

**Dataset Information:**

<b>Title</b>	<b>Manure applied to Soils</b>
<b>Abstract</b>	The FAOSTAT domain <a href="#">Manure applied to Soils</a> consists of nitrous oxide (N <sub>2</sub> O) from nitrogen (N) of manure added to agricultural soils. Estimates are computed following the Tier 1 method of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (NGHGI) (IPCC, 2006). Data are available by country and with global coverage, in complete time series for the period 1961–2020 and with projections for 2030 and 2050. The database is updated annually.
<b>Supplemental</b>	<p>The FAOSTAT domain <i>Manure applied to soils</i> disseminates information on activity data (number of animals, by animal type, and kilograms of N in manure applied to soils) and on greenhouse gas (GHG) emissions (kilotonnes of CH<sub>4</sub>, direct and indirect and total N<sub>2</sub>O). Data are available for most countries and territories, for standard FAOSTAT regional aggregations, and for Annex I and non-Annex I groups.</p> <p>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 corresponding category 'Agricultural soils – Animal manure applied to soils'. Activity data are sourced from the most recently available GHG National Inventories (NGHGI) or from National Communications. Emission data are sourced directly from the <a href="#">UNFCCC</a> data portal or from Biennial Update Reports (BURs). UNFCCC data are disseminated in FAOSTAT with permission, formalized via a FAO-UNFCCC Memorandum of Understanding.</p> <p>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.</p>
<b>Creation Date</b>	2012
<b>Last Update</b>	2022
<b>Data Type</b>	Climate Change - Greenhouse Gases
<b>Category</b>	Agriculture; Environment
<b>Time Period</b>	1961–2020; projections for 2030 and 2050
<b>Periodicity</b>	Annual
<b>Geographical Coverage</b>	World
<b>Spatial Unit</b>	In 2020, 190 countries and 7 territories (FAO Tier I)
<b>Language</b>	Multilingual (EN, FR, ES)

**Methodology and Quality Information:**

<b>Methods and processing</b>	<p><b>Overview</b></p> <p>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.</p> <p>The term manure includes both urine and dung (i.e., both liquid and solid material) produced by livestock. More specifically, CH<sub>4</sub> gas is produced by anaerobic decomposition of manure stored or treated, while N<sub>2</sub>O 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.</p> <p><u>CH<sub>4</sub> emissions</u> are estimated at country level, using the formula:</p> $Emission = A * EF$ <p>where:</p> <p><i>Emission</i> = GHG emissions in kg CH<sub>4</sub> yr<sup>-1</sup>;</p>
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$A$  = Activity data, representing number of livestock in heads (1);  
 $EF$  = Tier 1, default IPCC emission factors, expressed in  $\text{kg CH}_4 \text{ head}^{-1} \text{ yr}^{-1}$  (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\*, chickens layers and broilers\*\* and market and breeding swine\*\*\*.

For the period 1961–2020, activity data are derived directly from the FAOSTAT domain Production/Crops and Livestock (<http://www.fao.org/faostat/en/#data/QCL>). Projections of activity data for 2030 and 2050 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.

\*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 heads of cattle are available from item “Cattle” and element “Stocks”. Data on the number of heads 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 heads of non-dairy cattle is calculated as heads of cattle minus heads of dairy cattle ( $\text{NDC} = \text{C} - \text{DC}$ ).

The number of heads 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 heads for dairy cattle is higher than those for cattle ( $\text{DC} > \text{C}$ ), the number for cattle is assigned to dairy cattle (and therefore  $\text{DC} = \text{C}$ ).
- 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 ( $S = \text{DC}/\text{C}$ ) is applied. Therefore:  $\text{DC}_i = S_R * C_i$  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 heads (in 1000 heads) for chicken are available from item “Chickens” and element “Stocks”. Data on the number of heads (in 1000 heads) 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 heads of broilers is calculated as heads of (total) chickens minus heads of layers ( $\text{CHB} = \text{CH} - \text{CHL}$ ).

The number of heads for chickens and for layers 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 heads for layers is higher than those for chickens ( $\text{CHL} > \text{CH}$ ), the number for chickens is assigned to layers (and therefore  $\text{CHL} = \text{CH}$ ).
- 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 ( $S = \text{CHL}/\text{CH}$ ) is applied. Therefore:  $\text{CHL}_i = S_R * \text{CH}_i$  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).

(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)”

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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](http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download)).

Direct N<sub>2</sub>O emissions are estimated at country level, using the formula:

$$Emission = A * EF$$

where:

*Emission* = GHG emissions in kg N<sub>2</sub>O-N yr<sup>-1</sup>;

*A* = Activity data, representing the total amount of N in manure treated in manure management systems (MMS) in kg N yr<sup>-1</sup> (3);

*EF* = Tier 1, default IPCC emission factors, expressed in kg N<sub>2</sub>O-N/kg N yr<sup>-1</sup> (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 heads or poultry birds by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (N<sub>ex</sub>). 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<sub>ex</sub> 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, Ch. 10, Annex 10A.2 Tabs. 10A-4 to 10A-9 (for poultry: IPCC, 1997: Vol. 2, Ch.4 Tab. 4.7).

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

Indirect N<sub>2</sub>O emissions are estimated at country level, using the formula:

$$Emission = A * EF$$

where:

*Emission* = GHG emissions in kg N<sub>2</sub>O-N yr<sup>-1</sup>;

*A* = Activity data, representing the fraction of total amount of nitrogen (N) in manure treated in MMS that volatilizes as NH<sub>3</sub> and NO<sub>x</sub>, in kg N yr<sup>-1</sup>;

*EF* = Tier 1, default IPCC emission factors, expressed in kg N<sub>2</sub>O-N/kg N yr<sup>-1</sup> (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<sub>2</sub>O-N to kg N<sub>2</sub>O gas;

10<sup>-6</sup>, to convert kg to kt.

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

**References**

IPCC **1997**. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. OECD, Paris, France. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html>

IPCC **2006**. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (Eds), IGES, Hayama, Japan. Available at : <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>

FAO/IIASA **2011**. Global Agro-ecological Zones (GAEZ v3.0). FAO, Rome, Italy and IIASA, Laxenburg, Austria. Available at: <http://gaez.fao.org>.

Alexandratos, N. and Bruinsma J. **2012**. World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03. Rome, FAO. Available at : <http://www.fao.org/docrep/016/ap106e/ap106e.pdf>

The World Bank Group **2016**. Climate Change Knowledge Portal – Downscaled data, Historical temperature data for period 1960 – 1990. Available at : [http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled\\_data\\_download](http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download).

IPCC **2019**. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Available at: <https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/>.

Tubiello, F.N. **2019**. Greenhouse Gas Emissions Due to Agriculture. In: Ferranti, P., Berry, E.M., Anderson, J.R. (Eds.), Encyclopedia of Food Security and Sustainability, vol. 1, pp. 196–205. Elsevier. ISBN: 9780128126875

United Nations Framework Convention on Climate Change (UNFCCC). **2020**. Greenhouse gas inventory data – Detailed data by party. Available at: [https://di.unfccc.int/detailed\\_data\\_by\\_party](https://di.unfccc.int/detailed_data_by_party).

United Nations Framework Convention on Climate Change (UNFCCC). **2020**. National inventory submissions, 2019. Available at: <https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2019>.

**Data** Computed

**Collection Method**

**Completeness** 100%

**s**

**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>

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