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FAOSTAT ANALYTICAL BRIEF 18

Emissions due to agriculture

Global, regional and country trends

2000–2018

>> FAO Statistics Division

HIGHLIGHTS

- → **In 2018, global emissions due to agriculture (within the farm gate and including related land use/land use change) were 9.3 billion tonnes of CO_2 equivalent (CO_2eq).**
- → **Methane and nitrous oxide emissions from crop and livestock activities contributed 5.3 billion tonnes CO_2eq in 2018, a 14 percent growth since 2000.**
- → **Livestock production processes such as enteric fermentation and manure deposition on pastures dominated farm-gate emissions, together generating 3 billion tonnes CO_2eq in 2018.**
- → **Land use and land use change emissions were 4 billion tonnes CO_2eq in 2018, caused mainly by deforestation (2.9 billion tonnes CO_2eq) and drainage and burning of organic soils (1 billion tonnes CO_2eq). They decreased globally by 20 percent since 2000.**
- → **While emissions from deforestation decreased, those from drainage and fires of organic soils increased by nearly 35 percent since 2000.**
- → **In Africa, both farm-gate and land use-related emissions increased over the entire 2000–2018 period, by 38 and 20 percent respectively.**

FAOSTAT EMISSIONS

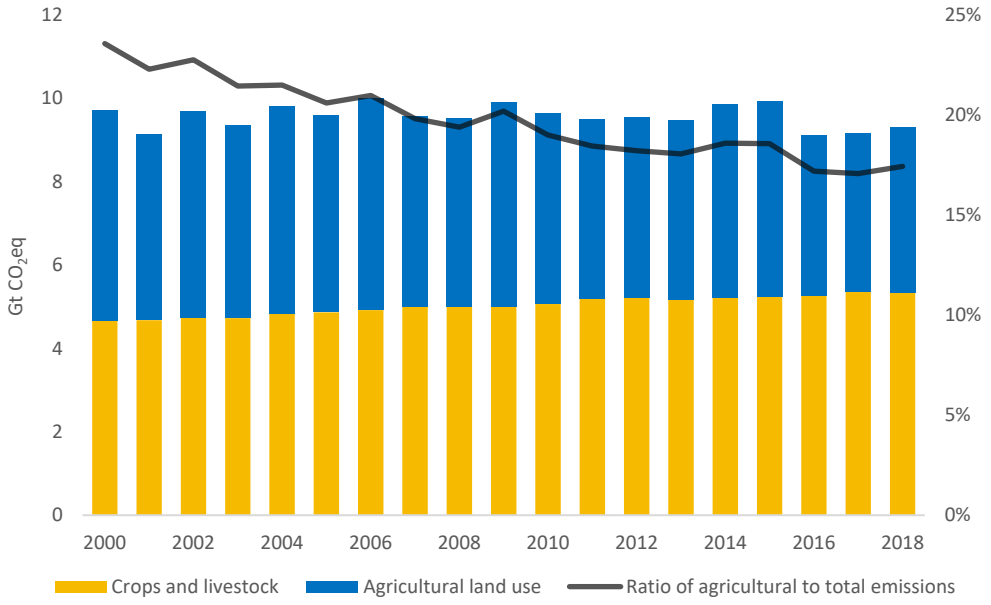
Agriculture as a sector is responsible for non-CO_2 emissions generated within the farm gate by crops and livestock activities, as well as for CO_2 emissions caused by the conversion of natural ecosystems, mostly forest land and natural peatlands, to agricultural land use.

The FAOSTAT Emissions database provides a comprehensive picture of methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) emissions and removals from agriculture production and associated land use activities at the country, regional and global levels. It helps document the main trends and impacts of food and agriculture on atmospheric greenhouse gas (GHG) concentrations over the period 1961–2018. The data use as input crop and livestock production reported by countries to FAO, using the guidelines for national GHG inventories of the International Panel on Climate Change (IPCC, 2006) to estimate emissions. This analytical brief focuses on overall trends over the period 2000–2018. Emissions from forest biomass fires and burning of organic soils in the humid tropics are included in these estimates. More in-depth analysis on the emissions and removals of GHG for livestock, forests, and the degradation of organic soils are discussed in other briefs and peer-reviewed publications.

GLOBAL

In 2018, world total agriculture and related land use emissions reached 9.3 billion tonnes of carbon dioxide equivalent (Gt CO_2eq). Crop and livestock activities within the farm gate generated more than half of this total (5.3 Gt CO_2 eq), with land use and land use change activities responsible for nearly 4 Gt CO_2 eq. These components were respectively 4.6 and 5.0 Gt CO_2 eq in the year 2000. During the 2000s, emissions from within the farm gate and those from land use both increased, and then trends in these two components began diverging. Emissions from crops and livestock activities kept growing over the entire 2000–2018 period and were 14 percent larger in 2018 than in 2000. Conversely, emissions from land use and land use change decreased over the study period, consistently with observed decreases in deforestation. As a result, the combined farm gate and land emissions due to agriculture were about 4 percent lower in 2018 than in 2000. In 2018, agriculture and related land use emissions accounted for 17 percent of global GHG emissions from all sectors, down from 24 percent in the 2000s. In addition to the noted slight decrease in absolute emissions, this reduction in 2018 was also the result of emissions from other economic sectors growing at relatively faster rates during 2000–2018 (Figure 1).

Figure 1. Yearly emissions from crops and livestock and related land use, and share of agriculture in global GHG emissions from all sectors, 2000–2018

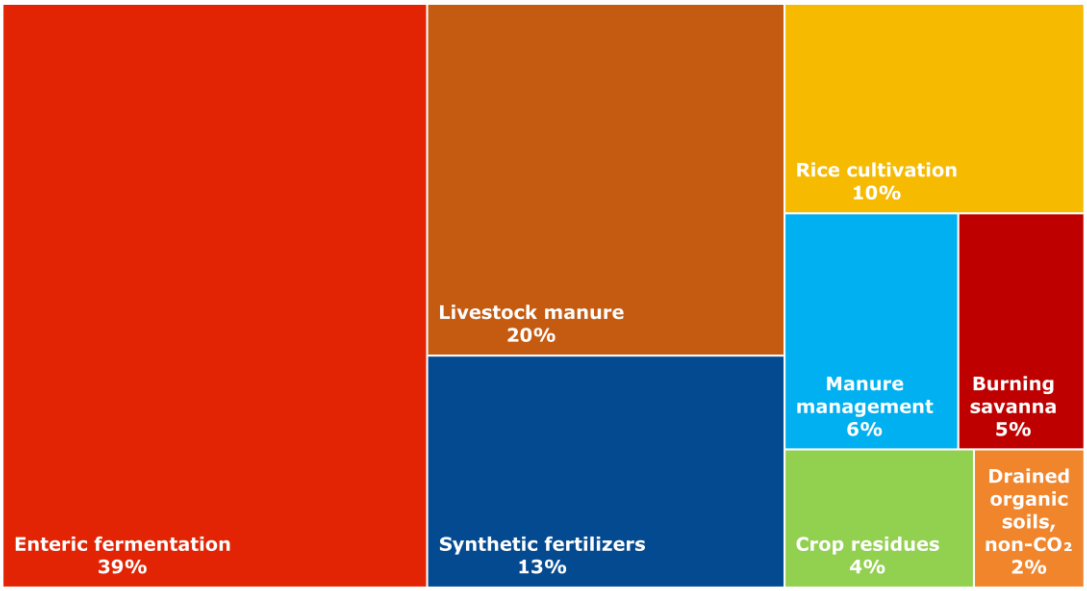


Source: FAOSTAT 2020.

Crops and livestock, non-CO_2 emissions

Agricultural activities from crops and livestock production release significant amounts of non-CO_2 emissions such as methane and nitrous oxide, both powerful greenhouse gases, totaling 5.3 Gt CO_2eq in 2018, with livestock production contributing two-thirds of this total (Figure 2). In particular, in 2018 CH_4 emissions from enteric fermentation in digestive systems of ruminant livestock continued to be the single largest component of farm-gate emissions (2.1 Gt CO_2eq).

Figure 2. Contribution of crops and livestock activities to total non-CO_2 emissions from agriculture in 2018 (5.3 Gt CO_2eq)



Source: FAOSTAT 2020.

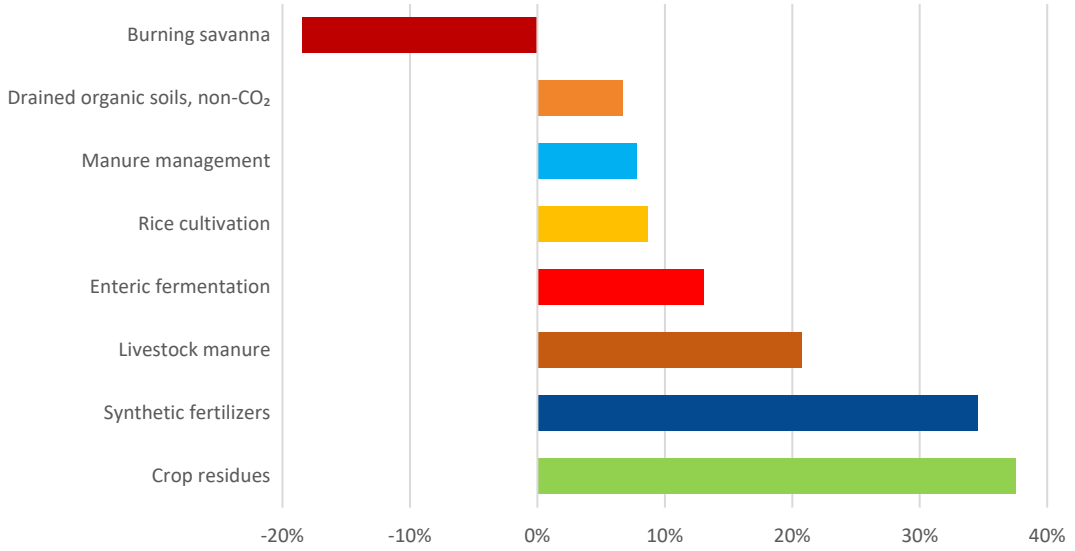
N_2O emissions from livestock manure left on pastures by grazing animals and applications of manure to cropland contributed an additional 1 Gt CO_2eq in 2018. Furthermore, N_2O emissions from synthetic fertilizers contributed 13 percent to the total (0.7 Gt CO_2eq) and CH_4 emissions from rice cultivation another 10 percent (0.5 Gt CO_2eq).

The relative contribution of each process in crop and livestock production did not vary significantly during the past two decades. N_2O emissions from synthetic fertilizers and crop residues incorporation had the largest relative growth over the study period, being more than 35 percent higher in 2018. This is consistent with the growing intensification of crop production globally and the related increase in chemical fertilizers inputs worldwide.

The growth in livestock numbers drove the increase in the emissions from manure and from enteric fermentation (i.e. 20 and 13 percent in 2018 compared to 2000, respectively). Finally, emissions from rice cultivation, manure management systems and drained organic soils increased by about 7 percent over the period 2000–2018.

The data showed a decline in emissions from prescribed fires on grasslands and savannahs, in line with previous findings in recent literature of an overall decline of fire rates in Africa between 2001 and 2016 (e.g. Wei *et al.,* 2020). These studies attributed these trends to cropland expansion in northern sub-Saharan Africa at the cost of traditional, fire-managed rangelands.

Figure 3. Changes in non-CO_2 emissions from crops and livestock activities, 2000–2018

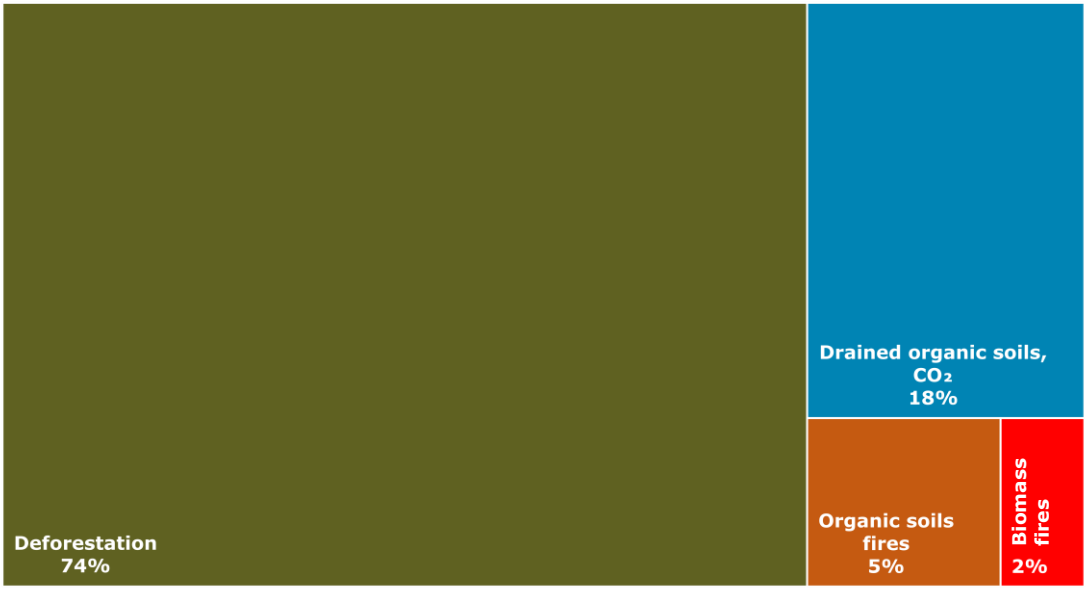


Source: FAOSTAT 2020.

Agricultural land use and land use change, CO_2 emissions

In 2018, global land use and land use change emissions related to agriculture were nearly 4 Gt CO_2 eq. Deforestation, assumed herein as fully driven by agriculture, represented nearly three-fourths of these global emissions. Drainage and burning of organic soils were responsible for the remaining quarter (Figure 4). While agriculture is the largest driver of deforestation globally, important non-agricultural drivers may exist at the regional and local levels, so that the overall global total is likely an overestimate.

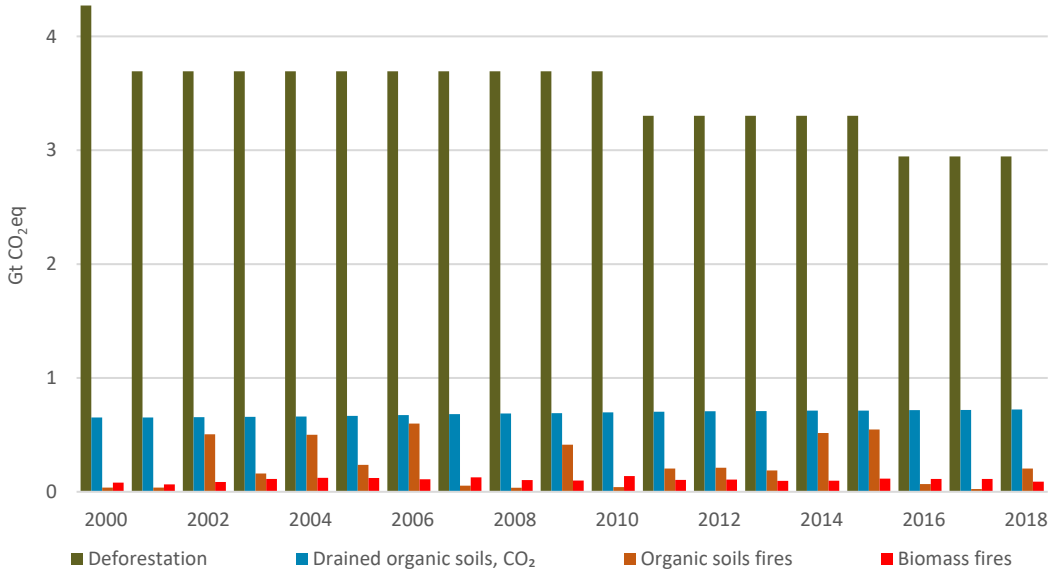
Figure 4. Contribution of activities to total agricultural land use and land use change emissions in 2018 (3.9 Gt CO_2eq)



Source: FAOSTAT 2020.

In 2018, global emissions from agricultural land use and land use change were about 3.9 Gt CO_2eq, or 21 percent less than in 2000 (5 Gt CO_2 eq). This decline was primarily due to significant declines in deforestation emissions, especially since 2010 (Figure 5). In 2018, global emissions from deforestation were 2.9 Gt CO_2eq, down from 4.3 Gt CO_2eq in 2000. Conversely, emissions from drainage and burning of peatlands were about 1 Gt CO_2eq in 2018, nearly 35 percent higher than in 2000. Finally, emissions from fires in humid tropical forests, though small in absolute terms, kept growing during the twenty-year period of this analysis. They reached 0.2 Gt CO_2eq in 2018, or 10 percent higher than in 2000.

Figure 5. Emissions from the components of agricultural land use, 2000–2018



Source: FAOSTAT 2020.

REGIONAL

Regional trends in emissions due to agriculture were significantly different from global trends discussed above (Figure 6).

In **Africa**, emissions due to agriculture exhibited an upward trend during the 2000–2018 period. They reached 2.2 Gt CO_2eq in 2018, or 24 percent of world total agricultural emissions, up from 18 percent in 2000.

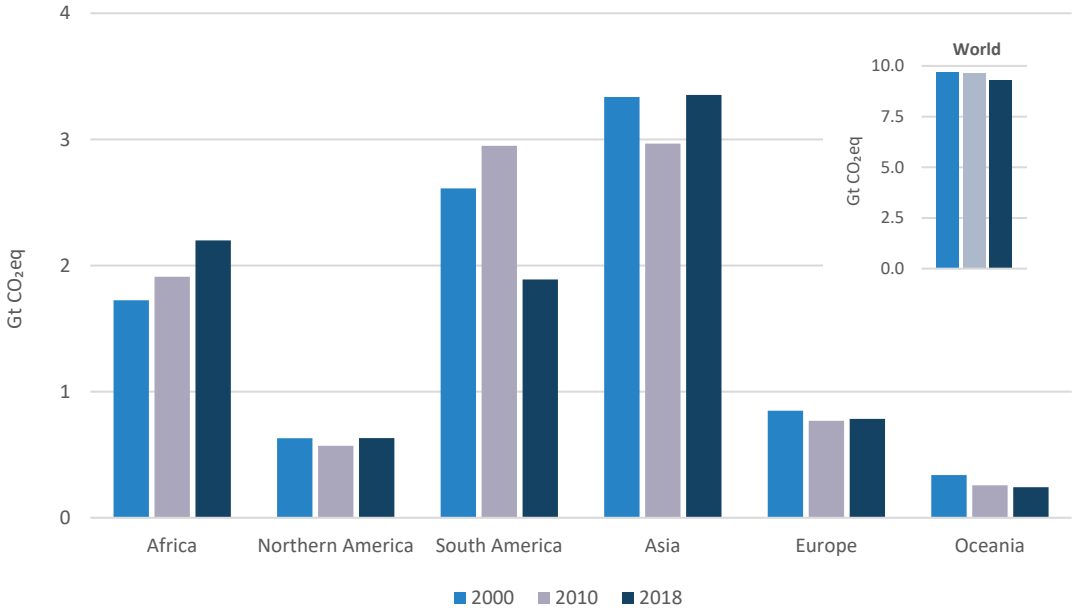
North America, which contributed on average 6 percent to the world total agriculture emissions, showed a decline in emissions in the 2000s, followed by a similar increase since 2010. Agriculture emissions decreased in **South America** by 10 percent over the 2000–2010 period, and by an additional 36 percent up to 2018, to reach 1.9 Gt CO_2eq in 2018. Sharp decreases in emissions from deforestation were the main driver of these trends.

In **Asia**, similarly to North America, the 2000s showed a decrease in emissions followed by an increase since 2010. In 2018, emissions due to agriculture were 3.3 Gt CO_2eq, substantially unchanged from their levels in 2000.

Europe (including the Russian Federation) accounted for approximately one-tenth of global emissions due to agriculture. Emissions declined during 2000–2010 and increased in the following decade, though this increase was less pronounced than in other regions. In 2018, total agricultural emissions were 0.8 CO_2eq, 8 percent less than in 2000.

Finally, agriculture and related land use emissions decreased steadily in **Oceania** during the two decades of this analysis, exhibiting the largest proportional reduction. In 2018, total agricultural emissions were 0.2 Gt CO_2eq, roughly 30 percent less than in 2000.

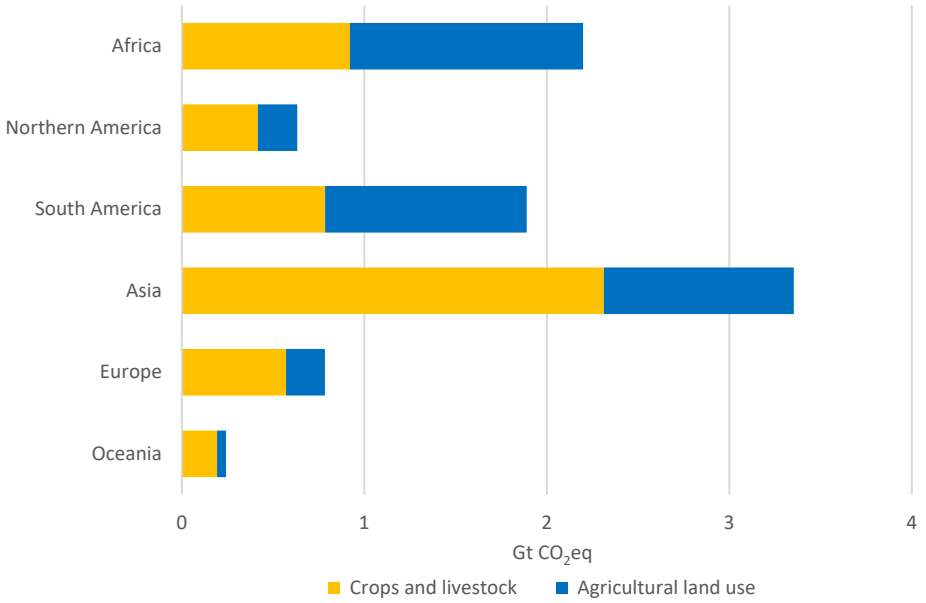
Figure 6. Trends in regional and global emissions due to agriculture



Source: FAOSTAT 2020.

Farm gate production and land use contributed differently to the emissions due to agriculture in the regions analysed (Figure 7). In 2018, crops and livestock production contributed two-thirds or more in **North America** (66 percent), **Asia** (69 percent), **Europe** (73 percent) and **Oceania** (80 percent). Conversely, land use and land use change processes contributed nearly 60 percent of the total in **Africa** and **South America**.

Figure 7. Regional contribution of crops and livestock and agricultural land use emissions, 2018

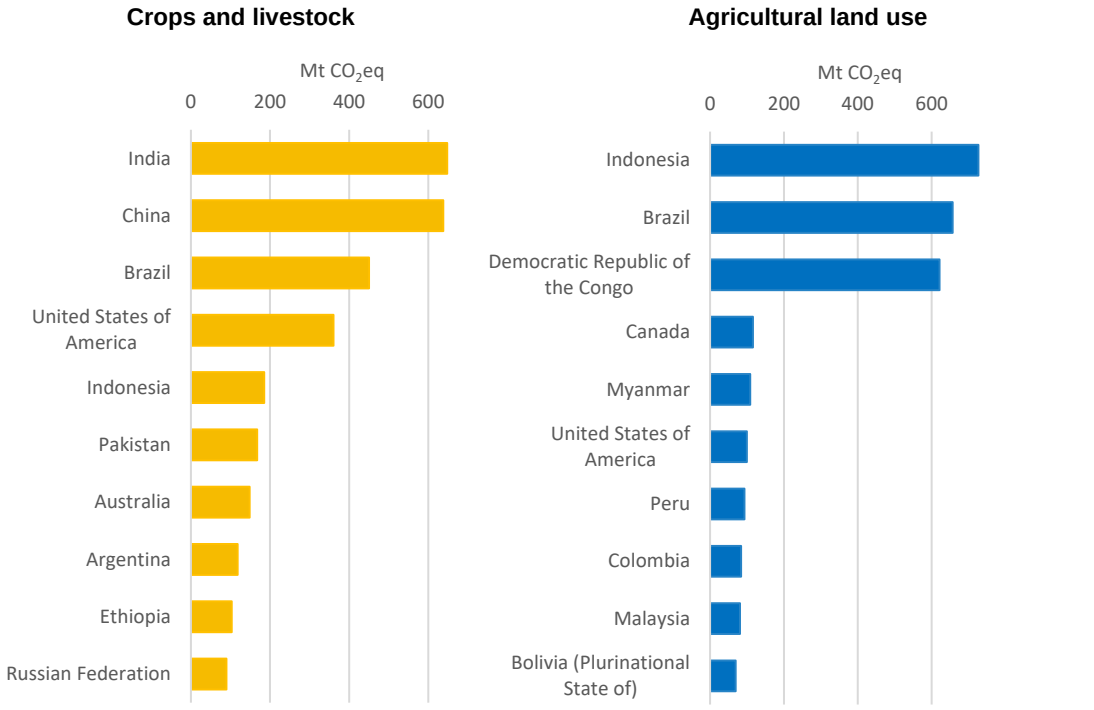


Source: FAOSTAT 2020.

COUNTRY

The list of top ten emitters from agricultural production reflects countries with a large agricultural area (Figure 7, left panel). In 2018, **India** and **China** contributed about 650 million tonnes (Mt) CO_2eq annual emissions each. **Brazil** and the **United States of America** followed with 450 and 360 Mt CO_2eq, respectively. **Indonesia** was the fifth largest emitter, with nearly 200 Mt CO_2eq. A different set of countries emerges instead when looking at the top ten emitters from land use and land use change processes linked to agriculture. In 2018, **Indonesia** was the first country by land use emissions related to agriculture, with nearly 730 Mt CO_2eq emitted largely through peatland degradation processes (drainage and fires), largely associated with the cultivation of oil palm. **Brazil** and the **Democratic Republic of the Congo** followed, with about 650 Mt CO_2eq and 620 Mt CO_2eq respectively, largely related to deforestation (Figure 8, right panel).

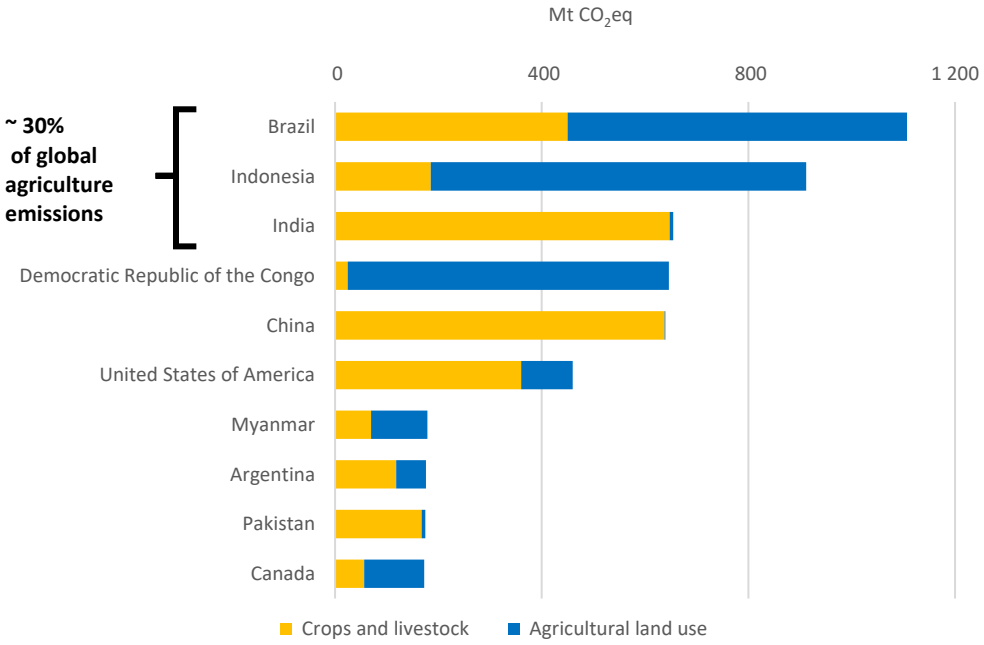
Figure 8. Top ten countries by non-CO_2 emissions from crop and livestock activities within the farm gate (left) and from agriculture-related land use (right), 2018



Source: FAOSTAT 2020.

Finally, when ranking countries in terms of total emissions due to agriculture (production and related land use processes), **Brazil**, **Indonesia** and **India** were the top three emitters, contributing nearly 30 percent to global agriculture emissions (Figure 9). In **Brazil**, nearly three-fifths of emissions were due to deforestation, although crops and livestock production was an important contributor. In **Indonesia** and the **Democratic Republic of the Congo**, the second and third largest emitters respectively, land use processes related to agriculture were even more dominant, representing over four-fifths of emissions due to agriculture. Conversely, crop and livestock production were by far the dominant component of emissions due to agriculture in **India** and **China**.

Figure 9. Top ten countries by total agriculture emissions and relative role of crops and livestock activities and agricultural land use, 2018



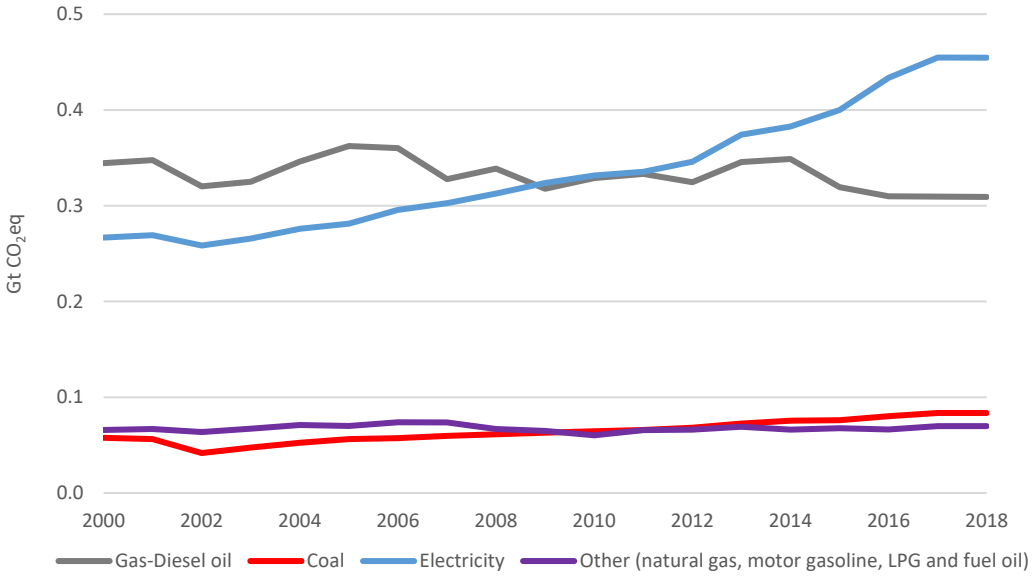
Source: FAOSTAT 2020.

ON-FARM ENERGY USE

The 2020 update of the FAOSTAT emissions database included new estimates of GHG emissions from on-farm energy use, including energy used in fisheries.

In 2018, emissions from energy consumed in agriculture were 0.9 Gt CO_2eq, having increased by 23 percent since 2000. In 2018, electricity represented nearly half of the total on-farm energy emissions, with gas and diesel oil contributing an additional one-third (Figure 10). The relative contribution of these two sources was the opposite in 2000, showing the fast growth of electricity as the dominant energy provider on farms over the study period.

Figure 10. World trends in emissions from on-farm energy use, by energy carrier, 2000–2018



Source: FAOSTAT 2020.

EXPLANATORY NOTES

- The FAOSTAT emissions database is composed of several data domains covering the categories of the IPCC Agriculture, Forestry and Other Land Use (AFOLU) sector of the national GHG inventory. Energy use in agriculture is additionally included as relevant to emissions from agriculture as an economic production sector under the ISIC A statistical classification, though recognizing that, in terms of IPCC, they are instead part of the Energy sector of the national GHG inventory.
- FAO emissions estimates are available over the period 1961–2018 for agriculture production processes from crop and livestock activities. Land use emissions and removals are generally available only for the period 1990–2019. Forest land data are collected from FAO Forest Resources Assessments (FRA) in five-year cycles. Other land use datasets are based geospatial information, for instance drained organic soils, savanna and forest fires, which are available for the period 1990–2019.
- Sources of non-CO_2 emissions from agricultural activities – i.e. methane (CH_4) and nitrous oxide (N_2O) emissions – are summarized in Emissions-Agriculture Total. The activity data underlying the emissions in this aggregate are based on country data officially reported to FAO (for instance, livestock numbers, harvested area, fertilizers use in agriculture). Projections to 2030 and 2050 are also available. They are computed with respect to the 2005–2007 baseline, following Alexandratos and Bruinsma (2012).
- The CO_2 emissions associated with land use and land use change are summarized in Emissions–Land Use Total. Geospatial data complement existing national statistics, for instance on management fires, burning biomass and organic soils drainage and fire. For emissions from burning of organic soils, in line with existing literature, only FAOSTAT

country-level emissions estimates for southeastern Asia countries (Indonesia, Malaysia, Papua New Guinea and Brunei Darussalam) were considered anthropogenic. They contributed as a result to country, regional and world total land use emissions. Conversely, emissions estimates for all other countries provided in FAOSTAT were not considered anthropogenic, to reflect the lack of evidence to this end in existing literature, and were not included in the estimation of country, regional and world total land use emissions.

- A comprehensive methodological note is available for each dataset of the emissions database. The detailed composition of the emissions database and corresponding data availability are as follows:

Agriculture crops and livestock 1961–2018	Land use 1990–2019
Enteric Fermentation	Forest Land 1990–2020
Manure Management	
Rice Cultivation	
Synthetic Fertilizers	
Manure applied to Soils	
Manure left on Pastures	
Crop Residues	
Burning Crop Residues	
Based on geospatial data and processing (1990–2019)	
Cultivation of organic soils	Cropland
Burning – Savanna	Grassland
	Burning – Biomass

- Finally, data on Energy Use are available for the period 1970–2018.

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