FAOSTAT Domain Emissions from livestock. Methodological note, release October 2026

Dataset Information:	
Title	**Enteric Fermentation**
Abstract	The FAOSTAT domain Emissions from livestock provides information on emissions generated from four livestock processes, namely Enteric fermentation; Manure left on pastures; Manure management; and Manure applied to soils. Estimates are computed following the Tier 1 method of the 2006 IPCC Guidelines for National greenhouse gas Inventories (IPCC, 2006). Data are available by country, with global coverage and relative to the period 1961–2024, with annual updates, and projections for 2030 and 2050.
Supplemental	The FAOSTAT domain **Emissions from livestock** provides information on: activity data (stocks by animal type) and greenhouse gas (GHG) emissions (kilotonnes of CH_4 and N_2O). Disaggregate direct and indirect N_2O emissions are also disseminated when applicable. Data are available for most FAOSTAT countries and territories, for standard FAOSTAT regional aggregations, and for Annex I and non-Annex I groups. This FAOSTAT domain also disseminates the activity data and emissions reported by countries to the United Nations Framework Convention on Climate Change (UNFCCC), under the category 'Enteric fermentation'. Activity data are sourced from the most recently available GHG National Inventories (NGHGI) or from National Communications. Emission data are sourced directly from the UNFCCC data portal or from Biennial Update Reports (BURs). UNFCCC data are disseminated in FAOSTAT with permission, formalized via a FAO-UNFCCC Memorandum of Understanding. The IPCC (2019) Guidelines indicate the FAOSTAT database as a useful tool for NGHGI QA/QC processes and validation of both activity data and emissions estimates.
Creation Date	2012
Last Update	2026
Data Type	Climate Change - Greenhouse Gases
Category	Agriculture - Environment
Time Period	1961–2024; projections to 2030 and 2050
Periodicity	Annual
Geographical Coverage	World
Spatial Unit	In 2024, 206 countries and territories (FAO Tier I)
Language	Multilingual (EN, FR, ES)

Methodology and Quality Information:	
Methods and processing	***Overview*** Emissions estimates are computed for the following livestock-related processes based on the IPCC 2006 guidelines (IPCC, 2006): Enteric fermentation; Manure left on pastures; Manure management; and Manure applied to soils. ***1) Enteric fermentation*** Greenhouse Gas (GHG) emissions from ***Enteric fermentation*** consist of methane gas (CH_4) emissions produced in digestive systems of and to a lesser extent of non-ruminants. The FAOSTAT data are computed at Tier 1, following IPCC 2006 Vol. 4, Ch. 10. The emissions are estimated at country level, using the formula: $$Emission = A \times EF$$ where: *Emission* = GHG emissions, in kg CH_4 yr^{-1};

A = Activity data, representing number of livestock in animals (1);
EF = Tier 1, default IPCC emission factors, expressed in units of kg CH_4 per animals per year (animals^{-1} yr^{-1}) (2).

(1) Activity data cover the following animal categories: buffaloes, sheep, goats, camels, llamas, horses, mules and asses, dairy and non-dairy cattle, swine market and swine breeding (***see information on "Stocks"***).

(2) The Emissions Factors (EFs) values are those specified by livestock type and regional grouping in IPCC, 2006, Vol. 4, Ch.10, Tabs. 10.10 and 10.11.

Dimensionless conversion factors:
10^{-6}, to convert the emissions from kg CH_4 to kt CH_4.

2) Manure left of pasture

Greenhouse gas emissions from ***Manure left on pasture*** consists of direct and indirect nitrous oxide (N_2O) emissions from nitrogen (N) in manure left on pasture by grazing livestock. Specifically, N_2O is produced by microbial processes of nitrification and de-nitrification taking place on the deposition site (direct emissions), and after volatilization/re-deposition and leaching processes (indirect emissions). The FAOSTAT data are estimated at Tier 1 following the IPCC, 2006, Vol. 4, Ch. 10 and 11.

Direct emissions are estimated at country level, using the formula:

$$Emission = A \times EF$$

where:

Emission = GHG emissions in kg yr^{-1};
A = Activity data, representing the total amount of N in manure left on pasture in kg N yr^{-1} (1);
EF = Tier 1, default IPCC emission factors, expressed in kg N_2O-N/kg N yr^{-1} (2).

(1) Computed as per IPCC, 2006: Vol.4, Ch. 11, Eq. 11.5, as the amount of total N excreted (see below, note *i*) by livestock type (*ii*) and for manure left on pastures as urine and dung (*iii*).

(i) Following IPCC, 2006: Vol.4, Ch. 10, Eq. 10.30, the total amount of N excreted by each livestock category is calculated multiplying the number of livestock animals or poultry birds by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (N_{ex}). Both parameters vary according to geographic region. TAM values are obtained from IPCC, 2006: Vol.4, Ch. 10, Annex 10A.2 Tabs. 10A-4 to 10A-9; N_{ex} values are derived from IPCC, 2006: Vol.4, Ch. 10, Tab. 10.19.

(ii) Activity data on livestock types cover the following animal categories: buffalo, sheep, goats, camels, llamas, horses, mules, asses, ducks, turkeys, dairy and non-dairy cattle, chicken layers and broilers and market and breeding swine (***see information on "Stocks"***).

The Manure Management domain of FAOSTAT GHG emissions database provides information on methane and nitrous oxide gases from aerobic and anaerobic decomposition processes. The FAOSTAT emission data are computed at Tier 1 following IPCC, 2006, Vol. 4, Ch. 10 and 11.

The term manure includes both urine and dung (i.e., both liquid and solid material) produced by livestock. More specifically, CH_4 gas is produced by anaerobic decomposition of manure stored or treated, while N_2O is produced directly by nitrification and de-nitrification processes in the manure, and indirectly by nitrogen (N) volatilization and re-deposition processes, as well as from leaching of manure N.

CH_4 emissions are estimated at country level, using the formula:

$$Emission = A \times EF$$

where:
Emission = GHG emissions in kg CH_4 yr^{-1};
A = Activity data, representing number of livestock in animals (1);
EF = Tier 1, default IPCC emission factors, expressed in kg CH_4 $head^{-1}$ yr^{-1} (2).

(1) Activity data cover the following animal categories: buffalo, sheep, goats, camels, llamas, horses, mules, asses, ducks, and turkeys, dairy and non-dairy cattle, chicken layers and broilers and market and breeding swine (***see information on "Stocks"***).

(2) Global default EF values taken from IPCC, 2006: Vol. 4, Chapter 11, Tab. 11.1.

Indirect emissions are estimated at country level, using the formula:

$$Emission = A \times EF$$

where:

Emission = GHG emissions in kg yr^{-1};
A = Activity data, representing the fraction of manure N left on pastures that volatizes as NH_3 and NO_x or the fraction that is lost through runoff and leaching in kg N yr^{-1} (3);
EF = Tier 1, default IPCC emission factors, expressed in kg N_2O-N/kg N yr^{-1} (4).

(3) Obtained through the volatilization (FracGASM) and leaching factors (FractLEACH) in IPCC, 2006: Vol.4, Ch. 11, Tab. 11.3. While the IPCC methodology estimates leaching only in regions where runoff occurs, in FAOSTAT leaching is assumed to occur in all regions, for lack of region-specific water balance information.

(4) Global IPCC default EF values from IPCC, 2006: Vol.4, Ch. 11, Tab. 11.3.

Dimensionless conversion factors:
44/28, to convert the emissions from kg N_2O-N to kg N_2O gas;
10^{-6}, to convert the emissions from kg N_2O to kt N_2O.

3) Manure management

Greenhouse Gas (GHG) emissions from ***Manure management*** consist of methane and nitrous oxide emissions from aerobic and anaerobic decomposition processes. The FAOSTAT emissions data are computed at Tier 1 following IPCC, 2006, Vol. 4, Ch. 10 and 11.

The term manure includes both urine and dung (i.e., both liquid and solid material) produced by livestock. More specifically, CH_4 gas is produced by anaerobic decomposition of manure stored or treated, while N_2O is produced directly by nitrification and de-nitrification processes in the manure, and indirectly by nitrogen (N) volatilization and re-deposition processes, as well as from leaching of manure N.

CH_4 emissions are estimated at country level, using the formula:

$$Emission = A \times EF$$

where:
Emission = GHG emissions in kg CH_4 yr^{-1};
A = Activity data, representing number of livestock in animals (1);
EF = Tier 1, default IPCC emission factors, expressed in kg CH_4 $animals^{-1}$ yr^{-1} (2).

(1) Activity data cover the following animal categories: buffalo, sheep, goats, camels, llamas, horses, mules, asses, ducks, turkeys, dairy and non-dairy cattle, chickens layers and broilers and market and breeding swine (***see information on "Stocks"***).
(2) The EF values assigned to each country depend on the region and the country average annual temperature. The EF values applied were taken from IPCC (2006) table 10.14 (for cattle, buffaloes, and pigs) and table 10.15 (for other animals), and the values for country average annual temperatures were taken from the FAO Global Agro-Ecological Zones (GAEZ) dataset (FAO/IIASA, 2011) "Mean annual temperature (baseline period 1961-1990)"
(See disclaimer at http://www.fao.org/fileadmin/user_upload/gaez/docs/User_Agreement_and_Disclaimer_EN.pdf).
For those territories with no specific values in the GAEZ dataset, other sources were used. These include mainly data from The World Bank Group (2016) Climate Change Knowledge Portal (see disclaimer at: http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download).

Direct N_2O emissions are estimated at country level, using the formula:

$$Emission = A \times EF$$

where:
Emission = GHG emissions in kg N_2O-N yr^{-1};
A = Activity data, representing the total amount of N in manure treated in manure management systems (MMS) in kg N yr^{-1} (3);
EF = Tier 1, default IPCC emission factors, expressed in kg N_2O-N/kg N yr^{-1} (4).

(3) It is the total amount of N excreted (*i*) for each livestock category (*ii*) treated in MMS (*iii*).

(i) Following IPCC, 2006: Vol. 4, Ch. 10 Eq. 10.30, the total amount of N excreted by each livestock category is calculated multiplying the number of livestock animals or poultry birds by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (Nex). Both parameters vary according to geographic region. TAM values are obtained from IPCC, 2006: Vol.4, Ch. 10, Annex 10A.2, Tabs. 10A-4 to 10A-9; Nex values are derived from IPCC, 2006: Vol. 4, Ch. 10, Tab. 10.19.

(ii) see (1) for the livestock categories.

(iii) Default IPCC percentages of total N treated in different MMS, by region and livestock category are taken from IPCC (2006) Vol 4, Tables 10.A4-9 pp.10.77-82 (cattle, swine and buffaloes); IPCC (1997) Vol 2, Table 4.7, pp.4.11-13 (other animals, including poultry).

(4) The EF values depend on the specific MMS, as per IPCC 2006, Vol.4, Ch. 10, Tab. 10.21.

Indirect N_2O emissions are estimated at country level, using the formula:

$$Emission = A \times EF$$

where:
Emission = GHG emissions in kg N_2O-N yr^{-1};
A = Activity data, representing the fraction of total amount of nitrogen (N) in manure treated in MMS that volatizes as NH_3 and NO_x, in kg N yr^{-1};
EF = Tier 1, default IPCC emission factors, expressed in kg N_2O-N/kg N yr^{-1} (5).

(5) The fractions for volatilization by animal and MMS are taken from IPCC, 2006: Vol. 4, Ch. 10, Tab. 10.22. (6) All countries are assigned global default EF values for volatilization (IPCC, 2006: Vol. 4, Ch. 11, Tab. 11.3).

Dimensionless conversion factors:

44/28, to convert the emissions from kg N_2O-N to kg N_2O gas;
10^{-6}, to convert kg to kt.

4) Manure applied to soils

Greenhouse gas emissions from ***Manure applied to soils*** consist of direct and indirect nitrous oxide (N_2O) emissions from the nitrogen (N) in manure added to agricultural soils. Specifically, N_2O is produced by microbial processes of nitrification and de-nitrification taking place on the application site (direct emissions), and after volatilization/re-deposition and leaching processes (indirect emissions). The FAOSTAT data are estimated at Tier 1 following the IPCC, 2006, Vol. 4, Ch. 10 and 11.

Direct emissions are estimated at country level, using the formula:

$$Emission = A \times EF$$

where:

Emission = GHG emissions in kg N_2O-N yr^{-1};

A = Activity data, representing the total amount of N in manure applied to soils in kg N yr^{-1} (1);

EF = Tier 1, default IPCC emission factors in kg N_2O-N/kg N yr^{-1} (2).

(1) It is the amount of N excreted (see below, note *i*) by livestock type (*ii*), treated in manure management systems (MMS) (*iii*) and net of losses through volatilization, runoff and leaching from MMS, and other human use (*iv*), plus the N contribution from bedding materials when available (*v*).

(i) Following IPCC, 2006: Vol.4, Ch. 10, Eq. 10.30, the total amount of N excreted by each livestock category is calculated multiplying the number of livestock animals or poultry birds by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (N_{ex}). Both parameters vary according to geographic region. TAM values are obtained from IPCC, 2006: Vol.4, Ch. 10, Annex 10A.2 Tabs. 10A-4 to 10A-9; N_{ex} values are derived from IPCC, 2006: Vol.4, Ch. 10, Tab. 10.19.

(ii) Activity data on livestock types cover the following animal categories: buffalo, sheep, goats, camels, llamas, horses, mules, asses, ducks, turkeys, dairy and non-dairy cattle, chicken layers and broilers and market and breeding swine (***see information on "Stocks"***).

(2) Global IPCC default EF values are taken from IPCC, 2006: Vol. 4, Ch. 11, Tab. 11.1.
Indirect emissions are estimated at country level, using the formula:

$$Emission = A \times EF$$

where:

Emission = GHG emissions in kg yr^{-1};
A = Activity data, representing the fraction of manure N applications that volatizes as NH_3 and NO_x and is lost through runoff and leaching in kg N yr^{-1} (3);
EF = Tier 1, default IPCC emission factors in kg N_2O-N / kg N yr^{-1} (4).

(3) Obtained through the volatilization and leaching factors in IPCC, 2006: Vol.4, Ch. 11, Tab. 11.3.

(4) Global IPCC default EF values from IPCC, 2006: Vol.4, Ch. 11, Tab. 11.3.

Dimensionless conversion factors
44/28, to convert the emissions from kg N_2O-N to kg N_2O gas;

10^{-6}, to convert the emissions from kg N_2O to kt N_2O

Stocks

The FAOSTAT domain Production/Crops and Livestock include data for (total) cattle (C) and for the subset dairy cattle (DC). Data on the number of animals of cattle are available from item "Cattle" and element "Stocks". Data on the number of animals for dairy cattle are available from item "Milk, whole fresh cow" and element "Producing Animals/Slaughtered: Milk Animals".

In the FAOSTAT Emissions database, data are reported separately for "Cattle, dairy" (DC) and "Cattle, non-dairy" (NDC). The number of animals of non-dairy cattle is calculated as animals of cattle minus animals of dairy cattle (NDC = C – DC).
The number of animals for cattle and for dairy cattle may not be fully harmonized. In these cases, the following corrections and imputations have been applied to the data for dairy cattle (DC):

- If the number of animals for dairy cattle is higher than those for cattle (DC > C), the number for cattle is assigned to dairy cattle (and therefore DC = C).
- If there are missing data only for dairy cattle:
  - If no data are available for an entire time series, a regional average value for the share "S" of dairy cattle in cattle (S = DC/C) is applied. Therefore: $DC_i = S_R \times C_i$ where "i" is a country and "R" a region or group of countries.
  - If one or more values are available in the time series, missing values between two available data are filled by linearly interpolating the share "S", and data points outside the time series of available data are filled by keeping constant the share value "S" of the closest available year.

FAOSTAT Production/Crops and Livestock domain includes data for (total) chicken (CH) and for the subset chicken layers (CHL). Data on the number of animals (in 1000 animals) for chicken are available from item "Chickens" and element "Stocks". Data on the number of animals (in 1000 animals) for chicken layers area available from item "Eggs, hen, in shell" and element "Producing Animals/Slaughtered: Laying".

In the FAOSTAT Emissions database, chicken data are reported separately for "Chickens, layers" (CHL) and "Chickens, broilers" (CHB). The number of animals of broilers is calculated as animals of (total) chickens minus animals of layers (CHB = CH – CHL).
The number of birds for chickens and for layers may not be fully harmonized. In these cases, the following corrections and imputations have been applied to the data for layers (CHL):

- If the number of animals for layers is higher than those for chickens (CHL > CH), the number for chickens is assigned to layers (and therefore CHL = CH).
- If there are missing data only for chicken layers:
  - If no data are available for an entire time series, a regional average value for the share "S" of layers in chickens (S = CHL/CH) is applied. Therefore: $CHL_i = S_R \times CH_i$ where "i" is a country and "R" a region or group of countries.
  - If one or more values are available in the time series, missing values between two available data are filled by linearly interpolating the share "S", and data points outside the time series of available data are filled by keeping constant the share value "S" of the closest available year.

FAOSTAT livestock data include stock numbers for item "Pigs". Market and breeding swine are calculated respectively as 90% and 10% of this item (IPCC, 2006, Vol.4, Ch.10, Tab.10.19).

Source of activity data and projections

For the period 1961–2021, activity data are derived directly from the FAOSTAT domain Production/Crops and Livestock. Projections of activity data for 2030 and 2050 by animal type are computed with respect to a baseline, defined as the 2005–2007 average of the

corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). Activity data for animal categories for which FAO projections were not available were set to the most recent available FAOSTAT value. The FAO projections used cover some 140 countries. Projections of activity data for countries not included assume the same growth rate of neighboring countries.

Uncertainties

Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors and activity data. They may be related to, inter alia, natural variability, partitioning fractions, lack of spatial or temporal coverage, spatial aggregation.

In the case of *enteric fermentation*, more detailed information is available in the IPCC guidelines: IPCC, 2006: Vol. 4, Ch. 10, Section 10.3.4.

For the *manure left on pasture* more detailed information is available in the IPCC guidelines (IPCC, 2006: Vol.4, Ch. 11, Section 11.2.1.4 for direct emissions, and Section 11.2.2.4 for indirect emissions).

In the case of *manure management*, more detailed information is available in the IPCC guidelines (IPCC, 2006: Vol. 4, Ch. 10, Section 10.5.5);

For the *manure applied to soil*, more detailed information is available in the guidelines (IPCC, 2006: Vol.4, Ch. 11, Section 11.2.1.4 for direct emissions, and Section 11.2.2.4 for indirect emissions).

References

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Data Collection Method	Computed

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Completeness	100%
Useful links	http://www.fao.org/faostat/en/#data/QCL http://www.fao.org/food-agriculture-statistics/statistical-domains/environment/en/ http://www.ipcc-nggip.iges.or.jp/public/ https://unfccc.int

Distribution Information:	
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Provider	FAO
Source	FAO
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