba/ba5-01_L5_Residues_mass_balance.pdf to study an example of mass balance of crop residues.

- **N₂O emissions from nitrogen mineralization**

Activity data:

- The term F_{SOM} refers to the amount of nitrogen mineralized from loss in soil organic carbon in mineral soils through land-use change or management practices.

As a reviewer:

- Note that the reporting in the agriculture sector covers only emissions from management in cropland remaining cropland and grassland remaining grassland. N₂O emissions from other land-use categories as well as their conversions should be reported under the LULUCF sector;

Methodologies for N₂O emissions from nitrogen mineralization/immobilization associated with loss/gain of soil organic matter resulting from management of mineral soils are based on equations 11.1, 11.2 and 11.8 in chapter 11 of volume 4 of the 2006 IPCC Guidelines and reported in (CRT 4(III)).

Please note that N₂O immobilization associated with gain of organic matter resulting from management of mineral soils can be reported only when a Party applies a tier 3 approach in the relevant calculation.

- Note that F_{SOM} should be estimated for all situations where soil carbon losses occur, such as land-use or management change. You must:

- Check for consistency with data reported under cropland (CRT 4.B) and direct and indirect nitrous oxide (N₂O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (CRT 4(III)) in the LULUCF sector;
- Check for consistency in the total carbon losses reported under cropland remaining cropland and land converted to cropland and respective N₂O emissions reported under the agriculture sector and in CRT 4(III);
- Check for potential double counting or omission of emissions from mineralization of soil organic matter in cropland.

- **Histosols, F₀₅**

Activity data:

- The term F₀₅ refers to the total annual area (ha) of drained/managed organic soils;
- The area of drained/managed organic soils may be collected from official national statistics. The areas should be stratified by climatic zone, and temperate grassland further by nutrient status and drainage class.

As a reviewer:

- Note that under the category direct N₂O emissions from managed soils (3.D.1), only N₂O emissions from cultivation/management of drained organic soils on **cropland and grassland** are to be included;
- Check the consistency of country-specific data on the areas of cultivated/managed organic soils by comparing them with the total areas of organic soils for each country available from FAOSTAT;

Note that FAOSTAT data are estimates and they may not be exactly the same as national data.



Note that methods to estimate N₂O emissions from rewetted organic soils are provided in the wetlands supplement

If major discrepancies are found between the Party's reported data and those provided by other recognized data sources (e.g. International Energy Agency (IEA) or FAOSTAT), and they cannot be adequately explained by the Party, you should encourage the Party to explore the reason for these discrepancies.

- N₂O emissions from rewetted organic soils on croplands and grassland are to be reported under the category direct N₂O emissions from managed soils (3.D.1), only *if a rewetted area is still proposed for use in agriculture* (e.g. paludiculture) and if no land-use change has occurred (*chapter 3 of the Wetlands Supplements*). N₂O emissions from rewetted cropland or grassland converted to wetlands, as well as all emissions from organic forest soils and other land-use categories, should be reported under the LULUCF sector in the category emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRT 4(II));

- As a reviewer, you should check that there is no double counting or omission of emissions from organic soils on cropland and grassland and compare with data reported under the category emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRT 4(II)) of the LULUCF sector.

Soils are organic if they satisfy requirements 1 and 2 or 1 and 3 below:

1. A thickness of 10 cm or more. A horizon less than 20 cm thick must have 12 per cent or more organic carbon when mixed to a depth of 20 cm.
2. The soil is never saturated with water for more than a few days and contains more than 20 per cent (by weight) organic carbon (about 35 per cent organic matter).
3. The soil is subject to water saturation episodes and has either:
 - i. At least 12 per cent (by weight) organic carbon (about 20 per cent organic matter) if it has no clay;
 - ii. At least 18 per cent (by weight) organic carbon (about 30 per cent organic matter) if it has 60 per cent or more clay; or
 - iii. An intermediate, proportional amount of organic carbon for intermediate amounts of clay.

For more information, see page 11.6 (footnote 4) in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

8.4. The IPCC tiers to estimate direct N₂O emissions

There are three different methodological tiers available in the 2006 IPCC Guidelines for estimating direct N₂O emissions due to nitrogen sources application to agricultural soils. The choice of the methods provided by the 2006 IPCC Guidelines primarily depends on data availability ([figure 11.2 of volume 4 of the 2006 IPCC Guidelines](#)).

Tier 1	Tier 2 and tier 3
<p>If there are no country-specific AD, if it's not a key category and if the source of nitrogen is not significant, the Party could use the tier 1 method, with default EFs and FAOSTAT data.</p> <p>If it's a key category and the source of nitrogen is significant, the Party should obtain country-specific AD; however, if country-specific EFs are not rigorously documented (EF₁, EF₂ and/or EF_{3PRP}) the Party may use tier 1.</p>	<p>If it's a key category, if the source of nitrogen is significant, and if country-specific EFs (EF₁, EF₂ and/or EF_{3PRP}) are rigorously documented, the Party should obtain country-specific AD and use the tier 2 equation and available country-specific EFs, or tier 3 methods.</p>

Q. Figure 5-2. The main features of the decision tree to determine which tier to use to estimate direct N₂O emissions from agricultural soils

See section 2.6 in lesson 2 (p.28) for:



- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

Tier 2 and tier 3

If more detailed EFs and corresponding AD are available, the Party should use equation 11.1 for that level of detail. For example, if EFs and AD are available for the application of synthetic fertilizers and organic

nitrogen (F_{SN} and F_{ON}) under different conditions, equation 11.1 should be further disaggregated for that level of detail.

In accordance with the decision tree in figure 11.2 in chapter 11 of volume 4 of the 2006 IPCC Guidelines, the selection of a tier 1 or tier 2 method is related to whether the category is a key category and to the availability of differentiated EFs and AD for each nitrogen source. For Parties that do not have the necessary information for tier 2, the use of tier 1 equations and country-specific AD are acceptable, even if direct N_2O emission from managed soils is a key category.

Tier 3 methods are modelling or measurement approaches. Models are useful because in appropriate forms they can relate the soil and environmental variables responsible for N_2O emissions to the size of those emissions. These relationships may then be used to predict emissions from whole countries or regions for which experimental measurements are impracticable. Models should only be used after validation by representative experimental measurements. Care should also be taken to ensure that the emission estimates developed through the use of models or measurements account for all anthropogenic N_2O emissions.

For more information, see page 11.6 in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

8.5. Emission factors to estimate direct N_2O emissions

Three EFs are needed to estimate direct N_2O emissions from managed soils. The default values presented here may be used in the tier 1 equation or in the tier 2 equation in combination with country-specific EFs:

	Refers to	Further disaggregation
EF ₁	<ul style="list-style-type: none"> • Various synthetic and organic nitrogen applications to soils, including crop residue; • Mineralization of soil organic carbon in mineral soils. 	May be disaggregated according to two types of conditions: <ul style="list-style-type: none"> • For mineral soils; • For flooded rice fields.
EF ₂	<ul style="list-style-type: none"> • N_2O emitted from an area of drained/managed organic soils. 	The 2006 IPCC Guidelines includes five values: <ul style="list-style-type: none"> • Temperate organic crop and grassland soils; • Tropical organic crop and grassland soils; • Temperate and boreal organic nutrient-rich forest soils; • Temperate and boreal organic nutrient-poor forest soils; • Tropical organic forest soils.
EF ₃	<ul style="list-style-type: none"> • N_2O emitted from urine and dung nitrogen deposited by grazing animals on pasture, range and paddock. 	Disaggregated for different animal types: <ul style="list-style-type: none"> • Cattle (dairy, non-dairy and buffalo), poultry and pigs; • Sheep and other animals.

 Please open PDF file https://unfccc.int/resource/tet/ba/ba5-02_L5_Learn_EF2.pdf to study more on EF₂.

For more information, see table 11.1 in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

8.6. The IPCC tiers to estimate indirect N₂O emissions

The decision tree for estimating indirect N₂O emissions from managed soils outlines the steps that Parties should follow (see 2006 IPCC Guidelines, vol. 4, chap. 11, figure 11.3). The main features of this decision tree are as shown in figure 5-3.

Tier 1	Tier 2	Tier 3
<p>If indirect emissions from managed soils is not a key category, or if the nitrogen source is not significant, and there are no country-specific AD or country-specific EFs or rigorously documented country-specific partitioning fractions, emissions can be estimated using the tier 1 method with default EFs and partitioning factors and available AD.</p>	<p>If indirect emissions from managed soils is not a key category, or if a nitrogen source is significant, but country-specific EFs (EF₄ or EF₅) and/or country-specific partitioning fractions (Frac_{GAS_F}, Frac_{GAS_M}, Frac_{LEACH}) values are available, emissions can be estimated with the tier 2 method.</p> <p>If it is a key category and a nitrogen source is significant, emissions should be estimated using tier 2 taking into account rigorously documented country-specific EFs (EF₄ or EF₅) and partitioning fraction (Frac_{GAS_F}, Frac_{GAS_M}, Frac_{LEACH}) values.</p>	<p>Tier 3 methods are modelling or measurement approaches. Models are useful as they can relate the variables responsible for the emissions to the size of those emissions. These relationships may then be used to predict emissions from whole countries or regions for which experimental measurements are impracticable.</p>

R. Figure 5-3. The main features of the decision tree to determine which tier to use to estimate indirect N₂O emissions from agricultural soils

See section 2.6 in lesson 2 (p.28) for:

- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

8.7. Emission factors to estimate indirect N₂O emissions

The method for estimating indirect N₂O emissions includes two EFs: one associated with volatilized and redeposited nitrogen (EF₄) and one associated with nitrogen lost through leaching/run-off (EF₅). The method also requires values for the fractions of nitrogen that are lost through volatilization (Frac_{GAS_F} and Frac_{GAS_M}) or leaching/run-off (Frac_{LEACH-(H)}). The default values of all these factors are presented below.

EF ₄	Associated with nitrogen volatilization and redeposition	Country-specific values for EF ₄ should be used with great caution because of the special complexity of transboundary atmospheric transport. Although inventory compilers may have specific measurements of nitrogen deposition and associated N ₂ O flux, in many cases, the deposited nitrogen may not have originated in their country.
EF ₅	Associated with nitrogen lost through leaching/run-off	
Frac _{GAS_F}	Associated with nitrogen volatilization from synthetic fertilizers	

Frac _{GASM}	Associated with nitrogen volatilization from all organic fertilizers, and dung and urine deposited by grazing animals	
Frac _{LEACH-(H)}	Associated with fraction of all nitrogen added to/mineralized in managed soils in regions where leaching/run-off occurs that is lost through leaching and run-off	Note that in the tier 1 method, for humid regions or in dryland regions where irrigation (other than drip irrigation) is used, the default Frac _{LEACH-(H)} is 0.30. For dryland regions, where precipitation is lower than evapotranspiration throughout most of the year and leaching is unlikely to occur, the default Frac _{LEACH} is 0.

8.8. CO₂ emissions from agricultural soils

Agricultural soils may also emit or remove CO₂:

- CO₂ emissions from the application of carbon-containing fertilizers (lime, urea and other) (covered in lesson 8 below);
- CO₂ emissions or removals on agricultural soils due to the change of carbon stocks are to be reported under the LULUCF sector (CRT 4.B cropland and CRT 4(II) emissions and removals from drainage and rewetting and other management of organic and mineral soils);
- CO₂ emissions from cultivation of histosols should be reported under the LULUCF sector in CRT 4(II) or CRT 4.B cropland and CRT 4.C grassland;



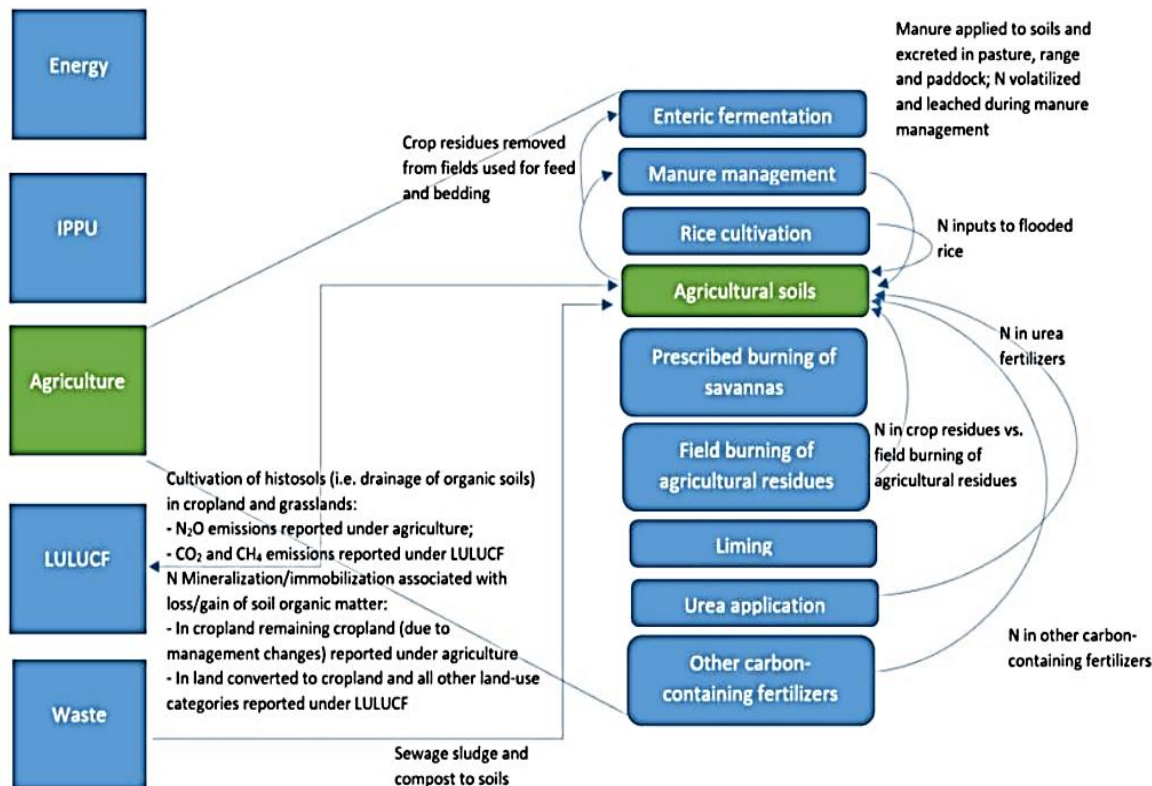
5. Figure 5-4. Understanding emissions from agricultural practices

CO₂ emissions from peat used as a soil amendment in agriculture and gardening may be reported either under the agriculture sector (CO₂ emissions from the application of carbon-containing fertilizers, lesson 8 below) or under the LULUCF sector (category 4.D wetlands, peat extraction).

Methodologies are discussed in chapters 2 and 5 of volume 4 of the 2006 IPCC Guidelines and chapters 2, 3, 4 and 5 of the Wetlands Supplement.

8.9. Main linkages between the agricultural soils category and other categories

The agricultural soils category is intensively interconnected with other categories within the agriculture sector and with the categories of other sectors (figure 5-5).



T. Figure 5-5. Main linkages between the agricultural soils category and the other categories in the agriculture sector and other sectors

8.10. Key reporting components of the agricultural soils category

Table 5-1 summarizes the main reporting components and the methodological references related to the agricultural soils category.

Table 5-1. Summary of key elements of the agricultural soils category

Overview	Category-specific information
Category name	Agricultural soils
General reference	2006 IPCC Guidelines, volume 4, chapter 11.2
Chapter of the NID	Chapter 5: Agriculture
Reported in CRT	Table 3.D <i>Click here to open the CRT</i> < https://unfccc.int/documents/311076 >

Main subcategories and GHGs to be reported	Direct N ₂ O emissions from managed soils	N ₂ O
	Indirect N ₂ O emissions from managed soils	N ₂ O

In addition to the generic reporting instructions, individual reporting requirements are included in the footnotes of each CRT. Parties may report additional information in the documentation boxes in the CRT. Hence, as an agriculture expert, you must familiarize yourself with the footnotes and the information provided by the Party in the documentation boxes. Moreover, you must assess the information reported in summary report tables and in cross-cutting tables.

9. Review approach

9.1. Key points to consider when reviewing the agricultural soils category



A brief description of three common review steps (prepare – assess - draft) is provided in https://unfccc.int/resource/tet/ba/ba5-03_L_R_steps.pdf. Please read carefully before continuing with the key points to consider when reviewing emissions from agricultural soils, if you have not yet done so.

The choice of methods, selection of assumptions, development and selection of EFs and collection and selection of AD are the main drivers of inventory quality. Hence, as a reviewer, you must assess and ensure that the selection of these data carried out by a Party are in accordance with the 2006 IPCC Guidelines and its supplements and the requirements in the UNFCCC decisions.

Table 5-2 summarizes the possible questions and actions that you can ask yourself when reviewing the emissions reported under the agricultural soils category. In addition, there are several common elements to be assessed across sectors/categories when reviewing the quality of the Party's submission (i.e. uncertainty analysis, QA/QC, time-series consistency, recalculations and progress in implementing planned improvements) – lesson 2 above provides a list of guiding questions.

Table 5-2. Possible questions by the review team in its review of the agricultural soils category

Review element	Question/Possible action
	General approach
Choice of method	Has the Party followed the recommendations and decision trees from the 2006 IPCC Guidelines and its choice of methods and parameters?
Use of method	Are country-specific methods and higher-tier methods, EFs and parameters well described in the national inventory report and do they agree? Are the reference documents published in peer-reviewed, accessible journals? Do the estimation methods used for estimating emissions follow good practice guidance?
Use of method/Documentation	Does the inventory submission provide a description of the method used to estimate emissions? If the method uses a country-specific methodology or sophisticated model (i.e. tier 3), is the model explained clearly?

Review element	Question/Possible action
AD	Has the Party followed the recommendations and decision trees from the 2006 IPCC Guidelines in its choice of AD? Is the use of the IPCC default AD appropriate? Are data available to enable the Party to move to higher tiers?
AD	What AD have been used? National statistics or other? Is it explained and documented? Are those data collection methods, approaches and data source well documented in the national inventory report?
Direct emissions from managed soils	
All subcategories	Are all subcategories estimated? Were the following sources of anthropogenic nitrogen inputs resulting in direct N ₂ O emissions from agricultural soils included? a) Application of synthetic fertilizers; b) Application of animal manure; c) Cultivation of nitrogen-fixing crops; d) Incorporation of crop residues into soils; e) Soil nitrogen mineralization due to cultivation of organic soils; f) Other sources such as sewage sludge, which should be included if sufficient information is available.
All subcategories	Have default or country-specific (Parties are encouraged to use country-specific information) AD, EFs and partition fractions been used for each of the categories of nitrogen added to soils?
Inorganic nitrogen fertilizers	Are the AD in line with the fertilizer data provided by FAOSTAT or the International Fertilizer Industry Association?
Inorganic nitrogen fertilizers	If fertilizer data are provided disaggregated by fertilizer type, is the reporting of use of urea in line with that reported for the category urea application?
Inorganic nitrogen fertilizers	If fertilizer data are provided disaggregated by fertilizer type, is the reporting of use of other carbon-containing fertilizers in line with that reported for the category other carbon-containing fertilizers?
Inorganic nitrogen fertilizers	Is the Party able to separate out fertilizers applied to cropland and grassland? If the application to other land categories cannot be identified, is this clearly described in the national inventory report?
Organic nitrogen fertilizers – animal manure applied to soils	Are the AD in line with the data provided in CRF table 3.B(b) excluding manure in pasture, range and paddock, and taking into account manure used for feed, fuel and construction ($Frac_{FEED} + Frac_{FUEL} + Frac_{CNST}$) and loss of nitrogen from manure management systems?
Organic nitrogen fertilizers – animal manure applied to soils	Is the estimated loss of nitrogen from manure management systems in line with the estimated nitrogen loss due to volatilization of ammonia and NO _x and, if reported, the loss of nitrogen through leaching from manure management? The total loss of nitrogen should be higher than (or equal to) losses due to volatilization and leaching.

Review element	Question/Possible action
Organic nitrogen fertilizers – animal manure applied to soils	If the Party assumes no leaching of nitrogen during manure management (not mandatory), is the estimate of total nitrogen loss before manure application to soils consistent with that approach?
Organic nitrogen fertilizers – animal manure applied to soils	If the Party assumes no leaching of nitrogen during manure management (not mandatory), is the estimate of total nitrogen loss before manure application to soils consistent with that approach?
Organic nitrogen fertilizers – animal manure applied to soils	Is the Party able to separate out organic fertilizers applied to cropland and grassland? If the application to other land categories cannot be identified, is this clearly described in the national inventory report?
Organic nitrogen fertilizers – animal manure applied to soils	If the Party reports “NO” or “NE”, check with the waste expert whether there is an indication that sewage sludge application occurs. If so, the Party should report the emissions to ensure completeness.
Organic nitrogen fertilizers – sewage sludge applied to soils	Is the reporting on sewage sludge applied to soils in line with data in the waste sector? (Cross-check with the waste sector to ensure there is no double counting of N ₂ O emissions from the nitrogen in sewage sludge.) What assumptions has the Party made regarding nitrogen content in sewage sludge, if the amount of sewage sludge in weight units is used as a basis for the calculation?
Organic nitrogen fertilizers – other organic fertilizers applied to soils	Is the reporting on compost addition to soils in line with data in the waste sector? What assumptions has the Party made regarding nitrogen content in compost, if the amount of compost in weight units is used as a basis for the calculation? Has the Party ensured that compost nitrogen is not double counted?
Urine and dung deposited by grazing animals	Is the nitrogen input the same as reported in CRF table 3.B(b) for pasture, range and paddock?
Urine and dung deposited by grazing animals	If the Party uses default EFs, is the IEF equal to the weighted average of EFs in table 11.1 in the 2006 IPCC Guidelines, when weighted based on nitrogen input for cattle, poultry and pigs (EF _{3PRP} , CPP) and nitrogen input for sheep and other animals (EF _{3PRP} , SO)?
Crop residues	Are the data on crop residues in line with the data reported for field burning of agricultural residues (i.e. is the amount of agricultural residues burned equal to or smaller than the amount of crop residues minus the amount used for feed, bedding or construction)?
Crop residues	If the Party has no data on Fra _{REMOVE} , has it assumed no removal, in line with the 2006 IPCC Guidelines?
Crop residues	Is relevant information reported under field burning of agricultural residues in CRF table 3.F (e.g. area burned for each crop and values for crop production, residue/crop ratios, dry matter fraction of residues and fraction residues burned on fields) and data used to estimate N ₂ O emissions from crop residues returned to managed soils?

Review element	Question/Possible action
Mineralization/immobilization associated with loss/gain of soil organic matter	Are losses of soil carbon in cropland remaining cropland (reported in the LULUCF sector) accompanied by N ₂ O emissions from mineralization associated with loss of soil organic matter reported in this category? Note that N ₂ O immobilization associated with a gain of organic matter resulting from the management of mineral soils can be reported only when a Party applies a tier 3 approach.
Mineralization/immobilization associated with loss/gain of soil organic matter	Are the emissions correctly allocated between the agriculture sector and the LULUCF sector, that is, only mineralization/immobilization in cropland remaining cropland included under the agriculture sector and the rest in the LULUCF sector CRF table 4(III)?
Cultivation of organic soils (i.e. histosols)	Is the area of cultivated histosols in line with the area of organic soils reported in the LULUCF sector for cropland remaining cropland, land converted to cropland, grassland remaining grassland and land converted to grassland? Large differences (e.g. "NO" reported for this category although organic soils in cropland or grassland occur) in these data may indicate a problem in the inventory.
Direct N ₂ O emissions from managed soils	Is the Party applying EFs for direct emissions to total nitrogen input to soils before subtracting the amount of nitrogen lost through volatilization, leaching and run-off?
Direct N ₂ O emissions	Are EF ₁ and EF ₃ applied to disaggregated data on soils (mineral and rice) and animal species, respectively?
Direct N ₂ O emissions	Have the updated EFs (EF ₂) for the cultivation of organic soils (i.e. histosols), that are provided in the Wetlands Supplement been used and are the areas stratified by climatic zone, and in the case of temperate grasslands, stratified further by nutrient status and drainage class?
Direct N ₂ O emissions	Have annual statistics on the use of nitrogen synthetic fertilizers, production of crops (e.g. area and yields) and areas of histosols been collected and are units of statistical data adequately considered (e.g. are statistical reported data on crop yields as field dry or fresh weight and a correction factor used)?
All subcategories – tier 2/3	<p>Have default or country-specific AD, EFs and partition fractions been used for the following categories of nitrogen?</p> <ul style="list-style-type: none"> • Synthetic fertilizers applied to soils; • Animal manure (including urine and dung nitrogen deposited on pasture, range and paddock by grazing animals and other organic amendments to soils discharged to rivers). <p>note: particularly, if they represent a significant portion of total emissions (and indirect N₂O emissions from agricultural soils is a key category).</p>
Indirect emissions from managed soils	
All subcategories	Are the AD consistent with the calculations in the direct emissions of N ₂ O from soils?
	Have all nitrogen input sources been estimated in a consistent mode to the nitrogen sources considered in direct emissions?
	Has it been demonstrated that any default factors used are applicable to the national circumstances?
	Have default or country-specific AD, EFs and partition fractions been used for the following categories of nitrogen: synthetic fertilizers applied to soils, animal manure (including urine and dung nitrogen deposited on pasture, range and paddock by

Review element	Question/Possible action
	grazing animals and other organic amendments to soils discharged to rivers; in particular, if they represent a significant portion of total emissions (and indirect N ₂ O emissions from agricultural soils is a key category).
Atmospheric deposition	Does the atmospheric deposition include NO _x from burning of savannahs and crop residues? (These emissions should be excluded from this category.)
Nitrogen leaching and run-off	Does the Party consider, in its estimate of nitrogen losses by leaching/run-off only those areas where soil water-holding capacity is exceeded, as a result of rainfall and/or irrigation? Note that consideration of soil water-holding capacity is a new element in the 2006 IPCC Guidelines.
Nitrogen leaching and run-off	Is the Party able to estimate the quantity of nitrogen mineralized from organic soils? If so, is this included in the indirect N ₂ O emissions from leaching/run-off?
Indirect N ₂ O emissions	Are nitrogen from crop residues returned to soils and nitrogen from mineralization included in the leaching/run-off component of indirect N ₂ O emission?
Indirect N ₂ O emissions	Is there any double counting with volatilization and subsequent deposition of nitrogen from the manure in manure management systems that should be covered in the category N ₂ O emissions from manure management (CRF table 3.B(b))?
Indirect N ₂ O emissions	Is there consistency in the usage of EFs (EF ₄ and EF ₅) among estimations of indirect N ₂ O emissions from managed soils and manure management?
Cross-cutting issues	<p>Are there are double counting or omissions of the following?</p> <ul style="list-style-type: none"> • Emissions due to potential reporting of inorganic nitrogen applied to other land-use categories except agricultural soils (e.g. forest land); • Different fractions of crop residues (e.g. those used for the input to soils, burning, animal production, etc.); • Nitrogen from animal manure (particularly, nitrogen from manure management systems with composting) and Nitrogen in compost included in the organic fertilizers; • Nitrogen from animal manure (F_{AM}) and nitrogen in urine and dung deposited on pasture, range and paddock by grazing animals (F_{PRP}); • N₂O emissions from areas of histosols on cropland and grassland reported here and under the category emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRF table 4(II)) of the LULUCF sector, and from the application of synthetic and organic fertilizers reported here and under the category direct nitrous oxide (N₂O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (CRF table 4(III)) of the LULUCF sector.

As a reviewer, you must first focus on the observations which have an impact on the level and/or trend of the GHG emissions. Moreover, in the case of issues related to transparency (i.e. the NID does not clearly describe how emissions were estimated), the TERT should specifically determine whether the lack of transparency in the inventory leads it to question the accuracy of the inventory estimates reported.



Please note that table 5-2 is not intended to provide an exhaustive list of questions; it is rather a starting point to stimulate your thinking. You may add or modify the questions as appropriate while conducting a review.

Paragraph 28 of decision 5/CMA.3 notes that the Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines. Hence, as a reviewer you must be aware of the improvements undertaken in the 2019 Refinement to the 2006 IPCC Guidelines.

An overview of the changes between the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC Guidelines is presented below:

Direct N₂O emissions from agricultural soils:

- Default EFs to estimate direct N₂O emissions from managed soils reported in table 11.1 have been updated;
- EF₁ has been disaggregated into values for synthetic fertilizer inputs in wet climates, other nitrogen inputs in wet climates and all nitrogen inputs in dry climates;
- EF_{1FR} for flooded rice fields has been updated and further disaggregated according to water regimes;
- EF_{3PRP, CPP} for cattle (dairy, non-dairy and buffalo), poultry and pigs has been updated and further disaggregated according to climate regimes;
- EF_{3PRP, SO} for sheep and other animals has been updated;
- A method to estimate annual amount of nitrogen in crop residues (above and below ground) annually returned to soils has been updated;
- Default values for N_{AG(T)}, N_{BG(T)}, R_{AG(T)}, R_{S(T)} and DRY have been updated;
- Default EF₂ has been eliminated from table 11.1; however, a tier 1 guidance to estimate N₂O emissions from cultivation of histosols has been revised. A more clear reference to the Wetlands Supplement has been introduced (2019 Refinement to the 2006 IPCC Guidelines, vol. 4, chap. 11, p.11.10);



Indirect N₂O emissions from agricultural soils:

- Default EF₄ (nitrogen volatilization and redeposition) and EF₅ (leaching/run-off) have been updated; In addition, EF₄ has been further disaggregated according to climate regimes;
- Default Fra_{CGASF} (volatilization from synthetic fertilizer), Fra_{CGASM} (Volatilization from all organic nitrogen fertilizers applied, and dung and urine deposited by grazing animals) and Fra_{CLEACH-(H)} (nitrogen losses by leaching/run-off in wet climates) have been updated; moreover, Fra_{CGASF} has been further disaggregated by type of synthetic fertilizer.

9.2. Walk-through examples: assessment of accuracy

Now you are invited to review the estimates of N₂O emissions from managed agricultural soils. Please review the inventory submitted by a Party from Western Europe in 2024.



Please open spreadsheet https://unfccc.int/resource/tet/ba/ba5-04_L5_CS1_WE.xlsx to study the relevant CRT and answer the following question.

What would be your assessment regarding consistency in the AD used to estimate direct and indirect N₂O emissions from managed agricultural soils and the emissions estimates reported under the other categories?

You may write your assessment here:

Hint:

As a reviewer, you can ask the following questions:

CRT 3.D.6 cultivation of organic soils (i.e. histosols)

- Is the area of cultivated histosols in line with the area of organic soils reported in the LULUCF sector for cropland remaining cropland, land converted to cropland, grassland remaining grassland and land converted to grassland?

CRT 3.D.a.5 mineralization immobilization associated with loss/gain of soil organic matter

- Are losses of soil carbon in cropland remaining cropland (reported in the LULUCF sector) accompanied by N₂O emissions from mineralization associated with loss of soil organic matter reported in this category?
- Are the emissions correctly allocated between the agriculture sector and the LULUCF sector, that is, only mineralization/immobilization in cropland remaining cropland included under the agriculture sector and the rest under the LULUCF sector CRT 4(III)?

CRT 3.D.b indirect N₂O emissions from managed soils

- Are the AD consistent with the calculations in the direct emissions of N₂O from soils?
- Have all nitrogen input sources been estimated in a consistent mode to the nitrogen sources considered in direct emissions?
- Has it been demonstrated that any default factors used are applicable to the national circumstances?

Assessment of accuracy – how to formulate questions

Effective communication between the TERT and the Party is one key to a successful review process. Hence, it is important that the TERT makes the necessary effort to ensure that the communications are clear and concise. Now it is your turn to practice; try to draft a clarification question regarding the first finding you identified (3.D.6 *Cultivation of organic soils*). You may use the guidance on how to formulate questions to be asked to a Party provided in lesson 2 above.

You may write your assessment here:

A hypothetical answer of the Party could be as follows:

Dear TERT, the total area of organic soils under grassland is 831 ha and this value was considered in the estimates of N₂O emissions from managed organic soils under the agriculture sector. However, 400 ha from the total area of organic soils under grassland has been defined as a part of a nature reserve and as such not subject to agricultural management or drainage. Therefore, we have not considered it in the estimates of CO₂ emissions from managed organic soils.

For the second (CRF 3.D.a.5 *mineralization/immobilization associated with loss/gain of soil organic matter*) and third (CRT 3.D.b *indirect N₂O emissions from managed soils*) findings, you may assume that the Party acknowledged the findings and stated that the calculation errors will be corrected by the next submission.

Assessment of accuracy – recording in the review report

Here you are invited to describe your findings in the review report. Please explain the TERT findings with references to the CRT and/or NID, summarize any communication with the Party during the review, indicate why the TERT finds that the Party is not meeting applicable reporting requirements of the MPGs and include the TERT recommendation or encouragement in a precise and clear manner. Draft the description of your findings here:

Assessment of accuracy – implementation status of the previous recommendations

To facilitate continuous improvement, each Party should, to the extent possible, identify, regularly update and include the information on areas of improvement identified by the Party and the TERT, and on any progress made, including those previously identified as part of the technical expert review (MPGs, para. 7). Moreover, paragraph 146 of the MPGs states that a technical expert review includes the identification of areas of improvement for the Party.

In real reviews, the progress in implementing recommendations identified by you will be assessed by another reviewer in the subsequent review cycle. However, since this is an educational exercise, you are invited to assess the progress of the Party towards the implementation of the recommendation posed in the first part of the exercise.



Please open CRT 3.D https://unfccc.int/resource/tet/ba/ba5-05_L5_CS1_WE_25s.xlsx (only assess the cultivation of organic soils (i.e. histosols) subcategory) submitted by the Party in its subsequent submission.

Assess whether the Party made progress in implementing the recommendation made within the previous review cycle.

You may write your assessment here:

9.3. Walk-through examples: assessment of completeness

You are invited to review the inventory results submitted by a developing country Party in 2026.



Please open a PDF copy of the NID https://unfccc.int/resource/tet/ba/ba5-06_L5_CS2_NID.pdf

The CRT has not been submitted and, therefore, it should not be considered for this exercise. Please review the information reported and answer the following question:

What would be your preliminary assessment regarding the completeness of the estimates for direct N₂O emissions from managed agricultural soils?

You may write your assessment here:

9.4. Answer key to walk-through examples

Assessment of accuracy

CRT 3.D.1.f cultivation of organic soils (i.e. histosols)

As a reviewer, you must assess whether the area of cultivated histosols reported in CRT 3.D is in line with the area of organic soils reported in the LULUCF sector for cropland remaining cropland, land converted to cropland, grassland remaining grassland, and land converted to grassland. Note that if you detect large differences in the areas, it may indicate a problem in the inventory (e.g. “NO” reported for this category even if organic soils in cropland or grassland occur).

Pay attention to the footnote to CRT 3.D. It states that the emissions from cultivation/management of cropland and grassland are to be included. For a definition of organic soils, see footnote 4, page 11.6, in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

The area cultivated histosols reported by the Party in its CRT 3.D was 2,779 ha in 2022. The total area of managed organic soils, calculated by summing areas of organic soils reported in CRT 4.B and 4.C for the same year was 2,379 ha (a sum of 1,958 ha and 421 ha, respectively). Hence, as a reviewer, you must raise a question and ask the Party to clarify the inconsistency in the data of the total histosols areas reported in CRT 3.D and in CRTs 4.B and 4.C.

CRT 3.D.1.e mineralization/ immobilization associated with loss/gain of soil organic matter

As a reviewer, you must assess whether the Party provided the estimates of N₂O emissions from mineralization associated with loss of soil organic matter in cropland remaining cropland. Note that N₂O immobilization associated with a gain of organic matter resulting from the management of mineral soils can be reported only when a Party applies a tier 3 approach. In addition, as a reviewer, you must assess whether the emissions between the agriculture sector and the LULUCF sector are correctly allocated, that is, only mineralization/immobilization in cropland remaining cropland included under the agriculture sector and the rest under the LULUCF sector in CRT 4(III).

In its CRT 4.B, the Party reported gains in carbon stocks in cropland remaining cropland in 2022. However, CRT 3.D.5 includes the N₂O emissions from mineralization associated with loss of soil organic matter in cropland remaining cropland in the same year. This is not in line with the 2006 IPCC Guidelines, as CO₂ emissions (i.e. soil carbon losses) should be accompanied by a simultaneous mineralization of nitrogen and the release of N₂O. Moreover, in its CRT 4(III), the Party reported the same amount of N₂O emissions occurring from managed soils as was reflected in CRT table 3.D.5 – that is, 0.0169 kt N₂O emissions.

As this is an educational case study, you do not have any opportunity to examine the Party’s NID and review how the Party conducted the estimates of N₂O emissions reported in CRT 4(III). Nevertheless, you may note from CRT 4(III) that the same amount of N₂O emissions (i.e. 0.0169 kt) was reported under the 4(III).B cropland subcategory. Moreover, a comparison of the data on mineral soil areas due to the land-use practices reported in CRT 4.B on forest land converted to cropland (subcategory 4.B.2.a of CRT 4.B) and grassland converted to cropland (subcategory 4.B.2.b of CRT 4.B) with those reported in CRT 4(III) (i.e. subcategory 4(III).B.2 land converted to cropland) shows that the areas are identical. Hence, you may preliminarily conclude that the Party double counted N₂O emissions resulting from the land-use change practices and reported the emissions twice: in CRT 3.D.5 and CRT 4(III).

CRT 3.D.2 indirect N₂O emissions from managed soils

Based only on the data presented in CRT 3.D, it is difficult to make the assessment regarding consistency in the AD used to estimate direct and indirect N₂O emissions from agricultural soils. However, a simple one-step cross-check might be performed: taking into account the values of Fra_{CGASM} , Fra_{CGASF} and $Fra_{CLEACH-(H)}$ and the AD on nitrogen inputs reported by the Party in its CRT 3.D, you may replicate the calculations of indirect N₂O emissions from agricultural soils (i.e. atmospheric deposition, and leaching and run-off). Your calculation will show that the amount of nitrogen volatilized is 57,233,820 kg N, and nitrogen leached is 169,574,095 kg N, in 2022. However, in its CRT 3.D the Party reported 49,233,820 kg N volatilized and 163,574,095 kg N leached. Hence, as a reviewer, you may preliminarily conclude that the Party overestimated indirect N₂O emissions from agricultural soils and contact the Party for further clarification.

Assessment of accuracy – how to formulate questions

One possible clarification question might be formulated as follows:

The TERT noted that the AD on the areas of cultivated histosols used to estimate N₂O emissions from managed soils (2,739 ha reported in CRT 3.D for 2022) is not consistent with those reported in CRT 4.B and CRT 4.C for the same year – 2,379 ha calculated by summing 1,958 ha organic soils under cropland (CRT 4.B) and 431 ha organic soils under grassland (CRT 4.C). Could the Party clarify the discrepancies in the AD used to estimate N₂O and CO₂ emissions from managed organic soils?

Assessment of accuracy – recording in the review report

3.D.1.f cultivation of organic soils (i.e. histosols)

The Party reported emissions for this category using a tier 1 approach, using a total area of organic soils and the default IPCC EF (8 kg N/ha). The TERT noted that the total area of organic cultivated soils reported in CRT 3.D (2,779 kha for 2022) is not consistent with those calculated as the sum of the areas reported in CRT 4.B and 4.C (2,379 ha for 2022).

During the review, the Party indicated that the total area of organic soils under grassland is 831 ha and this value was considered in the estimates of N₂O emissions from managed organic soils under the agriculture sector. However, since 400 ha of the total area of organic soils under grassland is a part of a nature reserve (i.e. not subject to agricultural management or drainage), CO₂ emissions for this area should not have been included. The TERT considers that this is an overestimation of emissions as, according to the 2006 IPCC Guidelines (vol. 4, chap. 11, p.11.7), such an area is considered out of the scope of cultivation of histosols.

The TERT recommends that the Party recalculate N₂O emissions from cultivated organic soils using only the total area of organic soils subject to agricultural management or drainage.

3.D.a.5 mineralization/immobilization associated with loss/gain of soil organic matter – N₂O

The TERT noted that the same N₂O emissions were reported in CRT 3.D and CRT 4(III). For example, in 2022, the Party reported 0.0167 kt N₂O emissions for category 3.D.a.5 in CRT 3.D under the agriculture sector and the same amount for category 4.B.2 land converted to cropland in CRT 4(III) under the LULUCF sector. The TERT considers that this may indicate double counting of emissions. Furthermore, the TERT considers that only N₂O emissions from the mineralization of soil organic matter under

cropland remaining cropland should be reported under the agriculture sector in accordance with footnote 2 to CRT 4(III) and footnote 4 to CRT 3.D.

The TERT recommends that the Party report only N₂O emissions from the mineralization of soil organic matter under cropland remaining cropland in category 3.D.a.5 in CRT 3.D, or, if there is no mineralization of soil organic matter under cropland remaining cropland, use the notation key “NO”.

3.D.2 indirect N₂O emissions from managed soils – N₂O

The Party reported indirect N₂O emissions from agricultural soils in CRT 3.D, including the values for $Frac_{GASM}$, $Frac_{GASF}$ and $Frac_{LEACH-(H)}$ used to estimate indirect N₂O emissions from agricultural soils.

The TERT calculated the amount of nitrogen volatilized and leached using those fractions and the AD provided in CRT 3.D. The TERT noted that its estimates were lower than the AD reported by the Party for indirect N₂O emissions in CRT 3.D (for 2022 the TERT estimated 57,233,820 kg N for atmospheric deposition and 169,574,095 kg N for leaching and run-off, while CRT 3.D reports 49,233,820 kg N and 163,574,095 kg N, respectively). The TERT therefore considers that the Party has overestimated indirect N₂O emissions from agricultural soils. During the review, the Party acknowledged the finding of the TERT and explained that CRT 3.D was the subject of recommendations and recalculations in previous reviews.

The TERT recommends that the Party correct the reporting of AD for indirect N₂O emissions from agricultural soils for the time series in CRT 3.D and revise the respective emission estimates.

Assessment of accuracy – implementation status of the previous recommendations

As you might have noted, the Party has not revised the data on areas of organic soils and has not recalculated N₂O emissions: 2,779 ha was reported in the 2024 submission and the same area has been employed to estimate N₂O emissions in the 2025 submission. Hence, as a reviewer, you may conclude that the Party has not made progress in implementing the improvement identified under the first part of the exercise.

Assessment of completeness

First of all, it should be noted that the Party has followed the reporting format of the 2006 IPCC Guidelines, rather than the CRT format as set out in decision 5/CMA.3. As a reviewer, you must be aware of the correspondence between these two reporting formats.

Despite the differences in reporting tables between the 2006 IPCC Guidelines and the CRTs, GHG emissions should be estimated using the methodologies from the 2006 IPCC Guidelines (MPGs, para. 20).

The estimates of direct N₂O emissions cover the following nitrogen input sources (CRT 3.D):

- Inorganic nitrogen fertilizers (i.e. nitrogen input from application of inorganic fertilizers to cropland and grassland) (category 3.D.1.a);
- Organic nitrogen fertilizers (i.e. nitrogen input from organic nitrogen fertilizers to cropland and grassland) (category 3.D.1.b);
- Urine and dung deposited by grazing animals (i.e. nitrogen excretion on pasture, range and paddock) (category 3.D.1.c);

- Crop residues (i.e., nitrogen in crop residues returned to soils) (category 3.D.1.d);
- Mineralization/immobilization associated with loss/gain of soil organic matter (i.e. nitrogen in mineral soils that is mineralized/immobilized in association with loss of soil carbon) (category 3.D.1.e);
- Cultivation of organic soils (i.e. histosols) (category 3.D.1.f);
- Other (category 3.D.1.g).

In chapter 5.10.1.3.3 of the NID, the Party reported that direct and indirect N₂O emissions from managed soil comprise nitrogen inputs from crop residues, application of synthetic nitrogen fertilizers and land-use practices associated with land-use change. Based on this information, as a reviewer, you can preliminarily consider that the Party has conducted the estimates of direct N₂O emissions from only three categories: 1) application of synthetic fertilizers (3.D.1.a) to managed agricultural soils; 2) decomposition and mineralization of nitrogen in agricultural residues left on site (3.D.1.d); and 3) from the loss of soil organic carbon stocks in mineral soils through land-use or management changes (3.D.1.e).

Regarding direct N₂O emissions released due to the application of organic fertilizers (i.e. animal manure, 3.D.1.b.i), the Party has not provided any information. Hence, this finding might be (preliminarily) treated as an issue of completeness.

Moreover, in chapters 5.10.1.2.4.2 (“Emissions from cropland”) and 5.10.1.2.4.3 (“Emissions from grassland”), the Party has not provided any detailed information on allocating the total managed area in the areas of mineral and organic soils.

As a reviewer, you must raise clarification questions on the findings discussed above. Moreover, if the Party confirmed that, for example, direct N₂O emissions due to animal manure application to agricultural soils have not been calculated, you must verify that the emissions/estimates would be insignificant in terms of threshold level. According to paragraph 32 of the MPGs, emissions from a category should be considered insignificant only if the likely level of emissions is below 0.05 per cent of the national total GHG emissions, excluding LULUCF, or 500 kt CO₂ eq, whichever is lower. The total national aggregate of estimated emissions for all gases from categories considered insignificant must remain below 0.1 per cent of the national total GHG emissions, excluding LULUCF.

FX

According to paragraph 32 of the MPGs, for those Parties that need flexibility in the light of their capacities, emissions from a category should be considered insignificant only if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO₂ eq, whichever is lower. The total national aggregate of estimated emissions for all gases from categories considered insignificant must remain below 0.2 per cent of the national total GHG emissions, excluding LULUCF.

10. Practical exercises

10.1. Practical exercise 1

A Party reported the following values of nitrogen in the agriculture sector of its inventory

Total nitrogen excreted in the liquid manure management system	337,987,068	kg N
Total nitrogen excreted in the solid manure management system	1,916,904,616	kg N
Total nitrogen excreted by grazing animals	452,967,935	kg N
Total nitrogen volatilized as NH ₃ and NO _x from the manure management system	784,649,554	kg N
Nitrogen lost through leaching and run-off from the manure management system	0	kg N
Total nitrogen lost from the manure management system	925,325,843	kg N
Amount of manure nitrogen available for application to soils (N _{MMS_Avb})	1,404,689,413	kg N
Applied animal manure (F _{AM})	1,123,751,530	kg N
Nitrogen deposited by grazing animals on pasture, range and paddock (F _{PRP})	452,967,935	kg N

Which statement best describes the consistency of the data provided in your opinion?

Select one:

- No value is consistent with the others
- The sum of nitrogen excreted in the manure management system corrected with total nitrogen lost from the manure management system is higher than the amount of manure nitrogen available for application to soils, which is not consistent
- The sum of nitrogen excreted in the manure management system corrected with the total nitrogen lost from the manure management system is lower than the amount of manure nitrogen available for application to soils, which is not consistent
- Total losses of nitrogen from the manure management system comprise about 41 per cent of the total nitrogen excretion in the manure management system, which is too high and is not consistent
- The animal manure applied to managed soils is lower than the amount of manure nitrogen available for application to soils, which is not consistent
- The total nitrogen volatilized as NH₃ and NO_x from the manure management system is lower than the total nitrogen losses from the manure management system, although nitrogen lost through leaching and run-off equals to zero, which is not consistent
- All data are consistent

Tip:

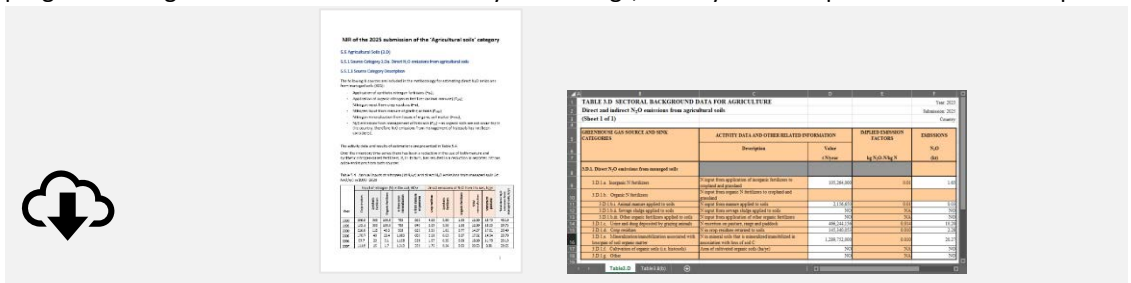
The total quantity of nitrogen produced in manure is not larger than (if nitrogen from bedding material is considered) or equal to (if nitrogen from bedding is not included) the sum of the nitrogen reported as urine and dung from grazing animals (F_{PRP}), managed animal manure (F_{AM}) applied to soils, nitrogen manure used for other purposes (e.g. energy sources, construction and animal fodder) and total nitrogen losses from manure

management systems. See equation 10.34 and table 10.23 in chapter 10 and equation 11.4 in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

10.2. Practical exercise 2

This exercise is more complex than the first two – you are invited to review the information reported by a Party in the NID of its 2025 GHG emission inventory submission in the agricultural soils (direct N₂O emissions from agricultural soils) category and to draft the text for the review report based on your findings.

As the review is likely to be your first experience of preparing an inventory review report for a Party, six questions have been prepared to test your knowledge and provide useful hints to support your progress through the exercise. Take notes of your findings, as they will be inputs for the review report.



The image shows two documents side-by-side. On the left is a page from a National Inventory Document (NID) titled 'Table 10.23. Direct N₂O emissions from managed soils'. It contains text describing the methodology and data used for the emissions calculation. On the right is a screenshot of an Excel spreadsheet titled 'TABLE 10.23. DIRECT N₂O EMISSIONS FROM MANAGED SOILS'. The spreadsheet has columns for 'ACTIVITY DATA AND OTHER RELATED INFORMATION', 'EMISSION FACTORS', and 'EMISSIONS'. It lists various agricultural activities and their corresponding emission factors and total emissions.

Please open a copy of the NID https://unfccc.int/resource/tet/ba/ba5-07_L5_Exercise_2_case.pdf and CRT https://unfccc.int/resource/tet/ba/ba5-08_L5_Exercise_2_CRT_tables.xlsx to start with the guiding questions.

Practical exercise 2 – question 1

Which statement best describes the completeness of the Party's submission on direct N₂O emissions from managed soils?

Select one:

- A. The inventory is complete
- B. The inventory would be complete if the Party included information to justify that the category does not occur within the country
- C. The inventory would be complete if verifiable information could be obtained from the Party that supports the assumption that no types of organic fertilizer other than animal manure are applied to soils
- D. The inventory is incomplete because nitrogen input from bedding material is not included in the estimations of F_{ON}; however, it is likely that bedding has been used in solid storage and dry lot manure management systems
- E. The inventory is incomplete because nitrogen mineralization on grasslands is not included
- F. B and C
- G. B and D
- H. B, C and D

Practical exercise 2 – question 2

Based on the analysis made for question 2.1 above, which of the conclusions of the TERT is correct?

Select one:

- A. The TERT recommends that the Party provide verifiable information that organic soils do not exist in the country and that no types of organic fertilizer other than animal manure are applied, or that the Party estimate respective N₂O emissions from soils. The TERT encourages the Party to investigate available data on nitrogen content in the bedding material and perform estimations of this nitrogen source to the soils. The TERT further encourages the Party to include nitrogen mineralization on grasslands in its reporting
- B. The TERT encourages the Party to provide verifiable information that organic soils do not exist in the country and that no types of organic fertilizer other than animal manure are applied, or that the Party estimate the respective N₂O emissions from soils. Furthermore, the TERT encourages the Party to investigate available data on nitrogen content in bedding material and perform estimations of this nitrogen source to the soils
- C. The TERT recommends that the Party provide verifiable information that organic soils do not exist in the country and that no types of organic fertilizer other than animal manure are applied, or that the Party estimate the respective N₂O emissions from soils. The TERT encourages the Party to investigate available data on nitrogen content in bedding material and perform estimations of this nitrogen source to the soils
- D. None of the above

Tip

If emissions from mandatory subcategories (management of histosols; application of F_{SEW} , F_{COMP} and F_{OOA}) are not estimated, verifiable information should be provided by the Party to demonstrate that these sources do not exist in the country.

In accordance with the 2006 IPCC Guidelines, estimations of nitrogen input to soils with bedding organic material from solid storage and deep bedding manure management systems are optional and may depend on the availability of data.

Practical exercise 2 – question 3

Which statement best describes the TERT assessment of the transparency of the information in the NID?

Select one:

- A. The information is mostly transparent; however, the NID does not provide AD on annual yields of crops. This information could be provided in an annex to the NID
- B. The information is mostly transparent; however, the NID does not explain transparently how AD on synthetic fertilizers for 1990–1995 have been adjusted to account for the consumption trend
- C. The information is mostly transparent; however, the NID does not provide AD on annual yields of crops or explain transparently how consistency of AD on synthetic fertilizers is ensured, taking into account that different sources of information have been used
- D. The information is transparent
- E. The information is not transparent

Tip

See the definition of transparency in the 2006 IPCC Guidelines on reporting of GHG inventories (vol. 1, chap. 1).

Practical exercise 2 – question 4

Review carefully the methodology used by the Party to estimate direct N₂O emissions from soils. What would be the conclusion based on your expertise?

Select one:

- A. The methodology used is in line with the 2006 IPCC Guidelines, volume 4, chapter 11
- B. The methodology used is not in line with the 2006 IPCC Guidelines, volume 4, chapter 11
- C. The methodology applied generally is in line with the 2006 IPCC Guidelines; however, the Party has not separated nitrogen inputs to the soils under irrigated rice where a different EF₁ is recommended (0.003 kg N₂O-N/kg N). This leads to overestimation of direct N₂O emissions
- D. The methodology applied is generally in line with the 2006 IPCC Guidelines; however, the Party has considered nitrogen inputs from crop residues from perennial grasses every year instead of calculations only in the year of pasture renewal. This leads to overestimation of direct N₂O emissions
- E. The methodology applied is generally in line with the 2006 IPCC Guidelines; however, the Party has not included nitrogen mineralization on grassland remaining grassland in the estimations. This leads to underestimation of direct N₂O emissions
- F. C and D
- G. C and E

Help:

See chapter 11 of volume 4 of the 2006 IPCC Guidelines.

Practical exercise 2 – question 5

Which statement best describes the TERT assessment of the consistency of the information contained in the NID and CRTs reported by the Party?

Select one:

- A. The information is fully consistent
- B. The information is not consistent between the NID and CRT because AD and direct N₂O emissions from crop residues for 2023 reported in NID table 5.4 and CRT table 3.D are different
- C. Information presented in the NID and the CRT is mostly consistent; however, inconsistencies were found between AD and direct N₂O emissions from crop residues reported in NID table 5.4 and CRT table 3.D for 2023
- D. The information is not consistent

Help

See table 5.4 of the NID and CRT 3.D.

Practical exercise 2 – question 6

Review carefully the calculations of AD used to estimate direct N₂O emissions as reported in the corresponding CRT.

What would be the conclusion based on your expertise?

Select one:

- A. AD for manure applied to soils (F_{ON}) are underestimated by two orders of magnitude. Therefore, N₂O emissions from managed soils are underestimated
- B. AD for synthetic fertilizers are overestimated as they are not adjusted for volatilization of NH₃ and NO_x
- C. AD for nitrogen mineralization in soils are underestimated
- D. All of the above
- E. None of the above
- F. A and B.

Tip

See section 10.5.4, chapter 10, of volume 4 of the 2006 IPCC Guidelines.

Practical exercise 2 – question 7

In the box below, draft the text for the review report on N₂O emissions from agricultural soils using the findings of questions 2.1 to 2.6 above.

Remember that you have to describe the problem identified, provide your assessment and give a clear recommendation or encouragement addressing the issue identified. Try to keep the text as short and concise as possible, but ensure that there is no trade-off in transparency.

Include in the review report only those findings that you consider to be major. Note that during a real review, you will also have to describe the response received from the Party before making any recommendation or encouragement.

Please draft your text here.

10.3. Answer key to practical exercises

Practical exercise 1

The correct answer is G.

All data is consistent.

To calculate the amount of manure nitrogen available for application to soils, the nitrogen excreted in all manure management systems is summed (2,254,891,685 kg N), except for nitrogen excreted by grazing animals (452,967,935 kg N).

The sum of nitrogen excretion in liquid and solid manure management systems corrected with total nitrogen losses from manure management systems is lower (1,329,565,841 kg N = 2,254,891,685 kg N – 925,325,843 kg N) than the amount of manure nitrogen available for application to soils. This could be consistent if nitrogen from bedding material used in the solid manure management system is included in calculations (*this information is missing in the table*). See equation 10.34, chapter 10, of volume 4 of the 2006 IPCC Guidelines.

The total nitrogen losses from manure management systems comprise about 41 per cent (925,325,843 kg N/2,254,891,685 kg N) of the total nitrogen excreted in liquid and solid manure management systems. This is consistent with data provided in table 10.23, chapter 10, in volume 4 of the 2006 IPCC Guidelines: for the solid manure management system (which is the larger contributor), default nitrogen losses are in the range of 40–50 per cent for cattle, swine and poultry, and 15 per cent for other animals. Therefore, these data could be consistent.

The animal manure applied to managed soils is lower than the amount of manure nitrogen available for application to soils, and it could be consistent if other fractions of managed manure (used for feed (F_{FEED}), burned for fuel (F_{FUEL}) or used for construction (F_{CONST})) were not zero (*this information is missing in the table*). See equation 11.4, chapter 11, in volume 4 of the 2006 IPCC Guidelines.

The total nitrogen losses from manure management systems (925,325,843 kg N) should be higher than the sum of nitrogen volatilized as NH_3 and NO_x and nitrogen lost through leaching and run-off in manure management systems (784,649,554 kg N + 0 kg N) because total losses also include losses with N_2O .

The data on the total nitrogen excreted by grazing animals is consistent with the data on the nitrogen deposited by grazing animals on pasture, range and paddock (F_{PRP}) (452,967,935 kg N = 452,967,935 kg N, accordingly).

Practical exercise 2 – question 1

The correct answer is F

The Party used the notation key “NO” to report emissions from management of organic soils (i.e. histosols) (F_{OS}). However, the NID does not include any information to justify that the category does not occur in the country (option B is correct).



As a reviewer, you must assess whether the Party provided justification that the category or process does not occur when the notation key “NO” is used.

In addition, you may use international data sets to check the data reported by the Party. Namely, the area of organic soils in the country could be compared with FAOSTAT data. If any differences with FAOSTAT data are identified, you must communicate with the Party to clarify the discrepancies.



If major discrepancies are found between the Party's reported data and those provided by other recognized data sources (e.g. International Energy Agency or FAOSTAT), and they cannot be adequately explained by the Party, you should encourage the Party to explore the reason for these discrepancies.

In accordance with the 2006 IPCC Guidelines, organic fertilizers (F_{ON}) include applied animal manure (F_{AM}), sewage sludge applied to soil (F_{SEW}), compost applied to soils (F_{COMP}) and other organic amendments of regional importance to agriculture (e.g. rendering waste, guano, brewery waste) (F_{OOA}). The Party has estimated direct N_2O emissions only from F_{AM} . The Party used the notation key "NO" to report emissions from sewage sludge applied to soils (3.D.1.b.ii) and other organic fertilizers applied to soils (3.D.1.b.iii). However, the NID does not include any information to justify that these activities do not occur within the country (option C is correct). Omission of other sources could lead to incompleteness of the inventory if the Party was not able to provide supporting documentation for its assumptions.

The 2006 IPCC Guidelines (vol. 4, chap. 10, p.10.64) state: "Where organic forms of bedding material (straw, sawdust, chippings, etc.) are used, the additional nitrogen from the bedding material should also be considered as part of the managed manure N applied to soils." In addition, the 2006 IPCC Guidelines (p.10.66) clarify the following: "Bedding materials vary greatly, and inventory compilers should develop values for $N_{beddingMS}$ based on the characteristics of bedding material used in their livestock industries. Limited data from scientific literature indicates the amount of nitrogen contained in organic bedding material applied for dairy cows and heifers is usually around $7 \text{ kg N animal}^{-1} \text{ yr}^{-1}$, for other cattle is $4 \text{ kg N animal}^{-1} \text{ yr}^{-1}$, for market and breeding swine is around 0.8 and $5.5 \text{ kg N animal}^{-1} \text{ yr}^{-1}$, respectively. For deep bedding systems, the amount of N in litter is approximately double these amounts." Moreover, the amount of nitrogen used as bedding material should be reflected in the crop residue mass balance and not taken into account in the estimates of N_2O emissions from crop residues left on fields (3.D.1.d). If a fraction of above-ground residues of crops removed annually for purposes such as feed, bedding and construction ($Frac_{Remove(T)}$; 2006 IPCC Guidelines, vol. 4, chap.11, p.11.14) is not evaluated, then the inventory compiler should assume that there was no removal, and the total amount of nitrogen contained in crop residues used as bedding is considered as nitrogen input to estimate N_2O emissions from residues left on agricultural fields, underestimation of N_2O emissions from the agricultural soils category can be avoided. Hence, this finding cannot be treated as an issue of completeness (option D is incorrect).

Footnote 5 to CRT 3.D states that "Methodologies for estimating N_2O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from management of mineral soils are based on equations 11.1, 11.2 and 11.8 of the 2006 IPCC Guidelines. N_2O immobilization associated with gain of organic matter resulting from management of mineral soils may only be reported if a Party applies a tier 3 approach in the relevant calculation." According to the NID, "In CRF table 4.C (2023) for Grassland remaining Grassland the Party reported the value of carbon stock changes in mineral soils as gain of 2,000 kt C." Hence, as you might have noted, the changes in

organic matter of mineral soils have been reported as gain and the Party could not report N₂O emissions from this subcategory (option E is incorrect).

Practical exercise 2 – question 2

The correct answer is C.

If a Party used the notation key “NO” to report emissions from any category, it should include information to justify that a category does not occur within the country. As a reviewer, you must assess, if “NO” is used, whether a Party has provided justification that the category or process does not occur within the country and, if not, to recommend that the Party include the justification in its next submission.

Nevertheless, as a reviewer, you may encourage the Party to obtain country-specific data on the amount of bedding (expressed in nitrogen) used in the livestock sector and perform estimations of this nitrogen source to the soils, as that is a matter of allocation of emissions with the agricultural soils category and does not lead to underestimation of N₂O emissions for this category.

Since the changes in organic matter of mineral soils under grassland result in gain of soil organic matter and nitrogen immobilization, and can be estimated using a tier 3 method, as a reviewer, you do not have to proceed with this and do not need to make either a recommendation or an encouragement (option A is incorrect).

The TERT encourages the Party to include nitrogen mineralization on grassland in its reporting.

Practical exercise 2 – question 3

The correct answer is C.

Vol. 1, Chap. 1.4 of the 2006 IPCC Guidelines provides the following definition of transparency: “There is sufficient and clear documentation such that individuals or groups other than the inventory compilers can understand how the inventory was compiled and can assure themselves it meets the *good practice* requirements for national greenhouse gas emissions inventories.”

In general, the information provided in the NID is mostly transparent. However, as you might have noted, the Party reported that the data on “the amounts of nitrogen-based fertiliser (F_{SN}) used on agricultural soils per year in kg N were obtained from the following sources 1) FAOSTAT: data for the period 1990–1995, and 2) National Statistics Office (NSO): data on the nitrogen-based fertilizer applied between 1996 and 2024”, but has not clarified how consistency of AD on synthetic fertilizers is ensured, for example, which splicing technique has been applied to minimize the potential inconsistencies in the time series taking into account that different sources of information have been used.

Moreover, the Party has provided the data on parameters used to estimate nitrogen input to the soil with crop residues (table 5.5 of the NID); however, AD on the amounts of crop produced (or crop yield) have not been reported in the NID, which makes the documentation not sufficiently accessible and transparent to enable the reviewer understand how the emissions from crop residues left on site have been compiled.

Practical exercise 2 – question 4

The correct answer is F: C and D.

In its NID (p.4), the Party reported that “Direct N₂O emissions have been estimated using the default emission factor from the 2006 IPCC Guidelines (0.01 kg N₂O-N per kg N).”

However, as you might have noted, table 11.1, chapter 11, in volume 4 of the 2006 IPCC Guidelines provides a disaggregated value of EF₁ according to two types of conditions: for mineral soils and for flooded rice fields.

Emission factor	Default value
EF ₁ for nitrogen additions from mineral fertilizers, organic amendments and crop residues, and nitrogen mineralized from mineral soils as a result of loss of soil carbon [kg N ₂ O-N (kg N) ⁻¹]	0.01
EF _{1FR} for flooded rice fields [kg N ₂ O-N (kg N) ⁻¹]	0.003

Moreover, you might have noted that the Party reported in table 5.5. of the NID that rice is produced in the country; hence, as a reviewer, you may conclude that the Party applied the inappropriate EF₁ to estimate direct N₂O emissions due to nitrogen inputs to the soils under irrigated rice (option C is correct).

In addition, in its NID (p.4), the Party clarified that “The coefficients A, B and D, used for calculation of the mass of nitrogen, which is additionally released into the soil with the crop residues, are shown in table 5.5. A renewal time (i.e., fraction = Fra_CRENEW) was assumed to be 1.” Moreover, the Party reported the coefficients A, B and D relevant for perennial grass seeded legumes and seeded perennial grasses, which clarifies that the production practice of perennial forage crops occur within the country. However, in the 2006 IPCC Guidelines, the nitrogen residue from perennial forage crops is only accounted for during periodic pasture renewal, that is, not necessarily on an annual basis as is the case with annual crops. The 2006 IPCC Guidelines (vol. 4, chap. 11, p.11.14) specify that “Fra_CRenew (T) = fraction of total area under crop T that is renewed annually. For countries where pastures are renewed on average every X years, Fra_CRenew = 1/X. For annual crops Fra_CRenew = 1” (option D is correct).

As discussed under question 4.1 of the current exercise, the NID states “In CRF table 4.C (2023) for Grassland remaining Grassland the Party reported the value of carbon stock changes in mineral soils as gain of 2,000 kt C.” Hence, the Party’s action was in line with the 2006 IPCC Guidelines (option E is incorrect).

Practical exercise 2 – question 5

The correct answer is C.

Information presented in the NID and the CRT is mostly consistent; however, inconsistencies were found between AD and direct N₂O emissions from crop residues reported in NID table 5.4 and CRT 3.D for 2023.

In table 5.4 of the NID, the Party reported 145.2 kt N from crop residues in 2023 and direct N₂O emissions of 2.28 kt N₂O. In CRT 3.D, the Party provided the following numbers for crop residues: 145,540,053 kg N (or 145.5 kt N) and 2.25 kt N₂O (option C is correct).

Practical exercise 2 – question 6

The correct answer is A.

The TERT may replicate estimations of nitrogen available for the application to soils using data on total nitrogen excretion per animal category, as reported in CRT 3.B(b), and correct them by total nitrogen losses, as indicated in the NID (for poultry (50 per cent), swine (50 per cent), dairy cows (40 per cent), other cattle (50 per cent) and other animals (15 per cent)). The result of such a calculation is 214,953,609 kg N, which is two orders of magnitude higher than the 2,156,650 kg N reported in CRT 3.D.

Practical exercise 2 – question 7

Exemplary answer:

In CRT 3.D, the Party used the notation key “NO” to report N₂O emissions from cultivation of organic soils. However, the TERT noted that in its NID, the Party stated that no organic soils occur in the country; it also noted that no references were provided.

The TERT recommends that the Party justify its assertion that organic soils do not exist and/or are not cultivated in the country.

The TERT noted that only animal manure was considered as a source of direct N₂O emissions under the organic fertilizers category (3.D.1.b). All other categories of organic fertilizers were reported using the notation key “NO”, but no information is provided in the NID to justify the assertion that the category does not occur within the country.

The TERT recommends that the Party estimate all the respective N₂O emissions from soils or provide in its next GHG inventory submission verifiable information confirming that no types of organic fertilizer other than animal manure are applied.

The Party used AD on the amount of synthetic fertilizers applied to agricultural soils from two different reference sources: 1) the data for 1990–1995 were obtained from FAOSTAT; and 2) the National Statistics Office was a reference source to obtain the data for 1996–2024. However, the TERT noted that no explanatory information on the type of adjustment technique used to ensure time-series consistency has been provided in the NID.

The TERT recommends that the Party improve the transparency of the reporting of direct N₂O emissions due to application of synthetic fertilizer (3.D.1.a) by providing explanatory information on the adjustment technique applied to ensure consistency of the AD time series for synthetic fertilizers.

The TERT noted that the AD on annual yields of crops produced and areas cultivated to produce crops are not provided in the NID, which makes it difficult to assess the total amount of crop residues produced over the entire reporting period and understand how direct N₂O emissions from crop residues left on the fields have been estimated.

The TERT recommends that the Party enhance the transparency of its reporting on crop residues in the NID by providing information on annual yields of crops produced and areas cultivated to produce crops.

The TERT noted that the methodology applied by the Party to estimate direct N₂O emissions due to nitrogen additions from crop residues is generally in line with the 2006 IPCC Guidelines (vol. 4, chap.

11, p.11.14). In its NID (p.4), the Party reported that “Direct N₂O emissions have been estimated using the default emission factor from the 2006 IPCC Guidelines (0.01 kg N₂O-N per kg N).” However, the TERT noted from table 5.5 of the NID that rice cultivation practices also occur in the country. Therefore, the TERT considers that the Party applied an inappropriate EF₁ to estimate direct N₂O emissions due to nitrogen inputs to the soils under irrigated rice (with lower default EFs, 0.003 kg N₂O-N/kg N), which can lead to a potential overestimation of direct N₂O emissions from crop residues left on the fields (3.D.1.d).

The TERT recommends that the Party revise its estimates of direct N₂O emissions from agricultural soils by distinguishing nitrogen inputs to soils under rice cultivation and other soils to prevent any overestimation of emissions.

The TERT noted that in its NID (p.4), the Party used a renewal time for all types of crops at the value of 1 (i.e., $Frac_{RENEW} = 1$) to calculate direct N₂O emissions from crop residues left on site (3.D.1.d). However, the TERT further noted that no clarification was provided on whether the fraction has been applied to calculate N₂O emissions from residues of annual crops and perennial grasses or only from residues of annual crops left on the fields. Hence, the TERT considers that if N from residues of perennial grasses has been calculated annually instead of only in the year of pasture renewal, it would lead to overestimation of direct N₂O emissions.

(As this is an educational exercise, as a reviewer, you are not able to communicate with the Party and clarify this finding. Therefore, the recommendation is to provide clarification on which $Frac_{RENEW}$ value has been used to calculate direct N₂O emissions from crop residues left on site (3.D.1.d). However, it is a less likely option during the real reviews, as one possible recommendation could be to use an appropriate $Frac_{RENEW}$ value, calculated as $Frac_{RENEW} = 1/X$, for pastures that are renewed on average every X years).

The TERT recommends that the Party clarifies the value of $Frac_{RENEW}$ applied to estimate direct N₂O emissions from pasture renewal.

The TERT noted that the AD on the amount of manure applied to soils (F_{ON}) as reported in CRT 3.D for 2023 are underestimated by two orders of magnitude (2,156,650.4 kg N) compared with those reported in CRT 3.B(b) (estimated by the TERT to be 214,953,609.1 kg N) for the same year.

The TERT recommends that the Party explain the discrepancies in the data on amounts of nitrogen manure available to be applied (CRT B(b)) and applied to agricultural soils (CRT 3.D) in 2023 and revise its estimates accordingly.

11. Self-check quiz

Question 1

The following nitrogen sources are included in the methodology for estimating indirect N₂O emissions from managed soils:

1. Synthetic nitrogen fertilizers (F_{SN});
2. Organic nitrogen applied as fertilizer (F_{ON});
3. Urine and dung nitrogen deposited on pasture, range and paddock by grazing animals (F_{PRP});
4. Nitrogen in crop residues, including from nitrogen -fixing crops and from forages during pasture renewal (F_{CR});
5. Nitrogen mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils (F_{SOM});
6. Drainage/management of organic soils (i.e., histosols) (F_{OS}).

Select one:

- A. True
- B. False

Question 2

The total nitrogen excreted by animals should be considered as available organic fertilizer to be applied to managed agricultural soils.

Select one:

- A. True
- B. False

Question 3

The term $Fra_{LEACH-(H)}$ is used to estimate N₂O emissions from leaching and run-off. However, the inventory compilers must apply the term only to regions where soil water-holding capacity is exceeded as a result of rainfall and/or irrigation (excluding drip irrigation) and leaching/run-off occurs. Hence, as a reviewer, you should consider this fraction.

Select one:

- A. True
- B. False

Question 4

A Party reported that the amount of synthetic fertilizers applied to agricultural soils is 100,000 t/year in 1990–1996 and 1,500 t/year in 2017. However, since the values for 1996–2017 and 2018–2025 are missing from the statistical authorities, the Party indicated that the value of 1990 has been constantly applied for 1996–2017 and the value of the amount of synthetic fertilizers reported for 2017 has been used in the estimates of N₂O emissions in 2018–2025. As a reviewer, you would agree with the approach used by the Party.

Select one:

- A. True
- B. False

Question 5

A developing country Party has not reported the quantitative uncertainty rates associated with the AD on the synthetic fertilizers applied to agricultural soils (a key category), noting its intent to apply flexibility for the uncertainty analysis. The Party also stated that the uncertainties related to the AD are extremely high and reported that due to the lack of quantitative information a quantitative uncertainty assessment could not be performed. As a reviewer, you would accept the approach used by the Party.

Select one:

- A. True
- B. False

Question 6

Read through the description of the finding recorded by the TERT in the review report and classify it into one of the TACCC principles:

A developed country Party reported N₂O emissions from mineralization/immobilization associated with loss/gain of soil organic matter using the notation key “NO” in CRT 3.D. During the review, the Party explained that it reported these emissions as “NO” because there is no mineralization/immobilization associated with loss/gain of soil organic matter in the country as there is no change in carbon stocks in mineral soils.

However, the TERT noted a net change in carbon stocks in mineral soils stemming from a loss of soil carbon due to the conversion of perennial crops to annual crops. During the review, the Party acknowledged the issue and provided a preliminary estimate of the amount of nitrogen mineralized in mineral soils as a result of loss of soil carbon through a change in land use or management equal to 5,427,544 kg N/year, which would result in emissions of 0.085 kt N₂O/year, or 25.41 kt CO₂ eq/year. The TERT noted that this amount is below the significance threshold indicated in paragraph 32 of the MPGs (47.71 kt CO₂ eq/year).

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness

Question 7

Read the finding recorded by the TERT in the review report and classify it into one of the TACCC principles:

An Eastern European Party reported in the NID that it assumed a nitrogen content in sewage sludge of 4 per cent to calculate N₂O emissions from sewage sludge applied to soils. The Party explained that the value was based on a short literature review consisting of a report on sewage sludge management in Western European countries and a peer-reviewed paper on soil microbial problems in sewage sludge disposal.

In the report on sewage sludge management provided by the Party during the review week, the TERT noted that the nitrogen content of sewage sludge is in the range of 2-6 per cent, according to the Association for Water, Wastewater and Waste of a Western European country. The peer-reviewed paper had been published in the Party in 1985 and reported the nitrogen content of sewage sludge in the range of 2.5–5 per cent; however, this figure has been taken over from another peer-reviewed paper, also provided by the Party during the review week, that reported an aggregate nitrogen content of sewage sludge of Western European countries in 1963.

The TERT considered that the applicability of the data of Western European countries to the Party's national circumstance, as well as the applicability of the data in the peer-reviewed publication based on research carried out in 1963, had not been justified.

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness

Question 8

Read the finding recorded by the TERT in the review report and classify it into one of the TACCC principles:

In its NID, the Party used the default fraction of nitrogen losses through leaching/run-off (0.3) provided in the 2006 IPCC Guidelines (vol. 4, table 11.3). However, in CRT 3.D (additional information), the Party used the notation key "NA" for $Fra_{LEACH-(H)}$.

The TERT recommends that the Party report the applied value 0.3 for $Fra_{LEACH-(H)}$ instead of the notation key "NA" in CRT 3.D.

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness

Question 9

Read the finding recorded by the TERT in the review report and classify it into one of the TACCC principles:

A Party reported “NO” in CRT 3.G-I for CO₂ emissions from liming for the entire time series. The Party explained in its NID that no liming has taken place in the country since 1987.

During the review, the Party clarified that, after discussion with the Institute of Soil Science, it became clear that liming had not been carried out in the country since 1988. Following agricultural reforms and the closure of so-called “labour cooperative farms”, liming became unprofitable. The TERT considers the Party’s response reasonable.

The TERT recommends that the Party explain in the NID that liming has not been carried out in the country since 1988, following agricultural reforms and the closure of so-called “labour cooperative farms”, which made liming unprofitable.

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness

11.1. Answer key to self-check quiz

Question 1

The correct answer is B.

Drainage/management of organic soils is not accounted as a nitrogen source for indirect N₂O emissions from managed soils.

For more information, see section 11.2.2, chapter 11, of volume 4 of the 2006 IPCC Guidelines.

Question 2

The correct answer is B.

A significant proportion of the total nitrogen excreted by animals in managed systems (i.e. all livestock except those in pasture and grazing conditions) is lost prior to final application to managed soils or for use as feed or fuel or for construction purposes. In order to estimate the amount of animal manure nitrogen that is directly applied to soils, or available for use as feed or fuel or for construction purposes (i.e. the value used in the 2006 IPCC Guidelines, vol. 4, chap. 11, equation 11.1 or 11.2), it is necessary to reduce the losses of nitrogen through volatilization (i.e. NH₃, dinitrogen and NO_x), conversion to N₂O and losses through leaching and run-off from the total amount of nitrogen excreted by animals in managed systems.

Question 3

The correct answer is A.

The term Fra_{CLEACH} previously used has been modified so that it now applies only to regions where soil water-holding capacity is exceeded, as a result of rainfall and/or irrigation (excluding drip irrigation) and leaching/run-off occurs.

For dryland regions, where precipitation is lower than evapotranspiration throughout most of the year and leaching is unlikely to occur, the default Fra_{CLEACH} is zero. The method of calculating whether Fra_{CLEACH-(H)} = 0.30 should be applied is given in table 11.3 in chapter 11 of volume 4 of the 2006 IPCC Guidelines.

Question 4

The correct answer is B.

Each Party should use surrogate data, extrapolation, interpolation and other methods consistent with splicing techniques contained in the 2006 IPCC Guidelines to estimate missing emission values resulting from lack of AD, EFs or other parameters in order to ensure a consistent time series (MPGs, para. 27).

As a reviewer, you must recommend that the Party apply the most appropriate splicing technique to derive the AD and to conduct the estimates of the emissions over time.

For more information on the techniques developed to resolve data gaps, please see chapter 5.3 in volume 1 of the 2006 IPCC Guidelines.

Question 5

The correct answer is A.

According to paragraph 29 of the MPGs, those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead provide, at a minimum, a qualitative discussion of uncertainty for key categories, and are encouraged to provide a quantitative estimate of uncertainty for all source and sink categories of the GHG inventory.

Hence, as a reviewer, you would accept the approach by the Party. When a developing country Party applies the flexibility provided for in the MPGs, the TERTs shall not review the Party's determination to apply such flexibility or whether the Party possesses the capacity to implement that specific provision without flexibility. The TERT could also note that according to paragraph 29 of the MPGs, Parties are encouraged to provide a quantitative estimate of uncertainty for all source and sink categories of the GHG inventory.

Question 6

The correct answer is E.

The issue must be defined as a completeness issue because the Party did not conduct and report N₂O emissions from category 3.D.a.5 mineralization/immobilization associated with loss/ gain of soil organic matter. The Party reported a net change in carbon stocks in mineral soils stemming from a loss of soil carbon due to the conversion of perennial crops to annual crops. However, the Party has not accompanied these losses with the estimates of N₂O emissions as required by the 2006 IPCC Guidelines (vol.4. chap. 11, p.11.15).

Question 7

The correct answer is B.

As indicated, the Party did not provide a reference source to support the nitrogen content of sewage sludge used to estimate N₂O emissions. Thus, it could appear as a transparency issue. However, during the review, the TERT clarified that the value used by the Party cannot be treated as country-specific, as it was derived from the studies conducted by a cluster of countries with different economic situations (i.e. for Western Europe), and therefore it may not be representative of Eastern European countries. Hence, the TERT concluded that using the reported nitrogen content of sewage sludge may lead to underestimation or overestimation of N₂O emissions and a failure to follow the requirements of the accuracy quality principle.

Question 8

The correct answer is D.

Paragraph 31(c) of the MPGs indicates that the notation key "NA" should be used "for activities under a given source/sink category that do occur within the Party but do not result in emissions or removals of a specific gas".

Comparability is defined in the 2006 IPCC Guidelines (vol. 1, chap. 1) as follows: "The national greenhouse gas inventory is reported in a way that allows it to be compared with national greenhouse

gas inventories for other countries.” This comparability should be reflected in an appropriate choice of key categories, and in the *use of the reporting guidance* and tables and use of the classification and definition of categories of emissions and removals.

The information on the value of $Fra_{CLEACH-(H)}$ has been provided by the Party in its NID and the value has been used in the estimates of the emissions. However, the Party used the notation key “NA” to report the value in the corresponding table (CRT 3.D). Hence, the TERT concluded that the requirements with regard to reporting guidance for this particular category (3.D.b.2 nitrogen leaching and run-off) have not been met.

Question 9

The correct answer is A.

The Party has not provided any information in the NID to justify that this practice is not being carried out in the country. During the review week, the Party presented the outcome of expert judgment. The TERT agreed with this information submitted by the Party during the review week; however, the TERT concluded that the Party’s reporting does not fulfil the requirement of the transparency quality criterion (i.e. the Party did not provide clear documentation such that individuals or groups other than the inventory compilers can understand how the inventory was compiled).

12. Key points to remember

- The N₂O emissions that result from anthropogenic nitrogen inputs or nitrogen mineralization occur through both:
 - A direct pathway (i.e. directly from the soils to which the nitrogen is added/released); and
 - Through two indirect pathways (i.e. volatilization of NH₃ and NO_x and the subsequent redeposition, and through leaching and run-off of nitrogen).
- Chapter 11 of volume 4 of the 2006 IPCC Guidelines contains the methodologies to estimate direct and indirect N₂O emissions from the agricultural soils category.
- Paragraph 28 of decision 5/CMA.3 notes that the Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines.
- Annex I to decision 5/CMA.3 provides the template of CRTs for the electronic reporting of the information in the national inventory reports of anthropogenic GHG emissions by sources and removals by sinks:
 - CRT 3.D contains information on the tier method used, AD and EFs applied and assumptions made in the estimates of direct and indirect N₂O emissions from managed soils.
- Annex V to decision 5/CMA.3 outlines the NID, pursuant to the MPGs:
 - Chapter 5 of the NID includes the information on methods, AD, EFs, parameters and GHG emissions released from the categories of the agriculture sector.
- As a reviewer, you must assess the following review elements (for more detail information please see “Key points to consider when reviewing the agricultural soils category” of the current lesson):
 - ② *Choice and use of method*, for example, whether a Party followed the route reflected in the decision tree of the 2006 IPCC Guidelines (vol. 4, chap. 11, figure 11.2); whether the estimation methods used to estimate direct and indirect N₂O emissions follow good practice guidance; and whether a Party has transparently explained the rationale for its selection of AD, parameters and assumptions applied in its calculations;
 - ② *AD*, for example, whether all nitrogen inputs are considered and estimated; whether default or country-specific AD, EFs and partition fractions for each of the categories of nitrogen added to soils have been used; and whether the AD used by a Party are comparable with those reported by international organizations;
 - ② *EFs*, for example, whether all parameters used in the estimates are documented and cited in the NID; and whether calculated EFs are compared with the IPCC defaults;
 - ② *Cross-cutting issues*: whether there are double counting or omissions of:
 - i. Emissions due to potential reporting of inorganic nitrogen applied to land-use categories other than agricultural soils (e.g. forest land);
 - ii. Different fractions of crop residues (e.g. those used for the input to soils, burning, animal production);
 - iii. Nitrogen from animal manure (particularly, nitrogen from manure management systems with composting) and nitrogen in compost included in the organic fertilizers;

- iv. Nitrogen from animal manure (F_{AM}) and in urine and dung deposited on pasture, range and paddock by grazing animals (F_{PRP});
 - v. N_2O emissions from areas of histosols on cropland and grassland reported under agricultural soils and under the category emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRT 4(II)) of the LULUCF sector) and from the application of synthetic and organic fertilizers reported under agricultural soils and under the category direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (CRT 4(III)) of the LULUCF sector.
- As a reviewer, you must record any finding identified by you; however, the review report is the written record of the key issues that the TERT concludes needs to be resolved by the Party in order for the Party to be fully in compliance with the reporting requirements of the MPGs.
 - As a reviewer, you must not jump to conclusions without consultation with a Party to obtain further clarifications of findings you identified; therefore, it is essential that you, as a reviewer, make the necessary effort to ensure that communications are clear and concise, as effective communication between the TERT and the Party is one key to a successful review process.

Lesson 6: Rice cultivation

1. Introduction

1.1. Learning objectives and time needed to complete the lesson

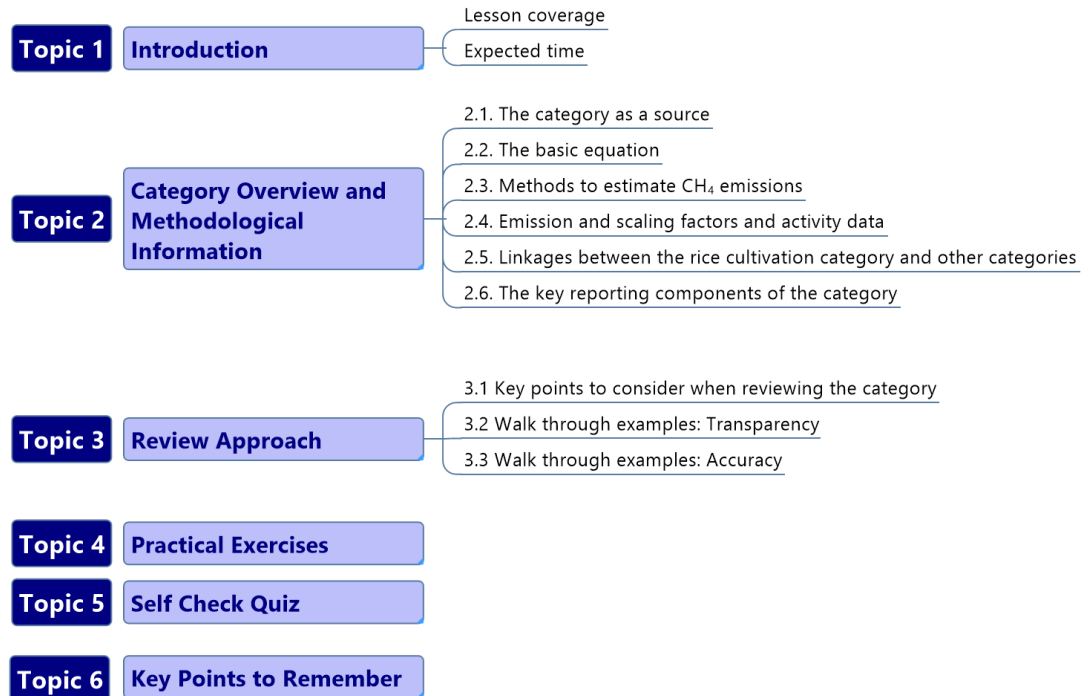
This lesson describes the methodological basis underlying the estimates of CH₄ emissions from rice cultivation and addresses the approaches that the TERT should apply in reviewing this category.

At the end of this lesson, you will be able to:

- Identify reporting components and methodological references relevant to the rice cultivation category;
- Understand how the rice cultivation category interlinks with other categories within the agriculture sector and other sectors of the inventory;
- Focus on the key review points and be aware of possible actions by the TERT in its review of CH₄ emissions from rice cultivation;
- Understand how to formulate clarification questions to a Party;
- Identify findings or issues, draft relevant encouragements or recommendations in a review report;
- Classify issues into one of the TACCC principles.

Expected time needed to complete lesson 6: ~60 minutes

1.2. Structure of the lesson



2. Category overview and methodological information

2.1. The rice cultivation category as a source

Anaerobic decomposition of organic material in flooded rice fields produces CH₄, which escapes to the atmosphere primarily by diffusive transport through the rice plants during the growing season. However, during land preparation and initial growth of rice, ebullition (bubbling) is the major release mechanism. Diffusion loss of CH₄ across the water surface is the least significant process (in terms of the volume of emissions). Upland rice fields, which are not flooded, do not produce significant quantities of CH₄.

The annual amount of CH₄ emitted from a given area of rice is a function of:

- The number and duration of cultivation periods per season;
- Water regimes before and during the cultivation period;
- Organic and inorganic soil amendments.

Soil type, temperature and rice cultivar also affect CH₄ emissions.



U. Figure 6-1. Rice cultivation

2.2. Basic equation to estimate CH₄ emissions

CH₄ emissions are estimated by multiplying daily EFs by rice cultivation period and annual harvested areas.

The basic equation to estimate CH₄ emissions from rice cultivation is given by the following function (2006 IPCC Guidelines, vol. 4, chap. 5, equation 5.1, p.5.45):

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

Where:

CH_{4 Rice} = annual CH₄ emissions from rice cultivation, Gg CH₄ yr⁻¹

EF_{ijk} = a daily EF for *i*, *j* and *k* conditions, kg CH₄ ha⁻¹ day⁻¹

A baseline EF for no flooded fields for less than 180 days prior to rice cultivation and continuously flooded fields during the rice cultivation period without organic amendments (EF_c) is used as a starting point. The IPCC default for EF_c is 1.30 kg CH₄/ha/day (with error range of 0.80 – 2.20)

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 CH₄ emissions from rice may vary. Hence, it is *good practice* to take these variables into account.

The conditions ***i*, *j* and *k***, represented in equation 5.1 of the 2006 IPCC Guidelines, are defined as follows:

Variable <i>i</i> - Water regime	Variable <i>j</i> - Organic amendment to soils	Variable <i>k</i> - Other conditions
<p>Combination of</p> <p>(i) <i>ecosystem type</i> (i.e., irrigated, rainfed, and deep-water rice production) and,</p> <p>(ii) <i>flooding pattern</i> (continuously/ intermittently flooded, regular rainfed, drought prone, and deep water).</p>	<p>The impact on CH₄ emissions depends on type and amount of the applied material, that can either be of</p> <p>(i) <i>endogenous origin</i> (straw, green manure, etc.) or</p> <p>(ii) <i>exogenous origin</i> (compost, farmyard manure, etc.)</p>	<p>It is known that other factors, such as soil type, rice cultivar or sulphate containing amendments can significantly influence CH₄ emissions.</p>
Table 5.12, Table 5.13	Equation 5.3; Table 5.14	p. 5.51



For more information, see chapter 5 of volume 4 of the 2006 IPCC Guidelines.

2.3. Methods to estimate CH₄ emissions from rice cultivation

The decision tree for estimating CH₄ emissions from rice production (see 2006 IPCC Guidelines, vol. 4, chap. 5, figure 5.2) outlines the steps that Parties should follow. The main features of this decision tree are as shown in figure 6-2.

Tier 1	Tier 2	Tier 3
<p>If CH₄ from rice production is not a key category, emissions can be estimated using the tier 1 method and default EFs and scaling factors together with AD for the harvested area and cultivation period.</p>	<p>If country-specific EFs are available for different water regimes or if CH₄ from rice production is a key category, emission estimates should follow the tier 2 method.</p>	<p>If country-specific methods, including modelling or direct measurement approaches, are available, emissions should be estimated using the tier 3 method.</p>

V. Figure 6-2. The main features of the decision tree for identification of the appropriate tier to estimate CH₄ emissions from rice cultivation

To learn more about the tier methods, see below.

<p>Tier 1</p> <p>Tier 1 requires disaggregation of the annual harvested area of rice for at least three baseline water regimes:</p> <ul style="list-style-type: none"> • Irrigated; • Rain-fed; • Upland. <p>Incorporating as many of the conditions (e.g. cropping management, water regime, organic amendments, etc.) that influence CH₄ emissions as possible is encouraged. Emissions for each subunit are adjusted by multiplying a baseline default EF (for a field with no pre-season flooding for less than 180 days prior to rice cultivation and continuously flooded fields without organic amendments) by various scaling factors. The calculations are carried out for each water regime and organic amendment separately. With this disaggregated approach, total annual emissions are equal to the sum of emissions from each subunit of harvested area.</p>
<p>Tier 2</p> <p>Tier 2 applies the same methodological approach as tier 1, but country-specific EFs and/or scaling factors should be used.</p>
<p>Tier 3</p> <p>Tier 3 includes models and monitoring networks that are tailored to address national circumstances of rice cultivation, repeated over time, driven by high-resolution AD and disaggregated at the subnational level. Proper documentation of the validity and completeness of the data, assumptions, equations and models used is critical.</p>



Please see p.5.47, chapter 5, volume 4 of the 2006 IPCC Guidelines for more information on tier approaches.



See section 2.6 in lesson 2 (p.28) for:

- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

2.4. Emission and scaling factors, and activity data

The detailed guidance on choice of emission and scaling factors is presented in section 5.5.2, chapter 5, in volume 4 of the 2006 IPCC Guidelines (p.5.48). Table 6-1 summarizes the information reported in the 2006 IPCC Guidelines.

Table 6-1. Emission and scaling factors used in tier methods

	Tier 1	Tier 2	Tier 3
EF	A baseline EF for no flooded fields for less than 180 days prior to rice cultivation and continuously flooded during the rice cultivation period without organic amendments (EF _c) is used as a starting point.	Country-specific EFs from field measurements that cover the conditions of rice cultivation in the country can be used.	The tier 3 approach does not require choice of EFs, but is instead based on a thorough understanding of drivers and parameters.
Scaling factor	Scaling factors are used to adjust the EF _c to account for the various conditions, e.g.: water regime during and before cultivation period and organic amendments (equation 5.2).	Country-specific definition of the baseline management and scaling factors for other conditions. If country-specific factors are not available, the default may be used.	

Activity data

- AD are primarily based on harvested area statistics, available from a national statistics agency together with information on cultivation period and agronomic practices.
- National data are preferable but if not available, international data sets such as the International Rice Research Institute and FAOSTAT can be used, especially with the tier 1 method.

International Rice Research Institute: www.irri.org

FAOSTAT: <https://www.fao.org/faostat/en/#home>

- The following rice cultivation characteristics should be considered in calculating CH₄ emissions as well as in developing emission factors (see table below):

Regional differences in rice cropping practices	If a country has distinct agricultural regions with different climate and/or production systems (e.g. flooding patterns), a separate set of calculations should be performed for each region.
Multiple crops	If more than one crop is harvested on a given area of land during the year, and the growing conditions vary among cropping seasons, calculations should be performed for each season.
Water regime	Water regime is defined as a combination of

	<p>i. Ecosystem type; and</p> <p>ii. Flooding pattern.</p> <p>Ecosystem type: at a minimum, separate calculations should be undertaken for each rice ecosystem (i.e., irrigated, rain-fed and deep water rice production).</p> <p>Flooding pattern: the flooding pattern of rice fields has a significant effect on CH₄ emissions. Rice ecosystems can further be distinguished into continuously and intermittently flooded (irrigated rice) and regular rain-fed, drought prone, and deep water (rain-fed), according to the flooding patterns during the cultivation period. The, flooding pattern before the cultivation period should also be considered.</p>
Organic amendments to soils	<p>Organic material incorporated into rice soils increases CH₄ emissions. The impact of organic amendments on CH₄ emissions depends on type and amount of the applied material which can be described by a dose response curve.</p> <p>Organic material incorporated into the soil can either be of endogenous (straw, green manure, etc.) or of exogenous origin (compost, farmyard manure, etc.). Calculations of emissions should consider the effect of organic amendments.</p>
Other conditions	<p>It is known that other factors, such as soil type, rice cultivar, sulphate containing amendments, etc., can significantly influence CH₄ emissions. Inventory agencies are encouraged to make every effort to consider these conditions if country-specific information about the relationship between these conditions and CH₄ emissions is available.</p>

- The use of locally verified areas correlated with available data for EFs under differing conditions such as climate, agronomic practices and soil properties is very useful, especially for higher-tier methods.

Regional differences in rice cropping practices	If a country has distinct agricultural regions with different climate and/or production systems (e.g. flooding patterns), a separate set of calculations should be performed for each region.
Multiple crops	If more than one crop is harvested on a given area of land during the year, and the growing conditions vary among cropping seasons, calculations should be performed for each season.
Water regime	Water regime is defined as a combination of <ul style="list-style-type: none"> iii. Ecosystem type; and iv. Flooding pattern. <p>Ecosystem type: at a minimum, separate calculations should be undertaken for each rice ecosystem (i.e., irrigated, rain-fed and deep water rice production).</p> <p>Flooding pattern: the flooding pattern of rice fields has a significant effect on CH₄ emissions. Rice ecosystems can further be distinguished into continuously and intermittently flooded (irrigated rice) and regular rain-fed, drought prone, and deep water (rain-fed), according to the flooding patterns during the cultivation period. The, flooding pattern before the cultivation period should also be considered.</p>
Organic amendments to soils	Organic material incorporated into rice soils increases CH ₄ emissions. The impact of organic amendments on CH ₄ emissions depends on type and amount of the applied material which can be described by a dose response curve. Organic material incorporated into the soil can either be of endogenous (straw, green manure, etc.) or of exogenous origin (compost, farmyard manure, etc.). Calculations of emissions should consider the effect of organic amendments.
Other conditions	It is known that other factors, such as soil type, rice cultivar, sulphate containing amendments, etc., can significantly influence CH ₄ emissions. Inventory agencies are encouraged to make every effort to consider these conditions if country-specific information about the relationship between these conditions and CH ₄ emissions is available.



As a reviewer, you should assess whether the AD on the rice harvested area broken down by regional differences in cropping practices or water regime is equal to the national totals.

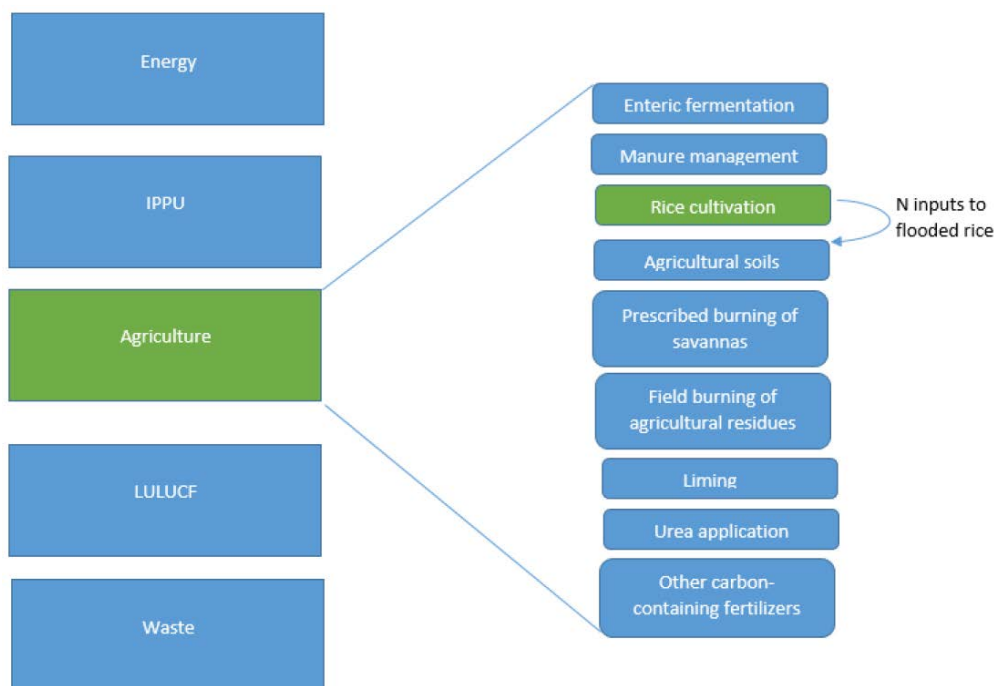


As a reviewer, you should assess whether a Party documented any reference sources and assumptions used to choose EFs and scaling factors and whether the EFs and scaling factors used correspond to the national circumstances.

2.5. Linkages between the rice cultivation category and other categories

Figure 6-3 demonstrates the main linkages between the rice cultivation category and the other categories in the agriculture sector.

The AD to estimate CH₄ emissions from organic amendments such as compost, farmyard manure, green manure and rice straw should be consistent with those used to estimate N₂O emissions from nitrogen inputs to flooded rice under the agricultural soils category.



W. Figure 6-3. Main linkages between the rice cultivation category and the other categories in the agriculture sector and other sectors

2.6. Key reporting components of the rice cultivation category

Table 6-2 summarizes the main reporting components and methodological references related to the rice cultivation category.

Table 6-2. Summary of key elements of the rice cultivation category

Overview	Category-specific information	
Category name	Rice cultivation	
General reference	2006 IPCC Guidelines, volume 4, chapter 5.5	
Relevant chapter of the NID	Chapter 5: Agriculture	
Reporting in CRT	CRT 3.C	
Main subcategories and GHG to be reported	Irrigated	CH ₄
	Rain-fed	CH ₄
	Deep water	CH ₄
	Other	CH ₄

In addition to the generic reporting instructions, individual reporting requirements are included in the footnotes of each CRT. Parties may report additional information in the documentation boxes in the CRT. Hence, as an agriculture expert, you must familiarize yourself with the footnotes and the information provided by the Party in the documentation boxes. Moreover, you must assess the information reported in summary report tables and in cross-cutting tables.

3. Review approach

3.1. Key points to consider when reviewing the rice cultivation category



A brief description of three common review steps (prepare – assess - draft) is provided in https://unfccc.int/resource/tet/ba/ba6-01_L-R-steps.pdf. Please read carefully before continuing with the key points to consider when reviewing emissions from rice cultivation, if you have not yet done so.

The choice of methods, selection of assumptions, development and selection of EFs and collection and selection of AD are the main drivers of inventory quality. Hence, as a reviewer, you must assess and ensure that the selection of these data carried out by a Party are in accordance with the 2006 IPCC Guidelines and its supplements and the requirements in the UNFCCC decisions.

Table 6-3 summarizes the possible questions and actions that you can ask yourself when reviewing the emissions reported under the rice cultivation category.

Table 6-3. Possible actions by the expert review team in its review of CH₄ emissions from the rice cultivation category

Review element	Possible question/action by the ERT
Choice of method	If CH ₄ emissions from rice cultivation are identified as a key category, whether country-specific seasonally integrated EFs for each region and scaling factors for water regime before and during cultivation periods, rates and types of organic amendments, and soil types have been developed and used.
Use of method	Does the method used account for the various conditions of rice cultivation within a country?
Completeness	Have all rice systems covered in the 2006 IPCC Guidelines been estimated?
EFs	Are the EFs specific or default IPCC? Are country-specific EFs based on recent research results within the country? Have scaling factors been used?
AD	If soil submergence is not limited to the actual rice growing season, are emissions outside of the rice growing season reported?
EFs	If default values (e.g. for scaling factors) were used, and whether these values are applicable to the national circumstances.
AD	In the case of multiple cropping during the same year, is the annual harvested area equal to the sum of the area cultivated for each cropping?
AD	Is the total cultivated area consistent with international data sources such as FAOSTAT and the International Rice Research Institute?

In addition, there are several common elements to be assessed across sectors/categories when reviewing the quality of the Party's submission (i.e. uncertainty analysis, QA/QC, time-series consistency, recalculations and progress in implementing improvements); lesson 2 above provides a list of guiding questions.

As a reviewer, you must first focus on the observations which have an impact on the level and/or trend of the GHG emissions. Moreover, in the case of issues related to transparency (i.e. the NID does not clearly describe how emissions were estimated), the TERT should specifically determine whether the lack of transparency in the inventory leads it to question the accuracy of the inventory estimates reported.



Please note that table 6-3 is not intended to provide an exhaustive list of questions; it is rather a starting point to stimulate your thinking. You may add or modify the questions as appropriate while conducting a review.



Paragraph 28 of decision 5/CMA.3 notes that the Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines. Hence, as a reviewer you must be aware of the improvements undertaken in the 2019 Refinement to the 2006 IPCC Guidelines.

An overview of the changes between the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC Guidelines is provided below:

- Default CH₄ baseline EF has been updated; the stratification by region has been introduced;
- Default CH₄ emission scaling factors for water regimes during the cultivation period relative to continuous flooded fields have been updated;
- Default CH₄ emission scaling factors for water regimes before the cultivation period have been updated;
- Default conversion factors for different types of organic amendments have been updated;
- Default cultivation periods of rice have been provided; the stratification by region has been introduced.

3.2. Walk-through examples: assessment of transparency

Now you are invited to review the estimates of CH₄ emissions from the rice cultivation.

Review the NID submitted by Riceland in 2025.



Please open a PDF copy https://unfccc.int/resource/tet/ba/ba6-02_L6_RICELAND.pdf of the NID.

What would be your assessment regarding the transparency of the information reported by the Party in its NID?

You may write your assessment here:

Assessment of transparency – how to formulate questions

Effective communication between the TERT and the Party is one key to a successful review process. Hence, it is important that the TERT makes the necessary effort to ensure that communications are clear and concise. Now it is your turn to practice; try to draft a clarification question regarding the finding you identified.

You may write your assessment here:

For the next exercise of this case study, please assume that in response to the question raised, the Party provided the TERT with the values of the parameters in question, and as a reviewer, you agreed with the information submitted by the Party during the review week.

Assessment of transparency – recording in the review report

Here you are invited to describe your finding in the review report. Please explain the TERT finding with references to the CRT and/or NID, summarize any communication with the Party during the review, indicate why the TERT finds that the Party is not meeting applicable reporting requirements of the MPGs and include the TERT recommendation or encouragement in a precise and clear manner.

You may write your assessment here:

3.3. Walk-through examples: assessment of accuracy

Review the NID submitted by the Party in 2026.



Please open a PDF copy https://unfccc.int/resource/tet/ba/ba6-03_L6_theParty.pdf of the NID.

What would be your assessment regarding the accuracy of the CH₄ estimates conducted by Party and reported in its NID?

You may write your assessment here:

Assessment of accuracy – how to formulate questions

Effective communication between the TERT and the Party is one key to a successful review process. Hence, it is important that the TERT makes the necessary effort to ensure that communications are clear and concise. Now it is your turn to practice; try to draft a clarification question regarding the finding you identified.

You may write your assessment here:

A hypothetical answer of the Party could be as follows:

Dear the TERT, thank you for the question. Unfortunately, the parameter has been mistakenly selected. The experts of the Party used the CF_{OA} parameter that represents “Straw incorporated shortly (<30 days) before cultivation” of table 5.14 in chapter 5, volume 4, of the 2006 IPCC Guidelines; however, we acknowledge that the use of the value in the row “Straw incorporated long (>30 days) before cultivation” (0.29) should be more appropriate to the national circumstances.

Assessment of accuracy – recording in the review report

Here you are invited to describe your finding in the review report. Please explain the TERT finding with references to the CRT and/or NID, summarize any communication with the Party during the review, indicate why the TERT finds that the Party is not meeting applicable reporting requirements of the MPGs and include the TERT recommendation or encouragement in a precise and clear manner.

Draft the description of your finding here:

3.4. Answer key to walk-through examples

Assessment of transparency

The Party provided the information regarding the method employed to calculate CH₄ emissions from rice cultivation activities in chapter 5.4.2 of the NID. However, the Party has not reported any numerical information on the parameters and the scaling factors applied in the estimates of CH₄ emissions. Hence, as a reviewer, you can conclude that the Party has not met the requirement of the transparency quality criterion (i.e. sufficient and clear documentation such that individuals or groups other than the inventory compilers can understand how the inventory was compiled and can assure themselves it meets the *good practice* requirements for national GHG emissions inventories). Moreover, as a reviewer, you must raise a clarification question to request more information on the numerical values of the parameters and the scaling factors used in the estimates and ensure that CH₄ emission from rice cultivation activities has not been underestimated.

Assessment of transparency – how to formulate questions

One possible version of the clarification question might be as follows:

The Party reported in its NID (section 5.4) that a tier 1 approach was used to estimate CH₄ emissions from rice cultivation along with default EFs. The adjusted daily EF was calculated based on equation 5.2 of the 2006 IPCC Guidelines. The required values of baseline EF (EF_c), water regime (SF_w), water regime in the pre-season (SF_p) to this equation were taken from tables 5.11–5.13 of the 2006 IPCC Guidelines. The adjusted CH₄ emission scaling factor for organic amendment (SF_o) was calculated using equation 5.3 of the 2006 IPCC Guidelines. The value of the conversion factor (CF_{OA}) was taken from table 5.14 of the 2006 IPCC Guidelines

However, the TERT noted that the Party has not provided the values of emission/scaling factors and parameters listed above.

Could the Party specify the values of the factors and parameters used in the estimates and provide the rationale for their selection?

For the next exercise of this case study, please assume that in response to the question raised, the Party provided the TERT with the values of the parameters in question, and as a reviewer, you agreed with the information submitted by the Party during the review week.

Assessment of transparency – recording in the review report

Examine how this issue has been described in the review report.

3.C.1 Irrigated rice:

The TERT noted that the NID does not include transparent information on the following values of parameters used for calculating the EFs for irrigated rice cultivation based on equation 5.2 of the 2006 IPCC Guidelines: baseline EF (EF_c), scaling factor for water regime (SF_w), scaling factor for water regime in the pre-season (SF_p), scaling factor for organic amendment (SF_o), conversion factor for organic amendment (CF_{OAi}) and application rate of organic amendment (ROA_i).

During the review, the Party provided the parameters to the TERT. The TERT assessed the parameters used by Riceland to calculate the EFs for irrigated rice cultivation and concluded that they are correct.

The TERT recommends that Riceland include the values of parameters used for calculating the EFs for irrigated rice cultivation in the NID.

Assessment of accuracy

The Party provided the information on the method used to calculate CH₄ from rice cultivation activities. Moreover, it described in detail the values of the scaling factors employed in the emissions estimates. However, when comparing the parameters and the scaling factors used by the Party with those reported in the 2006 IPCC Guidelines, it can be noted that the Party used the incorrect value for the conversion factor for organic amendment (CF_{OA}). Namely, the Party reported that the rice treatment practice that involves straw incorporated long before cultivation is in use in the country. However, the Party selected the CF_{OA} at the value of 1 from table 5.14 in chapter 5 of volume 4 of the 2006 IPCC Guidelines that corresponds to straw incorporated shortly before cultivation management practice. Hence, the correct value of 0.29 should be used in the calculation.

Assessment of accuracy – how to formulate questions

One possible version of the clarification question might be as follows:

The TERT noted that the Party reported in the NID that the rice cultivation treatment practice involved incorporating straw longer than 30 days before the cultivation of rice (i.e. incorporated under the CF_{OA} parameter). However, the TERT noted that the Party used the value of CF_{OA} that corresponds to “Straw incorporated shortly (<30 days) before cultivation” management practice of the rice fields.

Could the Party explain the inconsistency in the information reported in the NID and clarify which rice cultivation treatment practice is in use on the rice producing farms and specify the CF_{OA} employed to estimate CH₄ emissions from the rice cultivation?

Assessment of accuracy – recording in the review report

Examine how this issue has been described in the review report:

3.C rice cultivation

The TERT noted that the Party reported in the NID that the rice cultivation practice involved incorporating straw longer than 30 days before the cultivation of rice and clarified that the relevant C_{FOA} factor was applied at the value of 1. However, the TERT noted that the Party used the value of C_{FOA} that corresponds to “Straw incorporated shortly (<30 days) before cultivation” management practice of the rice fields.

During the review, the Party acknowledged that there was an error in the parameter selection. The C_{FOA} was selected from the row “Straw incorporated shortly (<30 days) before cultivation” of table 5.14 in chapter 5 of volume 4 of the 2006 IPCC Guidelines. However, the TERT noted that, in accordance with the cultivation practices carried out in the Party, the use of the value in the row “Straw incorporated long (>30 days) before cultivation” (0.29) would be more appropriate. The TERT noted that the use of the correct C_{FOA} parameter would result in a decrease in the estimated emissions.

The TERT recommends that the Party revise the estimate of CH₄ emissions by applying the correct C_{FOA}.

4. Practical exercises

4.1. Practical exercise 1

The following information is provided in the NID of a Party:

In order to estimate CH₄ emissions from rice cultivation, the default methodology suggested by the 2006 IPCC Guidelines was followed. The cultivated areas provided by the national statistical committee, the default EF (1.3 kg CH₄/ha/day) and typical cropping period (115 days) were used for the emissions calculation. Rice cultivated in the country is grown in continuously flooded fields with a non-flooded pre-season of less than 180 days, without the use of organic amendments and one cropping period is considered annually (*Reference to the case study, 2000*).

Does the Party's NID document the methodology and EFs used to estimate CH₄ emissions from rice cultivation (non-key category) in a transparent manner?

Select one:

- A. The information is not transparent enough because no justifications are given for the assumptions (e.g. the use of organic amendments), although they are referenced
- B. The information is not transparent at all
- C. The NID provides transparent information on the methodology and parameters used
- D. None of the above



Remember that as a reviewer, you may ask to see any related publications during the review.

4.2. Practical exercise 2

The annual amount of CH₄ emitted from a given area of rice is a function of the number and duration of crops grown, water regimes before and during the cultivation period and organic soil amendments. Soil type, temperature and rice cultivar also affect CH₄ emissions.

Select one:

- A. True
- B. False

4.3. Practical exercise 3

In the case of multiple cropping during the same year, the value of the harvested area used in the estimates should be taken as the average value of the areas cultivated for each cropping.

Select one:

- A. True
- B. False

4.4. Practical exercise 4

It is *good practice* to develop scaling factors that incorporate information on the type and amount of organic amendment applied (compost, farmyard manure, green manure and rice straw). The adjusted scaling factors should be used to estimate CH₄ emissions from the rice cultivation category. However, a Party may omit estimating N₂O emissions from the organic amendments applied, since CRT 3.C does not require reporting of N₂O emissions.

Select one:

- A. True
- B. False

4.5. Answer key to practical exercises

Practical exercise 1

The correct answer is C.

The information in the NID is transparent and allows replication of calculations. Although not enough substantiation is given in the NID on the choice of national parameters, a reference to a related case study is provided.

Practical exercise 2

The correct answer is A.

For more information, see page 5.44 in chapter 5 of volume 4 of the 2006 IPCC Guidelines.

Practical exercise 3

The correct answer is B.

In the case of multiple cropping during the same year, harvested area is equal to the sum of the area cultivated for each cropping.

Moreover, if more than one crop is harvested during a given year, emissions should be estimated for each cropping season taking into account possible differences in cultivation practice (e.g. use of organic amendments, flooding pattern before and during the cultivation period).

For more information, see page 5.45 in chapter 5 of volume 4 of the 2006 IPCC Guidelines.

Practical exercise 4

The correct answer is B.

N₂O emissions occurred due to the application of nitrogen in organic amendments to paddy should be reported under the agricultural soils category.

5. Key points to remember

- Anaerobic decomposition of organic material in flooded rice fields produces CH₄, which escapes to the atmosphere primarily by transport through the rice plants.
- Chapter 5 of volume 4 of the 2006 IPCC Guidelines contains the methodologies to estimate CH₄ emissions from the rice cultivation category.
- Paragraph 28 of decision 5/CMA.3 notes that Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines:
 - Chapter 5 provides the methodologies and the default EFs to be applied to estimate CH₄ emissions from rice cultivation.
- Annex I to decision 5/CMA.3 provides the template of CRTs for the electronic reporting of the information in the national inventory reports of anthropogenic GHG emissions by sources and removals by sinks:
 - CRT 3.C includes the information on the AD, EFs and CH₄ emissions released from rice cultivation according to their water regime practices during the cultivation period.
- CH₄ emissions from upland rice are assumed to be zero. However, the AD on harvested area should be reported by Parties in order to allow comparison with international statistics:
 - As a reviewer, you should assess whether the total cultivated area is consistent with international data sources such as FAOSTAT and the International Rice Research Institute.
- There are three tier methods described and implemented in the 2006 IPCC Guidelines; within this hierarchy, the level of disaggregation will depend upon the availability of activity and EF data, as well as the importance of rice as a contributor to a Party's national GHG emissions:
 - As a reviewer, you must assess whether the NID includes information on the IPCC tier used; whether the NID includes an explanation for key categories if the recommended methods from the appropriate decision tree in the 2006 IPCC Guidelines and its supplements are not used; if a recommended method is not used owing to lack of data or resources; and whether a Party adequately explained the national circumstances in the NID.
- CH₄ emissions from rice cultivation activities are estimated by multiplying daily EFs by cultivation period of rice and annual harvested areas; however, a set of different conditions should be considered to reflect country-specific agricultural practices in the estimation of CH₄ emissions:
 - As a reviewer, you must assess if default values (i.e. for scaling factors) were used and whether these values are applicable to the national circumstances.
- The national AD on harvested rice areas, emission and scaling factors should be disaggregated into subunits in order to cover different agricultural practices in rice cultivation and water regimes in the estimation of CH₄ emissions. As a reviewer, you should assess whether the sum of each subunit of harvested area is equal to the national totals.

- The rice cultivation category links to the agricultural soils category. As a reviewer, you should assess whether a Party ensured the consistency in the usage of the AD used to estimate GHG emissions from interlinked categories of the inventory.

Lesson 7: Prescribed burning of savannahs and field burning of agricultural residues

1. Introduction

1.1. Learning objectives and time needed to complete the lesson

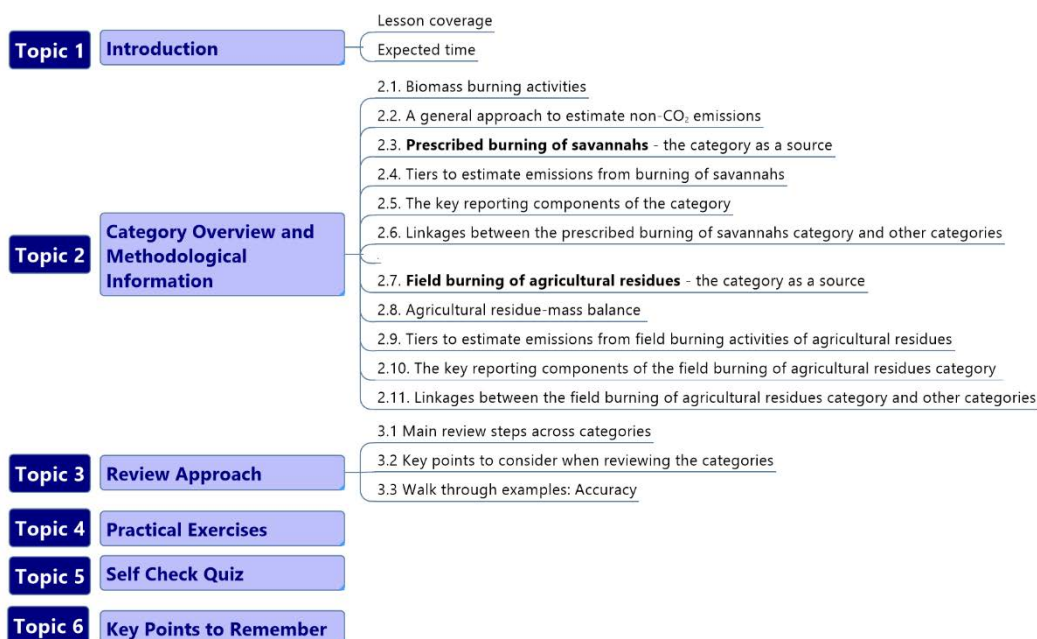
This lesson describes the methodological basis underlying the estimates of CH₄ and N₂O emissions from field burning of agricultural residues and prescribed burning of savannahs and addresses the approaches the TERTs should apply in reviewing these categories.

At the end of this lesson, you will be able to:

- Identify reporting components and methodological references relevant to each of the categories under which emissions from biomass burning are reported;
- Understand how the categories interlink with other categories within the agriculture sector and the categories of other sectors of the inventory;
- Focus on the key review points and be aware of possible actions by the TERT in its review of CH₄ and N₂O emissions from field burning of agricultural residues and prescribed burning of savannah categories;
- Understand how formulate clarification questions to a Party;
- Identify findings or issues, and draft relevant encouragements or recommendations in a review report;
- Classify issues into one of the TACCC principles.

Expected time needed to complete lesson 7: ~60 minutes

1.2. Structure of the lesson



2. Category overview and methodological information

2.1. Types of biomass burning activities

Emissions from fire include not only CO₂, but also other GHGs, or precursors of GHGs, that originate from incomplete combustion of the fuel. These include CO, CH₄, NMVOCs and nitrogen (e.g. N₂O, NO_x) species.

Paragraphs 48 and 51 of the MPGs stipulate that:

48. Each Party **shall** report seven gases (CO₂, methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF₆) and nitrogen trifluoride (NF₃)); those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the **flexibility** to instead report at least three gases (CO₂, CH₄ and N₂O) as well as any of the additional four gases (HFCs, PFCs, SF₆ and NF₃) that are included in the Party's NDC under Article 4 of the Paris Agreement, are covered by an activity under Article 6 of the Paris Agreement, or have been previously reported.

51. Each Party **should** provide information on the following precursor gases: carbon monoxide (CO), nitrogen oxides and non-methane volatile organic compounds (NMVOCs), as well as sulfur oxides.

Parties may use the methodologies for ambient air quality emission inventories, elaborated in detail in the EMEP/EEA air pollutant emission inventory guidebook, to estimate CO, NO_x, NMVOCs and SO₂ emissions. However, as a reviewer, you cannot recommend that a Party estimate and report other non-CO₂ gases (except CH₄ and N₂O).

The 2006 IPCC Guidelines provide a generic approach for estimating emissions from fire. Non-CO₂ emissions are addressed for the following five types of biomass burning (vol. 4, chap. 2, section 2.4):

- (1) Grassland burning (which includes perennial woody shrubland and savannah burning);
- (2) Agricultural residues burning;
- (3) Burning of litter, understory and harvest residues in forest land,
- (4) Burning following forest clearing and conversion to agriculture;
- (5) Other types of burning (including those resulting from wildfires).

However, the national GHG emission inventory of the agriculture sector focuses only on non-CO₂ emissions (CH₄ and N₂O) from **prescribed burning of savannahs** (CRT 3.E) and **field burning of agricultural residues** (CRT 3.F).

2.2. General approach to estimate emissions from biomass burning activities

The general method for estimating GHG emissions from biomass burning activities is described in equation 2.27 in chapter 2 of volume 4 of the 2006 IPCC Guidelines (p.2.42):

A = Area	M _B = Fuel	C _f = Combustion factor	G _{ef} = EFs
•Area burnt, ha	•Mass of fuel available for combustion (M _B), t/ha	•Combustion factor (C _f), dimensionless	•C _{ef} , emission factor, g kg ⁻¹ dry matter burnt

$$L_{fire} = A * M_B * C_f * G_{ef} * 10^{-3}$$

Where:

L_{fire} = amount of GHG emissions from fire, in tonnes of each GHG (e.g. CH₄, N₂O)

M _B	This includes biomass, ground litter and deadwood. When tier 1 methods are used then litter and deadwood pools are assumed to be zero, except where there is a land-use change (see section 2.3.2.2).
C _f	Default values in table 2.6.
C _{ef}	Default values in table 2.5. Note: where data for M _B and C _f are not available, a default value for the amount of fuel actually burned (the product of M _B and C _f) can be used (table 2.4) under a tier 1 methodology.

2.3. Prescribed burning of savannahs: the category as a source

Non-CO₂ emissions that result from incomplete combustion of biomass in managed grassland (predominantly from savannah burning) should be reported, regardless of their nature (natural or anthropogenic fire).

Savannahs, that is, tropical and subtropical vegetation formations with continuous grass interrupted by trees and shrubs, are often intentionally burned during the dry season in many countries, primarily for agricultural purposes such as ridding the grassland of weeds and pests, promoting nutrient cycling and encouraging growth of new grasses for animal grazing. It is also reasonable to assume that the net CO₂ emissions released to the atmosphere are essentially zero because the vegetation typically regrows between burning cycles.



X. Figure 7-1. Burning savannah

Emissions from forest and grassland fires can be reported under category 4(IV) in accordance with the 2006 IPCC Guidelines.

Emissions from fires on forest land and grassland defined as savannah may be separately identified and reported in CRT 3.E. In this case, this should be clearly documented in the documentation box and in the NID. Parties should avoid double counting with emissions reported in CRTs 3.E and 4(IV).

2.4. Tiers to estimate emissions from prescribed burning of savannahs

The 2006 IPCC Guidelines (vol. 4, chap. 6) provide a methodology to estimate non-CO₂ emissions from prescribed burning of savannahs as a part of biomass burning in grassland remaining grassland.

The generic decision tree for estimating emissions from biomass burning, including prescribed burning of savannahs, outlines the steps that Parties should follow (see figure 2.6 in volume 4 of the 2006 IPCC Guidelines). The key elements of each tier in the decision tree in estimating emissions from prescribed burning of savannahs are provided in figure 7-2.

Tier 1	Tier 2	Tier 3
If savannah burning is not a key category, emissions can be estimated using the IPCC tier 1 method and default EF values on the basis of national aggregated data on savannah burning.	If savannah burning is a key category , and if country-specific AD and/or EFs are available, emissions should be estimated using the tier 2 method.	If detailed data on biomass burning are available to estimate GHG emissions using advanced models or methods, Parties should use the tier 3 method.

Y. Figure 7-2. The main features of the decision tree for identification of the appropriate tier to estimate non-CO₂ emissions from prescribed burning of savannahs

To learn more about the tier methods, see below.

Tier 1

Even though data for tier 1 are usually highly aggregated, countries should seek to stratify the savannah areas affected by broad vegetation type (savannah woodland and savannah grassland), as well as according to the period of the burn (early dry season or mid/late dry season). Emissions from prescribed burning of savannahs should be estimated from the above-ground biomass and dead organic matter pools. With burning, below-ground biomass is assumed to remain constant after disturbance or transferred to the soil pool.

If the savannah is stratified by subcategory (e.g. savannah parkland or savannah woodland), countries can use the default values on biomass consumption per hectare provided in table 2.4 in chapter 2 of volume 4 of the 2006 IPCC Guidelines.



As a reviewer, you must check whether all parameters are accounted for; whether a Party applied a combustion factor and applied the default values on biomass consumption per hectare in an accurate manner.

CH₄ and N₂O emissions associated with the burning of forest land and grassland defined as savannah should be reported under the agriculture sector in CRT 3.E prescribed burning of savannahs. However, if it is not possible to distinguish fires in savannah from fires in forest land or grassland, all forest and grassland fires and the emissions associated with the burning should be reported under the LULUCF sector, category in CRT 4(IV) biomass burning, and this should be clearly documented in the documentation box and in the NID. Parties should avoid double counting with emissions reported in CRF 4(IV). As a reviewer, you must check whether CH₄ and N₂O emissions reported as “IE” are actually included elsewhere; and whether the NID/CRT 9 document where these emissions are reported.

CO₂ emissions associated with burning of savannahs should be included in CRT 4(IV).

Tier 2

Tier 2 methods employ the same general approach as the tier 1 methods but make use of more refined country-derived EFs and/or more refined estimates of fuel densities and combustion factors than those provided in the default tables.

As a reviewer, you must check whether:

- The NID include descriptions, references and sources of information for AD, EFs and assumptions as well as the rationale for their selection;
- The development or selection of AD, EFs and assumptions and their documentation are in line with the general guidance in the 2006 IPCC Guidelines and its supplements and with the guidance for the specific category;

Tier 3


Tier 3 methods are more comprehensive and include considerations of the dynamics of fuels (biomass and dead organic matter).

Reviewing tier 3 methods is often challenging because of their complexity and the limited time available for the review, particularly during centralized and desk reviews. However, as a reviewer, you must assess whether the NID includes verification information consistent with the 2006 IPCC Guidelines (vol. 4, chap. 6.10); and whether the NID includes additional information for improving transparency, such as information on basis and type of model; application and adaptation of the model; main equations/processes; key assumptions; domain of application; how the model parameters were estimated;

description of key inputs and outputs; details of calibration and model evaluation; uncertainty and sensitivity analysis; QA/QC procedures adopted; and references to peer-reviewed literature.

Moreover, there are two possible tests to compare the results of a tier 3 estimate with a tier 1 estimate: i) to check whether the results of the tier 3 method fall within the uncertainty range of tier 1; and ii) to check whether the uncertainty of the estimate generated by the tier 3 method is lower than the uncertainty of an estimate generated by the tier 1 method.

See section 2.6 in lesson 2 (p.28) for:



- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

2.5. Key reporting components of prescribed burning of savannah

Table 7-1 summarizes the main reporting components and the references related to the prescribed burning of savannah category.

Table 7-1. Summary of key elements of the prescribed burning of savannah category

Overview	Category-specific information	
Category name	Prescribed burning of savannah	
General reference	2006 IPCC Guidelines, volume 4, chapters 2 and 6	
Chapter of the NID	Chapter 5: Agriculture	
Reporting in CRT	CRT 3.E	
Main subcategories and GHGs to be reported	Forest land ^(*)	CH ₄ , N ₂ O
	Grassland ^(*)	CH ₄ , N ₂ O

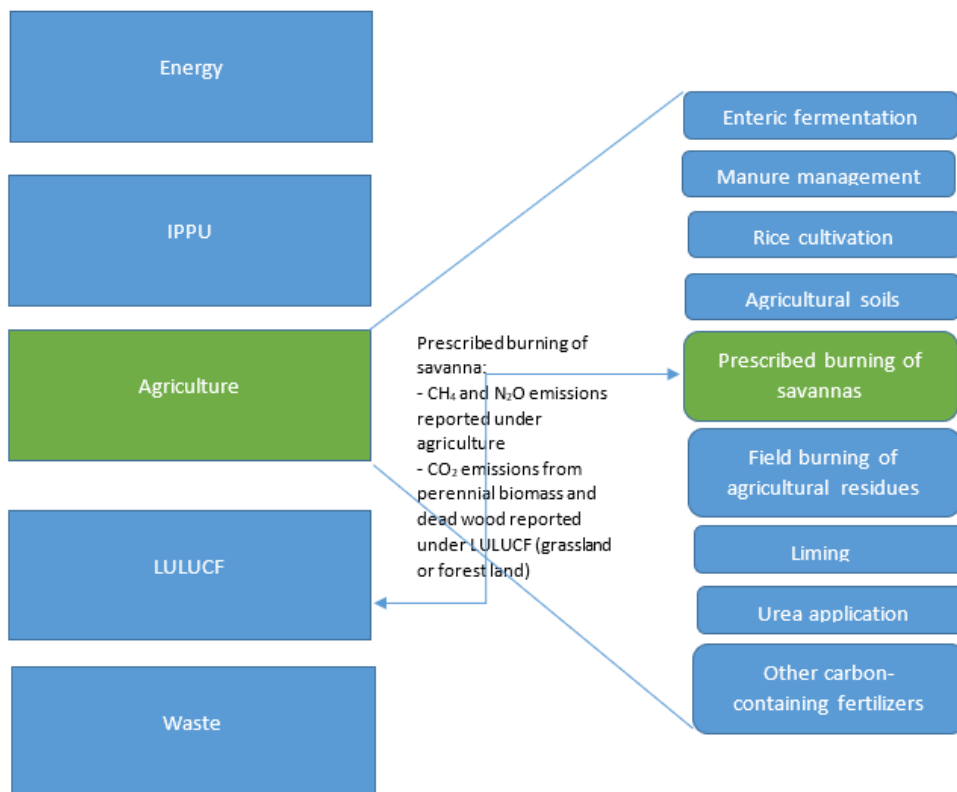
^(*) defined as savannah.

If Parties wish to do so, they may report CH₄ and N₂O emissions from burning of organic soils in savannahs in CRT 3.E. N₂O emissions from burning of organic soils may only be included if higher-tier methods are used.

In addition to the generic reporting instructions, individual reporting requirements are included in the footnotes of each CRT. Parties may report additional information in the documentation boxes in the CRT. As an agriculture expert, you must familiarize yourself with the footnotes and the information provided by the Party in the documentation boxes in the CRT. Moreover, you must assess the information reported in the **summary report tables** and in the **cross-cutting tables**.

2.6. Linkages between prescribed burning of savannahs category and other categories

Figure 7-3 demonstrates the main linkages between the prescribed burning of savannahs category and other categories of the inventory.



Z. Figure 7-3. Main linkages between the prescribed burning of savannahs category and other categories in the agriculture sector and other sectors

The LULUCF and agriculture sectors

- **CH₄ and N₂O emissions** from prescribed burning of savannah should be reported under the agriculture sector, category prescribed burning of savannahs (CRT 3.E).
- If it is not possible to distinguish fires in savannahs from fires in forest land or grassland, **CH₄ and N₂O emissions** in forest land or grassland associated with the burning should be reported under the LULUCF sector, category biomass burning (CRT 4(IV)), and this should be clearly documented in the documentation box and in the NID.
- **CO₂ emissions** associated with burning of savannahs should be included in CRT 4(IV).
- **CO₂ emissions** from perennial biomass and deadwood should be reported under the LULUCF sector (grassland or forest land).



As a reviewer you should be aware of possible double counting of emissions reported under the LULUCF sector in CRT 4(IV).

2.7. Field burning of agricultural residues: the category as a source

Where there is open burning associated with agricultural practices, GHGs are emitted during the combustion of organic matter.

Although biomass burning produces CO₂, these emissions should not be accounted for from annual or seasonal crops or for burning residues of permanent crops. This is because it is considered that the carbon that is released during the burning of the residues is recaptured by biomass regrowth in the subsequent year or season. However, in cases when the vegetation is not fully regrown in the subsequent year, GHG emissions are to be reported and accounted for under the LULUCF sector.

Agricultural residue burning releases gases that are by-products of incomplete combustion, namely: CH₄, CO, N₂O and oxides of nitrogen (NO_x, nitric oxide (NO) and nitrogen dioxide (NO₂)).

Emissions of CH₄ and N₂O should be accounted for under the agriculture sector, while CO, NO_x, NMVOCs and SO_x should be reported but not accounted in the total for the agriculture sector.

Burning of agricultural residues as an energy source should be covered in the energy sector.



AA. Figure 7-4. Field burning of crop residues

2.8. Agricultural residue mass balance

When dealing with the field burning of agricultural residues category, special care should be given to avoid double counting, as only the fraction of crop residues that are burned in the field to clear the land for the next crop should be included.

If this approach is used by the Party, you should check consistency between the AD and parameters used to estimate direct N₂O emissions from managed soils (nitrogen in crop residues) and non-CO₂ emissions from field burning of crop residues reported here.

Other fractions removed before burning for animal consumption, decay in the field and use in other sectors should be accounted for under other categories of the inventory such as:

- N₂O from agricultural soils (when applied to soils as fertilizers or organic amendments);
- Energy (when burned as fuel);
- Manure management (when used as bedding material) and enteric fermentation (when used to feed animals).

The mass of fuel (biomass) available for burning of agricultural residues could be:

- Obtained from national statistics; or
- Estimated with the same data and approach as for calculations of F_{CR} (the amount of nitrogen in crop residues (above-ground and below-ground)) in direct N₂O emissions from managed soils (see 2006 IPCC Guidelines, vol. 4, chap. 11, p.11.14).

As a reviewer you should check that there is no double counting among fractions of crop residues incorporated into soils, burned on site or used for animal consumption or for other purposes and in other sectors.

2.9. Tiers to estimate emissions from field burning of agricultural residues

The 2006 IPCC Guidelines provide a methodology to estimate non-CO₂ emissions from field burning of agricultural residues as a part of biomass burning in cropland remaining cropland (vol. 4, chap. 5 (Cropland)). The general method for estimating GHG emissions from biomass burning is described in equation 2.27 in chapter 2 of volume 4 of the 2006 IPCC Guidelines.

The generic decision tree for estimating emissions from biomass burning (including field burning of agricultural residues) is the same as for prescribed burning of savannahs (see [figure 2.6 in volume 4 of the 2006 IPCC Guidelines](#)). The key elements of each tier are provided in figure 7-5.

Tier 1	Tier 2	Tier 3
The AD are normally highly aggregated, and default value EFs are used.	The estimates are generally developed for the major crop types by climate zone, using country-specific crop residue accumulation rates and country-specific EFs.	Tier 3 is a country-specific method involving process modelling and/or detailed measurements.

BB. Figure 7-5. The key elements of a tier method in the estimates of non-CO₂ emissions from field burning of agricultural residues

To learn more about the tier methods, see below.

<p>Tier 1</p> <p>The default EFs from the 2006 IPCC Guidelines are used. AD include estimates of land areas under the crop types for which agricultural residues are normally burned. This can be obtained in consultation with national agricultural governmental sectors, if there is a lack of objective data from satellite imagery, for example. Countries can also estimate the crop area planted from the annual crop production and an estimate of the average productivity per hectare. If no national estimates are available, FAOSTAT statistics can be used. It is <i>good practice</i> to cross-check FAOSTAT data with national sources.</p>
<p>Tier 2</p> <p>This method expands tier 1 to include use of country-specific available fuel, combustion and emission factors. Countries may estimate the amount of available fuel from crop production statistics and from the ratio of crop yield and residue produced. Field studies are needed to estimate the fractions of crop residue removed from field (as fuel or fodder) and left as residue for burning for different crop systems. Countries should focus on the most dominant crops being burned or the systems with relatively high biomass per hectare and levels of emissions per unit of land (e.g. sugar cane, cotton).</p> <p>As a reviewer, you must check:</p> <ul style="list-style-type: none"> • If CH₄ or N₂O emissions from burning of agricultural residues are identified as a key category, whether country-specific AD, EFs, fractions and parameters for each crop type have been used; • Whether the NID include descriptions, references and sources of information for AD, the fractions of corresponding crop residue removed from field and left as residue for burning for different crop systems and EFs, as well as the rationale for their selection; and whether their documentation is in line with the general guidance in the 2006 IPCC Guidelines; • If the mass of fuel available for burning of crop residues has been estimated, whether there is consistency with the data used for calculations of F_{CR} in direct N₂O emissions from managed soils. <p>The same set of questions might be applied while reviewing the reporting of a Party for tier 1. For more information, please consult table 7-3 of the current lesson.</p>

Tier 3

This tier makes use of models based on country-specific parameters, using national inventory data to ensure that no burning of crop residues is omitted. Tier 3 depends on the field measurement of the amount of residues burned on site for different cropping systems under different climate zones and management systems.

Tier 3 requires high-resolution AD disaggregated at subnational to fine grid scales. Similar to tier 2, land area is classified into specific types of crops by major climate and soil categories and other potentially important regional variables (e.g. regional patterns of management practices) to be used in models.

2.10. Key reporting components of the field burning of agricultural residues category

Table 7-2 summarizes the main reporting components and the references related to the field burning of agricultural residues category.

Table 7-2. Summary of key elements of the field burning of agricultural residues category

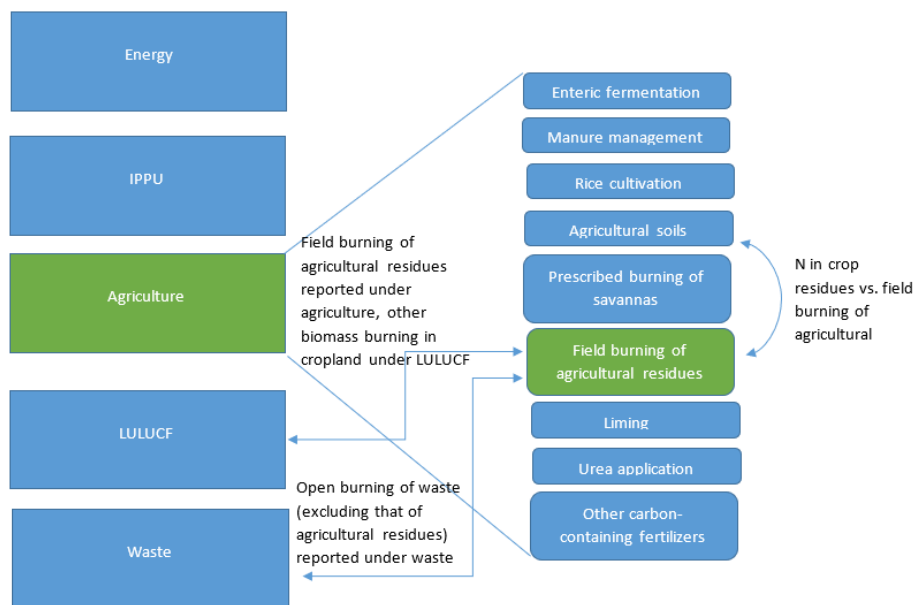
Overview	Category-specific information	
Category name	Field burning of agricultural residues	
General reference	2006 IPCC Guidelines, volume 4, chapters 2 and 11.2	
Chapter of the NID	Chapter 5: Agriculture	
Reporting in CRT	CRT 3.F	
Main subcategories and GHGs to be reported	Cereals	CH ₄ , N ₂ O
	Pulses	CH ₄ , N ₂ O
	Tubers and roots	CH ₄ , N ₂ O
	Sugar cane	CH ₄ , N ₂ O

Parties that wish to do so may report CH₄ and N₂O emissions from burning of organic soils in savannahs in CRT 3.E. N₂O emissions from burning of organic soils may only be included if higher-tier methods are used.

In addition to the generic reporting instructions, individual reporting requirements are included in the footnotes of each CRT. Parties may report additional information in the documentation boxes in the CRT. As an agriculture expert, you must familiarize yourself with the footnotes and the information provided by the Party in the documentation boxes in the CRT. You must also assess the information reported in **summary report tables** and in **cross-cutting tables**.

2.11. Linkages between field burning of agricultural residues and other categories

Figure 7-6 demonstrates the main linkages between the field burning of agricultural residues category and other categories of the inventory.



CC. Figure 7-6. Main linkages between the field burning of agricultural residues category and other categories of the inventory

Agricultural soils (3D) and manure management (3B)

- A mass balance approach should be adopted to account for the crop residues (interaction with the agricultural soil (3.D) and manure management (3.B) categories). As a reviewer, you must ensure that no underestimation or double accounting occurs among these categories.

Waste and energy sectors

- Open burning of agricultural waste (excluding that of crop residues) should be reported under the waste sector.
- Burning of agricultural residues to produce energy (as a fuel) should be reported under the energy sector.
- As a reviewer, you must check whether there is double accounting among these categories/sectors.

LULUCF sector

Cropland biomass burning (e.g. perennial woody biomass) should be reported under the LULUCF sector (CRT 4(IV)).



Field (on-site) burning of agricultural residues, as an agricultural practice, is banned in the majority of the developed country Parties, but it is still used in many other countries.

3. Review approach

3.1. Key points to consider when reviewing biomass burning



A brief description of three common review steps (prepare – assess - draft) is provided in https://unfccc.int/resource/tet/ba/ba7-01_L_R_steps.pdf. Please read carefully before continuing with the key points to consider when reviewing emissions from biomass burning, if you have not yet done so.

The choice of methods, selection of assumptions, development and selection of EFs and collection and selection of AD are the main drivers of inventory quality. Hence, as a reviewer, you must assess and ensure that the selection of these data carried out by a Party are in accordance with the 2006 IPCC Guidelines and its supplements and the requirements in the UNFCCC decisions.

Table 7-3 summarizes the possible questions and actions that you can ask yourself when reviewing the emissions reported under the biomass burning category. In addition, there are several common elements to be assessed across sectors/categories when reviewing the quality of the Party's submission (i.e. uncertainty analysis, QA/QC, time-series consistency, recalculations and progress in implementing planned improvements); lesson 2 above provides a list of guiding questions.

Table 7-3. Possible actions by the expert review team in its review of CH₄ and N₂O emissions from the field burning of agricultural residues and prescribed burning of savannahs categories

Review element	Possible question/action by the ERT
Field burning of agricultural residues	
Choice of method	If CH ₄ or N ₂ O emissions from field burning of agricultural residues are identified as a key category, were country-specific AD, EFs, fractions and parameters for each crop type used?
Use of method	Is there any double counting among fractions of crop residues incorporated to soils, burned on site or used for animal consumption or in other sectors?
AD	Were the source of AD documented?
AD	Is the amount of agricultural residues burned consistent with the amount of crop residues minus the amount used for feed, bedding construction, or returned to the field as N input to the soils?
AD	If the mass of fuel available for burning of crop residues has been estimated, is there consistency with the data used for calculations of F _{CR} in direct N ₂ O emissions from managed soils.
AD	Were emissions from burning of agricultural residues for energy production reported under the energy sector?
Use of method	Has the Party adequately separated reporting of field burning of agricultural residues in the agriculture sector from biomass burning in cropland (reported in CRF table 4(V)), by avoiding omission or double counting of emissions? Note that the 2006 IPCC Guidelines has a common approach for the estimation of fires in cropland.

	Prescribed burning of savannahs
Choice of method	If CH ₄ or N ₂ O emissions from prescribed savannah burning are identified as a key category, whether country-specific AD, parameters, fractions and EFs have been used.
AD	Are all parameters accounted for?
AD	Do the AD account for all parameters?
EFs	Has the Party correctly applied a combustion factor?
	Has the Party reported CH ₄ and N ₂ O emissions from prescribed burning of savannahs separately from other fires in forest land and grassland (i.e. avoiding double counting with CRF table 4(V)), even though the guidance in the 2006 IPCC Guidelines has a common approach for all fires in forest land and grassland?
Selection of assumptions	If savannah burning is included in CRF table 4(V), has the Party provided a justification in the NID?
AD/EFs	If default values (e.g. on biomass consumption) were used, whether AD have been disaggregated by subcategory (e.g. savannah grassland or savannah forestland).
Use of method	Whether there is any double counting with emissions reported under the LULUCF sector in the category biomass burning (CRF table 4(V)) (if it is not possible to separate savannah fires from other forest and grassland fires).

As a reviewer, you must first focus on the observations which have an impact on the level and/or trend of the GHG emissions. Moreover, in the case of issues related to transparency (i.e. the NID does not clearly describe how emissions were estimated), the TERT should specifically determine whether the lack of transparency in the inventory leads it to question the accuracy of the inventory estimates reported.



Please note that table 7-3 is not intended to provide an exhaustive list of questions; it is rather a starting point to stimulate your thinking. You may add or modify the questions as appropriate while conducting a review.

3.2. Walk-through examples: assessment of accuracy

Now you are invited to review the estimates of CH₄ and N₂O emissions due to field burning of agricultural residues. Please review the NID submitted by BBlund in 2025.



Please open a PDF copy https://unfccc.int/resource/tet/ba/ba7-02_L7_CS1.pdf of the NID submitted by BBlund in 2025.

What would be your assessment regarding the transparency of the information reported and the accuracy of the estimates performed by the Party?

Please submit your assessment here:

Assessment of accuracy – how to formulate questions

Effective communication between the TERT and the Party is one key to a successful review process. Hence, it is important that the TERT makes the necessary effort to ensure that communications are clear and concise. Now it is your turn to practice; try to draft a clarification question regarding the finding you identified.

Please submit your clarification question here:

3.3. Answer key to walk-through examples

Assessment of accuracy

The background information and the estimates performed within this category is presented in a sufficiently transparent manner: the country presented and clarified the mass balance of the crop residues and described the calculation algorithm used to estimate CH₄ and N₂O emissions from the crop residues burned on field; AD, parameters and EFs have been supported with references. It might be argued that the Party did not provide any information on the fractions of crop residues burned on field for the whole reporting period. However, the values can be assessed from CRT 3.F; hence, as a reviewer you must examine the information reported and compare the values reflected in CRT 3.F with those reported in the NID (if applicable).

However, a few findings might be identified regarding the accuracy of the estimates. Namely, in section 5.3.1 of the NID, the Party stated that “10% of (removable crop-) residues is burned on field-site (the combustion of the residues takes place in the field). The corresponding emissions are reported in the agriculture sector, field burning of agriculture residues (3.F).” In addition, in its NID (i.e. tables 5-36 and 5-37), the Party reported the algorithms developed to estimate CH₄ and N₂O emissions from the crop residue burning activities in 2023. However, by comparing the data on the amounts of the removable crop residues of wheat and barley burned on site (i.e. fraction burned on site) reported in table 5-36 with those reported in table 5-37, it is seen that the data are not consistent. Namely, a fraction of removable residues of barley that was burned on field and used to estimate CH₄ emissions (calculated based on the data reported in table 5-36), is higher than the one reported in the NID (i.e. 15 per cent versus 10 per cent, respectively) and a fraction of removable residues of wheat that was burned on field and used to estimate N₂O emissions (calculated based on the data reported in table 5-37) is higher than what is reported in the NID (i.e. 11 per cent versus 10 per cent, respectively). Hence, as a reviewer, you must clarify the reason behind the inconsistencies in the data (i.e. fraction burned on field).

	Table 5-36: data used to estimate CH ₄ emissions				Table 5-37: data used to estimate N ₂ O emissions			
	Annual harvest production, t	Amount of removable residues, t DM	Amount of removable residues burned on-site, t DM	Fraction burned in fields, %	Annual harvest production, t	Amount of removable residues, t DM	Amount of removable residues burned on-site, t DM	Fraction burned in fields, %
Wheat	6,583,309	7,616,889	761,689	10	6,583,309	7,616,889	837,858	11
Barley	1,426,518	1,523,521	228,528	15	1,426,518	1,523,521	152,352	10

Assessment of accuracy – how to formulate questions

One possible version of a clarification question might be as follows:

In its NID (chap. 5.3.2), the Party stated that “10% of (removable crop-) residues is burned on field-site (the combustion of the residues takes place in the field). The corresponding emissions are reported in

the agriculture sector in CRT 3.F Field burning of agriculture residues category.” In addition, the Party reported the AD used to estimate CH₄ and N₂O emissions from on-site burning activities of crop residues in table 5-36 and 5-37. However, the TERT noted that the on-field burned fractions of removable residues of wheat and barley reflected in the tables mentioned above do not correspond to those reported in the main body of the text (i.e. 10 per cent). Namely, the TERT derived the following values: 15 per cent was reported in table 5-36 (calculated by the TERT as 228,526 t dm burned on site by 1,523,521 t dm produced) and 11 per cent was reflected in table 5-37 (calculated by the TERT as 837,858 t dm burned on site by 7,616,889 t dm produced). Could BBl and comment on the finding identified by the TERT and clarify the inconsistencies in the values of the fractions burned on site?

4. Practical exercises

4.1. Practical exercise 1

A developed Party used the notation key "NO" to report emissions for the category field burning of agricultural residues, and provided the following justifications:

Article 17, paragraph 2(b), of the Law of 19 January 2004 relating to the preservation of nature and natural resources forbids clearing and burning of fields, meadows, grasslands, roadsides, and forests between 1 March and 30 September.

According to the law, the clearing and burning of agricultural residues (such as straw) is not strictly forbidden. However, for economic reasons (residues can be used as litter, as feeding stuff for animals or can be sold), field burning is not practiced and, therefore, emission estimates have been recorded as "NO" in the inventory.

Does the NID document the assumptions used to estimate GHG emissions from field burning of agricultural residues in a transparent manner?

Select one:

- A. The information provided is not transparent
- B. The NID provides transparent information on assumptions used; however, additional checks are required
- C. The NID provides transparent information on assumptions used, and no further actions from the reviewer are necessary

4.2. Practical exercise 2

Assess the information submitted by a developing country Party in its NID in 2026.

Burning of agricultural crop residues is a significant source of emissions of CH₄, N₂O, CO and NO_x. However, the burning of crop residues is not thought to be a net source of CO₂ because the carbon released to the atmosphere is reabsorbed during the next growing season.

Since CH₄ and N₂O emissions from field burning of agricultural residues are not key categories, neither from level nor from trend views, a tier 1 method has been applied. For calculation of CH₄ and N₂O emissions, equation 2.27 in the 2006 IPCC Guidelines (vol. 4, chap. 2, p.2.42) was used.

The default combustion factors from the 2006 IPCC Guidelines (vol. 4, chap. 2, table 2.6) were used: 0.9 for rye and wheat and 0.8 for barley and two-row barley, maize grains, sorghum and other cereals. The default CH₄ and N₂O EFs of the Revised 1996 IPCC Guidelines have been employed.

Data are included on six types of crop production: rye, wheat, barley, maize grains, sorghum and other cereals.

Emissions from field burning of agricultural residues in 2027 are lower than emissions in 1990 due to the lower agricultural yields.



Please open PDF copy https://unfccc.int/resource/tet/ba/ba7-03_L7_Table_5.8.pdf to see the table with the emissions reported by the Party.

After reviewing this information, which statement best describes the possible assessment of the TERT?

- A. The Party has not reported the information on the fraction of crop residues burned on site;
- B. The Party submitted the NID in 2026. However, the latest reporting year is 2023. Hence, the ERT can conclude that the Party has not met the reporting requirements in terms of completeness (i.e. the reporting of GHG emissions released in 2024 is missing from the NID) and must raise this finding as an issue;
- C. The Party submitted the NID in 2026 and indicated 2023 as the latest reporting year. However, as a reviewer, you may conclude that the Party reported the complete time series of the emissions released due to the burning activities of crop residues;
- D. The Party reported a consistent annual time series of CH₄ and N₂O emissions from 1990 to 2023. The emission trends and all significant inter-annual changes have been clearly explained in the NID;
- E. The Party reported a consistent annual time series of CH₄ and N₂O emissions from 1990 to 2023. Nevertheless, the Party has not explained the emission trend and has not provided any information to clarify the outliers in time series;
- F. Choice and use of a tier method and use of the default parameters and factors has been documented in the NID and supported with reference sources. Moreover, the Party has justified its choice of default EFs;
- G. Choice and use of a tier method and use of the default parameters and factors has been documented in the NID and supported with reference sources. However, the Party has not justified its choice of default EFs.

Select one:

- I. A, B, D and G
- II. A, C, F and G
- III. A, C, E and G
- IV. A, C, D and F
- V. A, C, E and F

Tip

See paragraphs 20, 26, 57 and 58 of the MPGs.

Section 5.4 of chapter 5 of volume 1 of the 2006 IPCC Guidelines.

4.3. Answer key to practical exercises

Practical exercise 1

The correct answer is B.

The information provided is sufficient to justify the assumptions used by the Party. As the Party states that crop residues are used as bedding material or for other purposes, you should check that there is no omission of any fractions of crop residues in the inventory and that nitrogen from the bedding material is included in the amount of manure nitrogen available for application to soils.

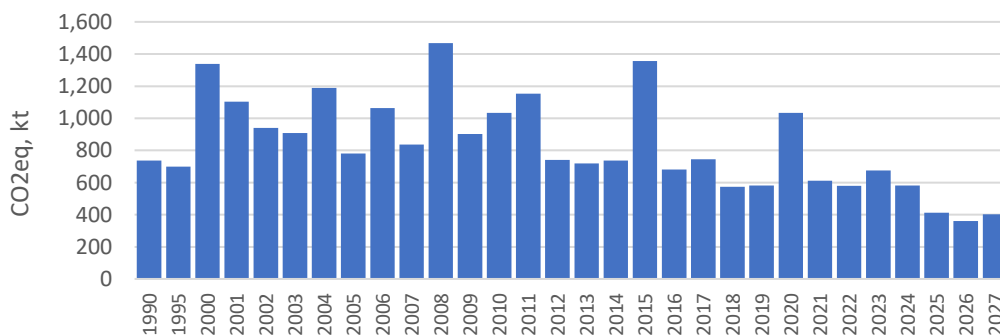
As a reviewer, you should check the completeness of the agricultural reporting and compare it with the reporting of countries with similar circumstances, particularly to check whether any field burning was reported by neighbouring countries in the 1990s and whether emissions may have occurred prior to 2004. You must also bear in mind that the completeness issue (to report consistent annual time series starting from 1990) is applicable only for developed Parties (para. 57 of the MPGs states that “each Party shall report a consistent annual time series starting from 1990; those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead report data covering, at a minimum, the reference year/period for its NDC under Article 4 of the Paris Agreement and, in addition, a consistent annual time series from at least 2020 onwards.”). In other words, a developing Party may need flexibility in the light of its capacity and provide consistent annual time series from at least 2020 onwards. Hence, as a reviewer, you cannot raise the finding as an issue in such a case.

Practical exercise 2

The correct answer is III.

As you might have noted, the Party has not reported the information on the fraction of crop residues burned on site (option A).

Paragraph 20 of the MPGs states that each Party shall use the 2006 IPCC Guidelines. In general, the Party has followed the ‘shall’ provision; however, the Party used the default CH₄ and N₂O EFs from the Revised 1996 IPCC Guidelines in its estimates. In this case, the Party had to justify and document the reason for choosing and using the default EFs reported in the Revised 1996 IPCC Guidelines (option G).



Section 5.4, chap. 5 of volume 1 of the 2006 IPCC Guidelines stipulates that “Generally, countries should explain inventory trends for each category, giving particular attention to outliers, trend changes, and extreme trends.” The Party included table 5.8 to report CH₄ and N₂O emissions released due to the on-

site burning activities of crop residues for the entire reporting period. However, the Party has not provided any documentation to explain the significant inter-annual changes in CH₄ and N₂O emissions between 2003 and 2004, between 2007 and 2008, between 2014 and 2015 and between 2019 and 2020. (option E).

The Party submitted its NID in 2026; however, 2023 has been identified as the latest reporting year. According to the MPGs (para. 58), the latest reporting year shall be no more than **two years** prior to the submission of a Party's national inventory report. However, for developing country Parties there is the flexibility to instead have their latest reporting year as **three years** prior to the submission of their national inventory report. Therefore, as a reviewer you should not raise an issue (option B is correct).

5. Self-check quiz

Question 1

As a reviewer you must assess the consistency between the AD and parameters (e.g. crop/residue ratios, etc.) used to estimate direct N₂O emissions from managed soils (nitrogen in crop residues) and non-CO₂ emissions from field burning of crop residues reported by a Party.

Select one:

- A. True
- B. False

Question 2

As a reviewer you must be aware that non-CO₂ emissions from field burning of agricultural residues should be reported under the agriculture sector; however, non-CO₂ emissions from other biomass burning in cropland are reported under the LULUCF sector.

Select one:

- A. True
- B. False

Question 3

Non-CO₂ emissions from fires on grassland defined as savannahs should be separately identified from forest land fires and reported under the agriculture sector.

Select one:

- A. True
- B. False

5.1. Answer key to self-check quiz

Question 1

The correct answer is A.

It is important to use appropriate AD to estimate CH₄ and N₂O emissions from burning of agricultural residues, taking into consideration the mass balance of residues and avoiding double counting. The amount of agricultural residues burned on field should be consistent with the amount of crop residues minus the amount used for feed, bedding or construction left on site, etc. (note that this list is not exhaustive).

The same parameters (e.g. crop residue ratio) should be applied across the two categories (i.e. agricultural soils (3.D.1.d) and field burning of agricultural residues (3.F)) of the inventory.

Question 2

The correct answer is A.

A Party should separate and report non-CO₂ emissions from the field burning of agricultural residues under the agriculture sector; however, non-CO₂ emissions from other biomass burning in cropland should be reported under the LULUCF sector (in CRT 4(IV)).

Question 3

The correct answer is A.

If it is possible to separate fires on forest land and grassland defined as savannah, CH₄ and N₂O emissions should be separately identified and reported under the agriculture sector, category prescribed burning of savannahs (CRT 3.E). If it is not possible to separate the fires, all forest and grassland fires and the emissions associated with the burning should be reported under the LULUCF sector, category biomass burning (CRT 4(IV)), and this should be clearly documented in the documentation box and in the NID. In addition, CO₂ emissions associated with burning of savannahs should be included in CRT 4(IV).

6. Key points to remember

- Biomass burning associated with prescribed burning of savannahs and field burning of agricultural residues is a source of CH₄ and N₂O emissions to be reported under the agriculture sector.
- A general method to estimate non-CO₂ emissions from biomass burning is described in equation 2.27 in chapter 2 of volume 4 of the 2006 IPCC Guidelines.
- The 2006 IPCC Guidelines provide a methodology to estimate non-CO₂ emissions from:
 - Savannah burning, as a part of biomass burning in grassland remaining grassland (vol. 4, chap. 6 (Grassland));
 - Crop residue burning, as a part of biomass burning in cropland remaining cropland (vol. 4, chap. 5 (Cropland)) and as a fraction of crop residues (above-ground and below-ground) estimated under the agricultural soils category (vol. 4, chap. 11).
- Paragraph 28 of decision 5/CMA.3 notes that the Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines.
- Annex I to decision 5/CMA.3 provides the template of CRTs for the electronic reporting of the information in the national inventory reports of anthropogenic GHG emissions by sources and removals by sinks:
 - CRT 3.E covers information relevant to the prescribed burning of savannah category;
 - CRT 3.F covers information on AD, background parameters and non-CO₂ emissions released due to field burning of agricultural residues.
- Field (on-site) burning of agricultural residues, as an agricultural practice, is banned in the majority of developed countries, but it is still used in many other countries.
- The prescribed burning of savannahs category has linkages with the LULUCF sector categories. As a reviewer you should be aware of possible double counting of emissions reported under the LULUCF sector in CRT 4(IV):
 - CH₄ and N₂O emissions associated with the burning of forest land and grassland defined as savannah should be reported under the agriculture sector in CRT 3.E (prescribed burning of savannahs);
 - However, If it is not possible to separate the fires, all forest and grassland fires and the emissions associated with the burning should be reported under the LULUCF sector in category biomass burning (CRT 4(V)), and this should be clearly documented in the documentation box and in the NID;
 - CO₂ emissions associated with burning of savannahs should be included in CRT 4(IV);
 - As a reviewer you should look for possible double counting of emissions reported in CRT 3.E and CRT 4(IV).
- The field burning of agricultural residues category has close linkages with many other categories of the agriculture sector (i.e. enteric fermentation, manure management system and agricultural soils) and with the categories of the LULUCF and waste sectors. As a reviewer you must assess whether a Party ensured consistency in the AD and other parameters applied across these categories.
- A Party must follow a residue mass balance to estimate GHG emissions from the relevant agricultural activities (the categories mentioned above). As a reviewer, you must assess whether double accounting or omissions occur in these categories by checking fractions of

crop residues incorporated into soils, burned on site or used for animal consumption or for other purposes and in other sectors.

Lesson 8: Liming and urea application to soils

1. Introduction

1.1. Learning objectives and time needed to complete the lesson

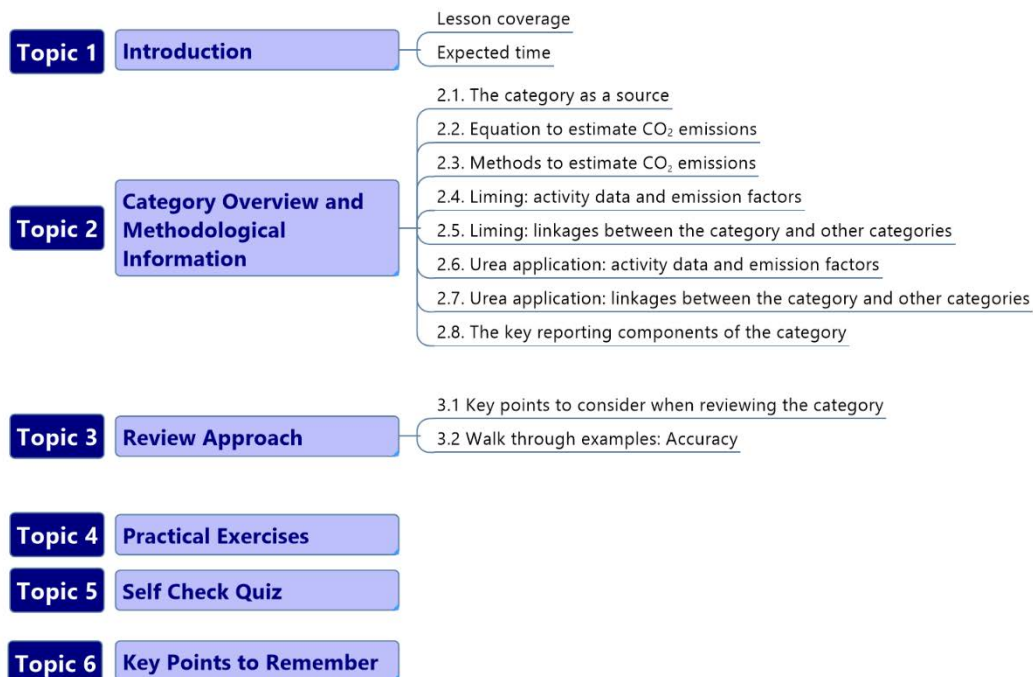
This lesson describes the methodological basis underlying the estimates of CO₂ emissions from liming and urea application to agricultural soils. It addresses the approaches the TERT should apply in reviewing this category.

At the end of this lesson, you will be able to:

- Identify reporting components and methodological references relevant to the liming and urea application category;
- Understand how the liming and urea application category interlinks with other categories within the agriculture sector and the categories of other sectors of the inventory;
- Focus on the key review points and be aware of possible actions by the TERT in its review of CO₂ emissions for the liming and urea application category;
- Understand how to formulate clarification questions to the Party under review;
- Identify findings or issues and draft relevant encouragements or recommendations in a review report;
- Classify issues into one of the TACCC principles.

Expected time needed to complete lesson 8: ~60 minutes

1.2. Structure of the lesson



2. Category overview and methodological information

2.1. The category as a source

Liming is used to reduce soil acidity and improve plant growth in managed systems, particularly agricultural lands and managed forests. Adding carbonates to soils in the form of lime (e.g. calcitic limestone (CaCO₃), or dolomite (CaMg(CO₃)₂) leads to CO₂ emissions as the carbonate limes dissolve and release bicarbonate (2HCO₃⁻), which evolves into CO₂ and water (H₂O).

Adding **urea** to soils during fertilization leads to a loss of CO₂ that was fixed in the industrial production process. Urea (CO(NH₂)₂) is converted into ammonium (NH₄⁺), hydroxylion (OH⁻) and bicarbonate (HCO₃⁻), in the presence of water and urease enzymes. Similar to the soil reaction following addition of lime, the HCO₃⁻ that is formed evolves into CO₂ and water.



DD. Figure 8-1. Liming of agricultural soils

Photo credit:
https://commons.wikimedia.org/wiki/File:Spreading_lim

2.2. The basic equation to estimate CO₂ emissions from lime and urea application

The basic equation to estimate CO₂ emissions released due to lime and urea application to soils:

$$CO_2 - C_{Emissions} = M \cdot EF_{lime/urea}$$

Where:

CO₂-C_{Emissions} – annual carbon emissions from lime and urea application, tonnes carbon year⁻¹

M – annual amount of lime / urea applied, t year⁻¹

EF – emission factor, t CO₂-carbon per tonne of lime or urea applied



Please see p.11.27 and p.11.32 of chapter 11 of volume 4 of the 2006 IPCC Guidelines for more information.

2.3. Methods to estimate CO₂ emissions from liming and urea application

The decision trees for estimating emissions from the application of lime and urea in chapter 11 of volume 4 of the 2006 IPCC Guidelines are similar and outline the steps that Parties should follow ([figure 11.4 for liming](#) and [figure 11.5 for urea application](#)). The main features of these decision trees are provided in figure 8-2.

Tier 1	Tier 2	Tier 3
If CO ₂ emissions from liming and urea application is not a key category , emissions can be estimated using the tier 1 method and default EFs.	If CO ₂ emissions from liming and urea application is a key category , and country-specific AD and EFs are available.	If detailed data on lime and urea application are available, and information to estimate carbonate mineral formation/dissolution [for liming only], leaching and transport of inorganic carbon (for application of models and/or measurement-based approaches) is available.

EE. Figure 8-2. The main features of these decision trees for estimating emissions from liming and from urea application to soils



Please see p.11.28 and p.11.33 of chapter 11 of volume 4 of the 2006 IPCC Guidelines for more information on tier methods.



See section 2.6 in lesson 2 (p.28) for:

- Further guidance on the choice of a tier method;
- General guidance on the review of a tier method.

2.4. Liming: activity data and emission factors

The 2006 IPCC Guidelines provide the following information on AD and EFs to be employed under each tier approach. Each successive tier requires more detail and resources than the previous one.

Element	Tier 1	Tier 2	Tier 3
AD	<ul style="list-style-type: none"> - National usage statistics for carbonate lime on the annual amount applied to soils (more direct inference on application); - Annual sales of carbonate lime to infer the amount that is applied to soils (assumes all lime sold to farmers, ranchers and foresters, etc., is applied during that year); - Availability computed on the basis of new supply for the year (annual domestic mining and import records) minus exports and usage in industrial processes. 	In addition to tier 1 AD, tier 2 may incorporate information on the purity of carbonate limes, site level and hydrological characteristics.	Tier 3 based on estimating variable emissions from year to year, which depends on a variety of site-specific characteristics and environmental drivers.
EF	Default IPCC EFs are 0.12 t carbon per tonne of limestone and 0.13 t carbon per tonne of dolomite.	Use of country-specific data to differentiate sources with variable composition of lime, different liming materials, overall purity and carbon content of liming materials.	Model-based or direct measurements-based inventories.



Please see p.11.29 in chapter 11 of volume 4 of the 2006 IPCC Guidelines for more information.

Tier 1

As a reviewer, you must check:

- Whether AD are based on actual usage statistics or on annual sales or estimated through a balance of production. If based on annual sales or estimated through a balance of production, imports and exports whether data are sufficient to estimate national emissions;
- Whether a Party used different EFs to estimate CO₂ emissions from limestone and dolomite application on agricultural soils.

Tier 2

Derivation of EFs using country-specific data could entail differentiation of sources with variable compositions of lime; different carbonate liming materials (limestone as well as other sources such as marl and shell deposits) can vary somewhat in their carbon content and overall purity. Each material would have a unique EF based on the carbon content.

As a reviewer, you must look for documentation of the underlying basis for country-specific EFs, and data sources used to estimate country-specific values. Reporting documentation should include the new factors (i.e. means and uncertainties) and discussion in the inventory report about differences between these values and default factors or country-specific factors from regions with similar circumstances to those of the reporting country.

Tier 3

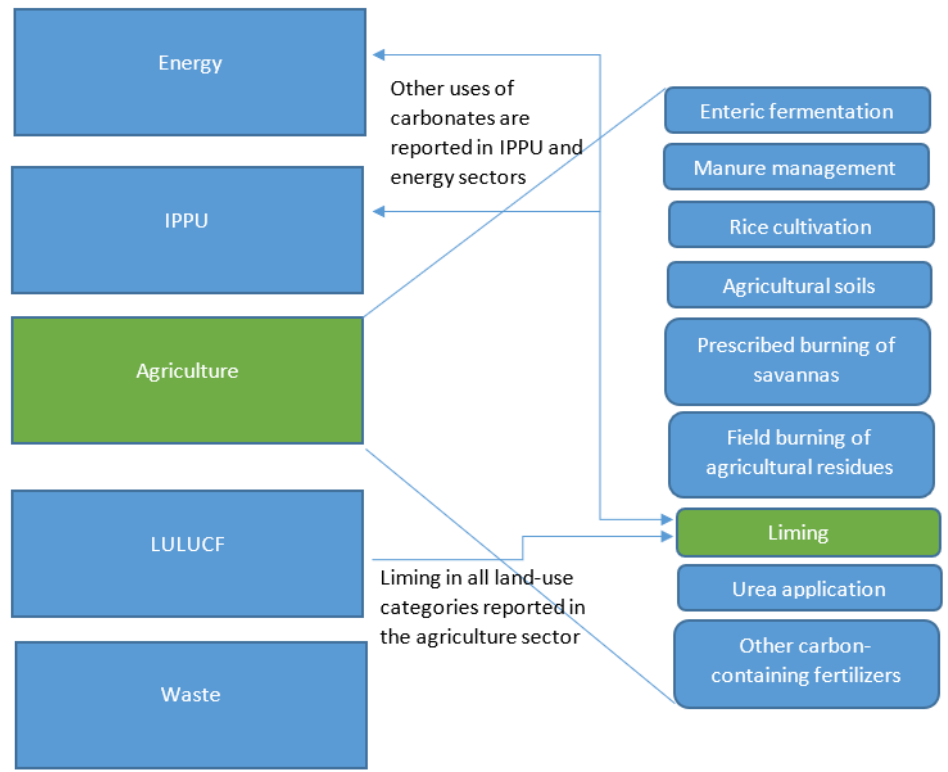
Review of tier 3 methods is often challenging because of their complexity and the limited time available for the review, particularly during centralized and desk reviews. However, as a reviewer, you must assess i) whether the NID includes verification information consistent with the 2006 IPCC Guidelines (vol. 4, chap. 6.10); whether the NID includes additional information for improving transparency, such as information on basis and type of model; application and adaptation of the model; main equations/processes; key assumptions; domain of application; how the model parameters were estimated; description of key inputs and outputs; details of calibration and model evaluation; uncertainty and sensitivity analysis; QA/QC procedures adopted; and references to peer-reviewed literature.

Moreover, there are two possible tests to compare the results of a tier 3 estimate with a tier 1 estimate: i) to check whether the results of the tier 3 method fall within the uncertainty range of tier 1; and ii) to check whether the uncertainty of the estimate generated by the tier 3 method is lower than the uncertainty of an estimate generated by the tier 1 method.

2.5. Liming: linkages between the liming category and other categories

The IPPU and the energy sectors

- Please study section 2.5.1.4 in chapter 2 of volume 3 of the 2006 IPCC Guidelines to examine the linkages between the liming category and the categories of the IPPU sector.



FF. Figure 8-3. Main linkages between the liming category and the other categories in the agriculture sector and other sectors

The LULUCF sector

- Liming in all land-use categories are reported in the agriculture sector (see footnote 1 to CRT 3.G-J).

2.6. Urea application: activity data and emission factors

The 2006 IPCC Guidelines provide the following information on AD and EFs to be used under each tier approach. Each successive tier requires more detail and resources than the previous one.

Element	Tier 1	Tier 2	Tier 3
AD	Domestic production records and import/export data on urea can be used to obtain an approximate estimate of the amount of urea applied to soils on an annual basis; supplemental data on sales and/or usage of urea can be used to refine the calculation.	In addition to tier 1 information, tier 2 may incorporate additional information on site-level and hydrological characteristics that were used to estimate the proportion of carbon in urea that is emitted to the atmosphere.	Application of dynamic models and/or a direct measurement-based inventory.
EF	The default EF is 0.20 t carbon per tonne of urea.	All carbon in urea may not be emitted in the year of application. If sufficient data and understanding of inorganic carbon transformation are available, a country-specific specific EF could be derived;	Based on estimating variable emissions from year to year, which depends on a variety of site-specific characteristics and environmental drivers. No EF is directly estimated.

Domestic production records and import/export data on urea can be used to obtain an approximate estimate of the amount of urea applied to soils on an annual basis.

It can be assumed that all urea fertilizer produced or imported annually minus annual exports is applied to soils.

<p>Tier 1</p> <p>Tier 1 inventories are complete if emissions are computed based on a full accounting of all urea that is applied to soils.</p> <p>The same EFs should be applied across the entire time series for consistency. As a reviewer, you must check this.</p> <p>Regardless of the approach, the annual application estimates for urea fertilizers should be consistent between CO₂ emission from urea and N₂O emissions from soils.</p>
<p>Tier 2</p> <p>Consistency in AD records across the time series is important for tier 2 inventories. In addition, new factors that are developed based on country-specific data should be applied across the entire time series. In rare cases when this is not possible, the Party should determine the influence of changing EFs on the trends.</p> <p>As a reviewer, you must look for the documentation that describes the underlying basis for country-specific EFs, as well as archive metadata and data sources used to estimate country-specific values. Reporting documentation should include the new factors (i.e. means and uncertainties) and discussion in the inventory report about differences between country-specific factors and default values or country-specific factors from regions with similar circumstances to those of the reporting country.</p>
<p>Tier 3</p>

Review of tier 3 methods is often challenging because of their complexity and the limited time available for the review, particularly during centralized and desk reviews. However, as a reviewer, you must assess i) whether the NID includes verification information consistent with the 2006 IPCC Guidelines (vol. 4, chap. 6.10); whether the NID includes additional information for improving transparency, such as information on basis and type of model; application and adaptation of the model; main equations/processes; key assumptions; domain of application; how the model parameters were estimated; description of key inputs and outputs; details of calibration and model evaluation; uncertainty and sensitivity analysis; QA/QC procedures adopted; and references to peer-reviewed literature.

Moreover, there are two possible tests to compare the results of a tier 3 estimate with a tier 1 estimate: i) to check whether the results of the tier 3 method fall within the uncertainty range of tier 1; and ii) to check whether the uncertainty of the estimate generated by the tier 3 method is lower than the uncertainty of an estimate generated by the tier 1 method.



Please see p.11.34 in chapter 11 of volume 4 of the 2006 IPCC Guidelines for more information.

2.7. Urea application: linkages between the urea application category and other categories

The IPPU sector, category 2B1 chemical industry

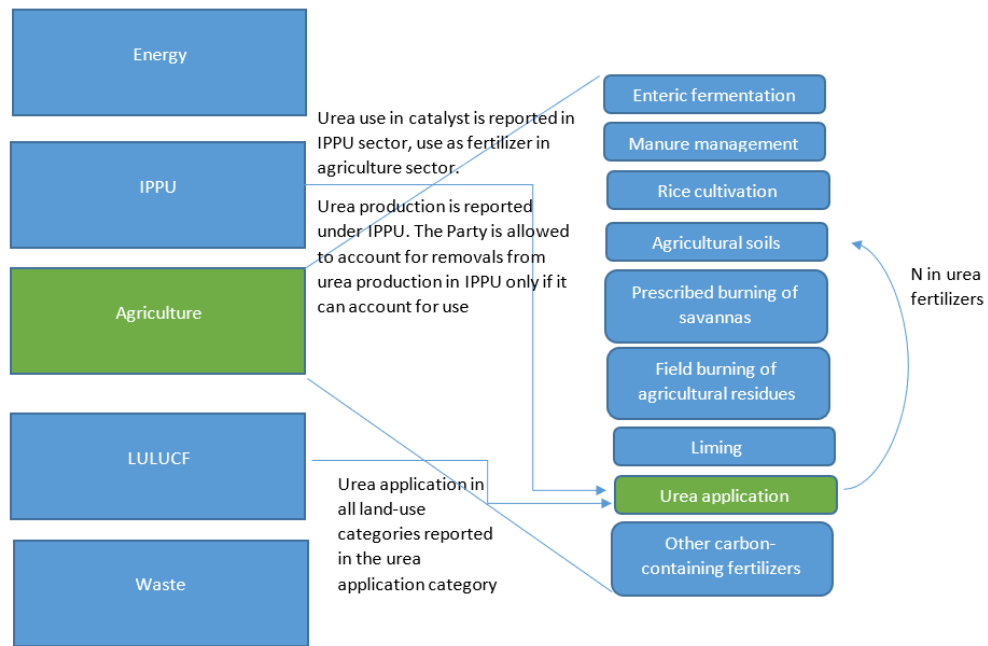
- Urea is made of ammonia (NH₃);
- The main GHG emitted from NH₃ production is CO₂. CO₂ used in the production of urea, a downstream process, should be subtracted from the CO₂ generated and accounted for under the agriculture sector.

The LULUCF sector

- Urea application in all land-use categories are reported under the agriculture sector.

The agricultural soils category

- Urea is also included in the AD of category 3.D, as it contains nitrogen. Hence, the AD on the amount of urea applied should be consistent between 3.D and the urea application category.



GG. Figure 8-4. Main linkages between the urea application category and the other categories in the agriculture sector and other sectors

2.8. Key reporting components of the category

Table 8-1 summarizes the main reporting components and the methodological references related to the lime and urea application category.

Table 8-1. Summary of key elements of the lime and urea application categories

Overview	Category-specific information	
Category name	CO ₂ emissions from liming, urea application and other carbon-containing fertilizers	
General reference	2006 IPCC Guidelines, volume 4, chapter 11	
Chapter of the NID	Chapter 5: Agriculture	
Reporting in CRT	CRT 3.G-J	
Main subcategories and GHGs to be reported	Limestone (CaCO ₃)	CO ₂
	Dolomite (CaMg(CO ₃) ₂)	CO ₂
	Urea application	CO ₂
	Other carbon-containing fertilizers	CO ₂

Other carbon-containing fertilizers

The category includes, for example, the emissions due to application of calcium ammonium nitrate (CAN) to agricultural fields. The CAN fertilizer contains 21–27 per cent nitrogen and 8 per cent calcium as calcium carbonate (lime). The 2006 IPCC Guidelines do not provide a specific method and EF for this category and therefore it **is not** considered as a **mandatory** category. However, it could be expected that the Parties report emissions from this category using a similar approach to that used for urea (i.e. use of fertilizer as AD, EF based on carbon content). If that is the case, as a reviewer, you could undertake the same checks outlined in table 8-2. However, if a Party has not provided any estimates of the emissions, it should not be considered as an issue of completeness.

In addition to the generic reporting instructions, individual reporting requirements are included in the footnotes of each CRT. Parties may report additional information in the documentation boxes in the CRT. As an agriculture expert, you must familiarize yourself with the footnotes and the information provided by the Party in the documentation boxes in the CRT. Moreover, you must assess the information reported in **summary report tables** and in **cross-cutting tables**.

3. Review approach

3.1. Key points to consider when reviewing the liming and urea application category



A brief description of three common review steps (prepare – assess - draft) is provided in https://unfccc.int/resource/tet/ba/ba8-01_L_R_steps.pdf. Please read carefully before continuing with the key points to consider when reviewing emissions from liming and urea application, if you have not yet done so.

The choice of methods, selection of assumptions, development and selection of EFs and collection and selection of AD are the main drivers of inventory quality. Hence, as a reviewer, you must assess and ensure that the selection of these data carried out by a Party are in accordance with the 2006 IPCC Guidelines and its supplements and the requirements in the UNFCCC decisions.

Table 8-2 summarizes the possible questions and actions that you can ask yourself when reviewing the emissions reported under the liming and urea application category. In addition, there are several common elements to be assessed across sectors/categories when reviewing the quality of the Party's submission (i.e., uncertainty analysis, QA/QC, time-series consistency, recalculations and progress in implementing improvements); lesson 2 above provides a list of guiding questions.

Table 8-2. Possible actions by the expert review team in its review of CO₂ emissions from the liming and urea application categories

Review element	Possible question/action by the ERT
Choice of method	If CO ₂ emissions from liming/urea fertilization is a key category, has the Party collected data and applied tier 3 or tier 2 methods?
AD – liming	Are AD based on actual usage statistics? If based on annual sales or estimated through a balance of production, imports and exports, are data sufficient to estimate national emissions?
AD – liming	Are the AD available separately for calcitic limestone and dolomite or have assumptions been made? Are any assumptions sufficiently justified and documented?
EFs – liming	Has the Party used different EFs to estimate CO ₂ emissions from limestone and dolomite application on agricultural soils?
EFs – liming	Does AD include all lime applied to soils, even the proportion applied in mixture with fertilizers?
AD – liming	Does the reporting on lime application cover all land uses?
AD – urea application	Are the AD based on urea fertilizer use or sales instead of production?
AD – urea application	If AD are estimated through a balance of production, imports and exports are data sufficient to estimate national emissions?
AD – urea application	Are the AD (amount of urea fertilizers used) consistent with the data used in the category direct and indirect N ₂ O emissions from agricultural soils (category 3.D)?
AD – urea application	Does the reporting on urea application cover all land uses?
Completeness	Are carbon-containing fertilizers other than lime and urea used? If other carbon-containing fertilizers are used, are the AD consistent with the data used in category 3.D?



Please note that table 8-2 is not intended to provide an exhaustive list of questions; it is rather a starting point to stimulate your thinking. You may add or modify the questions as appropriate while conducting a review.

As a reviewer, you must first focus on the observations which have an impact on the level and/or trend of the GHG emissions. Moreover, in the case of issues related to transparency (i.e. the NID does not clearly describe how emissions were estimated), the TERT should specifically determine whether the lack of transparency in the inventory leads it to question the accuracy of the inventory estimates reported.



Paragraph 28 of decision 5/CMA.3 notes that the Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines. Hence, as a reviewer you must be aware that neither the EFs nor the methodologies to estimate the emissions from the liming and urea application have been updated in the 2019 Refinement to the 2006 IPCC Guidelines.

3.2. Walk-through examples: assessment of accuracy

You are invited to review the information provided by LIMELAND. Please review the NID and CRT submitted in 2027.

Please open a PDF copy https://unfccc.int/resource/tet/ba/ba8-02_L8_CS_NID.pdf of the NID and CRT https://unfccc.int/resource/tet/ba/ba8-03_L8_CS_CRT.xlsx submitted by LIMELAND



NID 2027

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA	IMPLIED EMISSION FACTORS	EMISSIONS
	Amount applied (t/y)	CO ₂ -E per unit of CO ₂ -E	CO ₂ (t/y)
G. Liming²⁰			14.75
Limestone CaCO ₃	39914.40	0.11	14.75
Dolomite CaMg(CO ₃) ₂	0	0	0
H. Urea application	614388.20	0.20	450.42
I. Other carbon-containing fertilizers	ND	ND	ND
J. Other (please specify)	ND	ND	ND

CRT 3.G-J

What would be your assessment regarding the accuracy of the estimate conducted by the Party in its submission?

Please submit your assessment here:

Assessment of accuracy – how to formulate questions

Effective communication between the TERT and the Party is one key to a successful review process. Hence, it is important that the TERT makes the necessary effort to ensure that communications are clear and concise. Now it is your turn to practice; try to draft a clarification question regarding the finding you identified.

Please submit your question here:

A hypothetical answer of the Party could be as follows:

Dear TERT, many thanks for your question! A national statistical office reports the aggregated data on the amount of lime fertilizers applied to agricultural soils. However, upon your query, we have approached the largest lime producer in our country and specified data on the disaggregation between limestone and dolomite produced at a factory: namely, a share of 55 per cent for limestone and 45 per cent for dolomite of the total amount of lime produced. Hence, the same ratios will be applied to estimate CO₂ emissions from lime usage on agricultural fields in the next inventory submission.

Assessment of accuracy – recording in the review report

Here you are invited to describe and reflect your finding as a part of the review report. Please explain the TERT finding with references to the CRT and/or NID, summarize any communication with the Party during the review, indicate why the TERT finds that the Party is not meeting the applicable reporting requirements of the MPGs and include the TERT recommendation or encouragement in a precise and clear manner.

Draft the description of your finding here:

3.3. Answer key to walk-through examples

Assessment of accuracy

The Party clarified that CO₂ emissions from liming have not been identified as a key source in its NID. Therefore, a tier 1 approach has been applied to estimate CO₂ emissions from lime application activities. The Party also noted that as a national authority collects and reports an aggregate annual amount of lime, an overall EF of 0.13 t carbon (t limestone or dolomite)⁻¹ has been applied for the estimates. Moreover, in its CRT 9, the Party clarified that “CO₂ emissions from 3.G.2 category are included in 3.G.1 category. Amount applied of dolomite is included in limestone amount (3.G.1 category)”.

However, chapter 11 of volume 4 of the 2006 IPCC Guidelines (p.11.27), states that the total amount of carbonate containing lime applied annually to soils in the country must be differentiated between limestone and dolomite. The total annual CO₂-carbon emissions must be calculated by multiplying the total amounts of limestone and dolomite by their respective EFs (default EFs are 0.12 for limestone and 0.13 for dolomite) and summing up the two values to obtain the total CO₂-carbon emissions .

Hence, as a reviewer, you may preliminarily conclude that the estimates conducted by the Party may lead to overestimation of CO₂ emissions, as the country has not disaggregated the total amount of lime between limestone and dolomite and applied one common factor of 0.13 t carbon/tonne to estimate CO₂ from both components.

Assessment of accuracy – how to formulate questions

One possible version of the clarification question might be as follows:

The TERT noted in its CRT 3.G-J that LIMELAND used the notation key “IE” to report CO₂ emissions from dolomite and indicated in its NID that CO₂ emissions from agricultural dolomite application have been included in CO₂ emissions from limestone application, as national statistics on amount of lime applied do not allow to disaggregate into two components (i.e. limestone and dolomite). In addition, the Party stated that “an overall emission factor of 0.13 t C (t limestone or dolomite)⁻¹ has been used to estimate CO₂ emissions”.

However, the TERT would like to note that the 2006 IPCC Guidelines provide two separate default EFs for limestone (0.12 t CO₂-carbon/t) and for dolomite (0.13 t CO₂-carbon/t), which must be multiplied with the respective amounts of limestone and dolomite applied. Hence, the TERT considers that the use of the aggregate AD on lime applied to agricultural soils may lead to overestimation of CO₂ emissions from this category.

Could the Party comment on the observation made by the TERT and clarify procedural steps to obtain or disaggregate the data on the total amount of lime usage into two components: limestone and dolomite?

Walk-through examples: assessment of accuracy – recording in the review report

Examine how this issue could be described in the review report:

In CRT 3.G-J, LIMELAND reported CO₂ emissions from dolomite using the notation key “IE”, indicating that there are no national statistics to disaggregate statistics of liming material. However, the tier 1 default value from the 2006 IPCC Guidelines for limestone is 0.12 t CO₂-carbon/t and for dolomite it is 0.13 t CO₂-carbon/t.

During the review, LIMELAND explained that the largest lime producer in the country provided data on the disaggregation between limestone and dolomite used in agriculture showing a share of 55 per cent for limestone and 45 per cent for dolomite; these data will be used in the next submission. Although the TERT accepted the Party’s reporting, it believes that this issue should be considered further in future reviews to confirm that there is no underestimation or overestimation of emissions.

The TERT recommends that LIMELAND estimate emissions from limestone and dolomite application separately to improve the accuracy of reporting liming emissions in accordance with the 2006 IPCC Guidelines and confirm the amount of lime and dolomite for liming.

4. Practical exercises

4.1. Practical exercise 1

The following information is provided in the NID of a Party:

Adding urea (CO(NH₂)₂) to soils during fertilization leads to a loss of CO₂. Emissions of CO₂ from use of urea contributes with less than 1 per cent of the CO₂ emissions from the agriculture sector in 2025.

The amount of urea used on agricultural soils in 2006–2025 is provided by the National Service for Plant Protection (table 5.5). The default EF of 0.20 t carbon/tonne has been employed. A tier 1 method from the 2006 IPCC Guidelines has been applied to estimate CO₂ emissions.

Table 5.5. Consumption of urea fertilizers (t/year) for 1990–2025

1990	1995	2000	2005	2006	2007	2010	2015	2020	2021	2022	2023	2024	2025
23.34 8	23.34 8	23.34 8	23.34 8	23.34 8	22.88 1	21.48 1	42.71 2	36.08 0	34.27 6	35.99 0	37.78 9	39.67 9	41.66 3

Assess whether the methodologies, choice of EFs and other parameters, collection of AD and cross-cutting inventory elements (e.g. documentation, time-series consistency) are in accordance with the MPGs.

After reviewing this information, which statement best describes the possible assessment of the TERT?

Select one:

- A. The Party followed the route classified in the decision tree to identify an appropriate tier to estimate CO₂ emissions from urea fertilization – that is, the Party used tier 1 as the emissions from this category are not key. The Party also employed the time-series consistent AD on the amount of urea applied to the managed land – that is, a reference source of the data is a national statistical authority. The default EF has been used (0.20 t carbon per tonne of urea applied to the soil) for the whole time series. Hence, as a reviewer, you may conclude that the Party followed the requirements of the 2006 IPCC Guidelines and the MPGs and you do not identify any failure in the Party's reporting
- B. As the results of the key category analysis are not provided, it is impossible to assess whether the Party applied a recommended method from the appropriate decision tree in the 2006 IPCC Guidelines
- C. The Party followed the route classified in the decision tree to identify an appropriate tier to estimate CO₂ emissions from urea fertilization – that is, the Party used tier 1 as the emissions from this category are not key. The Party has not provided a reference source for the AD on the amount of urea applied to the soils in 1990–2005. Moreover, table 5-5 of the NID demonstrates that the Party applied constant data on the amount of urea applied to the soils to estimate CO₂ emissions in 1990–2005. However, as a reviewer, you would not raise this as an issue, as the problem relates to the past and, most likely, there are no data available for this period, and the country will no longer be able to collect them
- D. The Party followed the route classified in the decision tree to identify an appropriate tier to estimate CO₂ emissions from urea fertilization – that is, the Party used tier 1 as the emissions from this category are not key. The Party has not provided any reference source for the AD on

the amount of urea applied to the soils in 1990–2005. Moreover, table 5-5 of the NID demonstrates that the Party applied constant data on the amount of urea applied to the soils to estimate CO₂ emissions in 1990–2005. Hence, as a reviewer, you would recommend that the Party make efforts to evaluate specific data on urea application in the country for this time period by identifying a proxy variable, which will enable it to obtain an accurate and consistent time series of CO₂ emissions from urea application for 1990–2005.

Tip

See paragraphs 26–28 and 39 of the MPGs, and chapter 5 of volume 1 of the 2006 IPCC Guidelines on time-series consistency and approaches to fill the gaps in AD.

The methodologies used to estimate emissions, as well as the methodologies to collect AD, should be consistent across the time series; otherwise, the results of estimates for the earlier and later years of the inventory would not be comparable.

4.2. Practical exercise 2

The following information is provided in the NID of a Party:

5.8.1 category description

Liming is used to reduce soil acidity and improve plant growth in managed systems and is applied to cropland and grassland in the Party. Liming is a key category. Emissions from liming only occur from limestone (CaCO_3), with no activities identified for dolomite ($\text{CaMg}(\text{CO}_3)_2$) which is reported as “NO” (a reference source confirming this information is provided by the Party). Total emissions from liming amounted to 382.32 kt CO_2 eq in 2025.

5.8.2 methodological issues

The tier 1 approach in the 2006 IPCC Guidelines is used for liming. Annual sales of lime are used to infer the quantity applied to soils, assuming that all lime sold to farmers is applied during the same year. Lime is applied to grassland and cropland in the country. The default EF of 0.12 is used for the proportion of carbon in lime.

5.8.6 category-specific planned improvements

There are no planned improvements for this category.

After reviewing this information, which statement best describes the possible assessment and recommendation of the TERT?

Select one:

- A. The methodological choice implemented by the Party is in line with the 2006 IPCC Guidelines; no further actions are foreseen on the part of the TERT
- B. The Party used a tier 1 method to estimate emissions from liming, even though this category is a key category. Hence, noting that the use of tier 1 is a conservative estimate, the TERT recommends that the Party apply a tier 2 method to this category in its next submission
- C. The Party used a tier 1 method to estimate emissions from liming, even though this category is a key category. Hence, noting that the use of tier 1 is a conservative estimate, the TERT recommends that the Party make the effort to collect country-specific data to apply a tier 2 method to this category and reflect this issue in the improvement plan for the next submission

Tip

Please see paragraphs 21–23 of the MPGs.

In general, a higher-tier method will yield a more accurate estimate of the emissions from a category, and is therefore to be preferred. The appropriate choice of tier for the particular category in question will depend upon the overall national circumstances and availability of data (2006 IPCC Guidelines, vol. 1, figure 4.1), and on the decision tree specific to the category. In its review of the choice of method for each category, the TERT may consider the following:

- i. Does the national inventory report include information on the IPCC tier used?
- ii. For key categories, does the NID include an explanation if the recommended methods from the appropriate decision tree in the 2006 IPCC Guidelines and its supplements are not used?
- iii. If a recommended method is not used owing to lack of data or resources, has the Party adequately explained the national circumstances in the NID? Does the Party have plans to improve the situation?

4.3. Answer key to practical exercises

Practical exercise 1

The correct answer is D.

The Party has not provided any reference source for the AD on the amount of urea applied to land from 1990 to 2005. Moreover, table 5-5 of the NID illustrates that the Party applied constant data on the amount of urea applied to the soils to estimate CO₂ emissions in 1990–2005, which may lead to overestimation or underestimation of CO₂ emissions for this period. However, the problem relates to the past, and, in practical terms, it is not possible to collect the necessary regional data at present. One of the most straightforward approaches to improving consistency in the time series might be to employ the splicing techniques defined and described in chapter 5 of volume 1 of the 2006 IPCC Guidelines – for example, the implementation of the surrogate data technique. The approach presumes that EFs, AD or other estimation parameters used in the new method are strongly correlated with other well-known and more readily available indicative data.

Practical exercise 2

The correct answer is C.

As a reviewer, you should not immediately jump to conclusions, as primarily it is necessary to examine the NID on whether a Party provided a clear documentation on why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines and whether the Party prioritized any improvements for this category in its future improvement plan.

5. Self-check quiz

Question 1

Domestic production records and/or import/export data on urea can be used to obtain an approximate estimate of the amount of urea applied to soils on an annual basis. It can be assumed that all urea fertilizer produced or imported annually minus annual exports is applied to soils.

Select one:

- A. True
- B. False

Question 2

A Party should report in its CRT 3.G-J total estimates for total lime application, regardless of land use.

Select one:

- A. True
- B. False

Question 3

CO₂ emissions associated with storage of digested residues can be reported by a Party under subcategory 3.J of CRT 3.G-J.

Select one:

- A. True
- B. False

Question 4

A developing Party in its description of uncertainty rates associated with the AD on the amount of urea applied to soils stated that the rates are extremely high and has not provided any quantitative information. As a reviewer, you would accept the reporting submitted by the Party.

Select one:

- A. True
- B. False

Question 5

Read through the description of the finding recorded by the TERT in the review report and classify it into one of the TACCC principles:

3.G Liming:

Under category 3.G (liming) the Party only reports AD and CO₂ emissions for limestone use (in CRT 3.G-J). For dolomite use, the Party reported “IE”. However, the documentation box in the CRT states that emissions from limestone include dolomite, and that an adjusted EF of 0.1224 was used to account for dolomite. In the NID, the Party noted that the ratio of dolomite was derived on the basis of an expert consultation with the National Fertilizer Institute. However, no AD on limestone and dolomite use are presented in the NID.

In response to a question raised by the TERT during the review, the Party explained that it does not have consistent AD throughout the time series to quantify the amounts of limestone and dolomite independently, and therefore developed a weighted EF based on the estimated proportion of limestone and dolomite derived from the expert consultation with the National Fertilizer Institute.

The limestone EF of 0.12 and dolomite EF of 0.13 were weighted, resulting in a national EF of 0.1224. The Party also explained that it reports “IE” for dolomite because limestone and dolomite emissions are calculated together and reported under limestone. The TERT concluded that the Party reflected its assumptions about limestone and dolomite use in the IEF for limestone use.

However, the TERT recommends that the Party develop the underlying AD time series for limestone and dolomite, for example, by using the ratio of limestone to dolomite used to calculate the weighted EF, and use the corresponding IPCC default EFs separately for limestone and dolomite, as specified in the 2006 IPCC Guidelines (vol. 4, section 11.3.2). The TERT recommends that the Party report separately the emissions from limestone and dolomite assumed to be applied to soils in CRT 3.G-J in its next submission.

Select one:

- A. Transparency
- B. Accuracy
- C. Consistency
- D. Comparability
- E. Completeness

5.1. Answer key to self-check quiz

Question 1

The correct answer is A.

Please consult p.11.34 of chapter 11 of volume 4 of the 2006 IPCC Guidelines for more information.

Question 2

The correct answer is A.

Footnote (1) to CRT 3.G-J indicates that emissions should include all national liming regardless of land use. A Party should report total estimates for total lime application.

Question 3

The correct answer is A.

Footnote 2 to CRT 3.G-J specifies that “for example, emissions associated with storage of digested residues can be reported in this category”.

Question 4

The correct answer is A.

Paragraph 29 of the MPGs stipulates that those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead provide, at a minimum, a qualitative discussion of uncertainty for key categories, using the 2006 IPCC Guidelines, where quantitative input data are unavailable to quantitatively estimate uncertainties, and are encouraged to provide a quantitative estimate of uncertainty for all source and sink categories of the GHG inventory.

Question 5

The correct answer is D.

The Party used the notation key “IE” to report CO₂ emissions from dolomite use. However, the Party used an adjusted EF taking into account a ratio of limestone and dolomite in the total amount of lime applied to soils. Hence, the TERT agreed with the Party’s estimates and concluded that the results are accurate and do not lead to overestimation or overestimation of CO₂ emissions. However, the TERT indicated that the reporting performed by the Party is not comparable with those established by the reporting guidance.

Comparability: the national GHG inventory is reported in a way that allows it to be compared with national GHG inventories for other countries. This comparability should be reflected in an appropriate choice of key categories, and in the use of the reporting guidance and tables and use of the classification and definition of categories of emissions and removals presented in table 8.2 in chapter 8 of volume 1 of the 2006 IPCC Guidelines.

6. Key points to remember

- Addition of carbonates to soils in the form of lime (e.g. calcitic limestone (CaCO_3) or dolomite ($\text{CaMg}(\text{CO}_3)_2$) leads to CO_2 emissions as the carbonate limes dissolve to release bicarbonates which evolve to CO_2 and water).
- Liming is used to reduce soil acidity and improve plant growth in managed systems.
- Adding urea to soils during fertilization leads to a loss of CO_2 that was fixed in the industrial production process.
- Chapter 11 of volume 4 of the 2006 IPCC Guidelines contains the methodologies developed to estimate CO_2 emissions from lime and urea application.
- Paragraph 28 of decision 5/CMA.3 notes that Parties may use on a voluntary basis the 2019 Refinement to the 2006 IPCC Guidelines.
- There are three tier methods developed in the 2006 IPCC Guidelines to estimate CO_2 emissions from lime and urea application – the level of disaggregation depends upon the availability of activity and EF data, as well as the importance of this category as a contributor to a Party's national GHG emissions.
- CO_2 emissions from lime and urea fertilization activities are estimated by multiplying EFs by the amount of fertilizer (limestone, dolomite and urea) applied to soils.
- In its estimates of CO_2 emissions, a Party can use actual usage data (e.g. in tonnes of dolomite applied). However, if there are no actual usage data, a Party may alternatively use the estimated data based on annual sales data or production data. As a reviewer, you must ensure that no double accounting or omission incurred.
- Annex I to decision 5/CMA.3 provides the template of CRTs for the electronic reporting of the information in the national inventory reports of anthropogenic GHG emissions by sources and removals by sinks:
 - CRT 3.G-J includes the information on the AD, EFs and CO_2 emissions released due to lime and urea application to soils (regardless of land use).
- The lime and urea application category is closely linked with the agricultural soil category (CRT 3.D) and the energy and the IPPU sectors. As a reviewer, you should assess whether a Party ensured consistency in the usage of the AD to estimate GHG emissions from interlinked categories of the inventory.