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FAOSTAT ANALYTICAL BRIEF 25

Emissions from agriculture and forest land

Global, regional and country trends

1990–2019

>> FAO Statistics Division

HIGHLIGHTS

- → **In 2019, global emissions from agriculture (farm gate and land use change processes) were nearly 11 billion tonnes of CO_2 equivalent (CO_2eq), having remained largely constant for the last 30 years, due to a balance of increasing emissions within the farm gate and decreases from land use change.**
- → **Regional emissions in 2019 were the largest in Asia on an absolute basis (4 billion tonnes), and in Oceania and Latin America on a per capita basis (4–6 tonnes/cap). The largest increase since 1990 was in Africa (30 percent), while the largest decrease was in Latin America (20 percent).**
- → **Brazil, Indonesia and China represented more than 50 percent of global emissions from agriculture. Emissions from deforestation and from peat fires dominated the national emissions from agriculture in Brazil and Indonesia, respectively, whereas farm-gate emissions were the larger contributor in China.**
- → **Non-CO_2 (methane and nitrous oxide) and CO_2 emissions within the farm gate contributed in 2019 more than 7 billion tonnes CO_2eq, a 9 percent increase since 1990. Two-thirds of the non-CO_2 emissions were related to livestock.**
- → **Land use change added 3.5 billion tonnes CO_2eq, mostly as CO_2 from carbon losses via deforestation and peatland fires. The former decreased by roughly 30 percent since 1990, while the latter increased by nearly 60 percent.**
- → **Fossil fuel energy use within the farm gate emitted 0.5 billion tonnes CO_2 in 2019, with a significant decrease since 1990 of over 30 percent, largely due to a shift to electricity generated off-farm.**
- → **Estimates of activity data and GHG emissions were disseminated for the first time together with data officially reported by countries to the UN Framework Convention on Climate Change (UNFCCC), to facilitate analysis and validation in line with the guidelines of the Intergovernmental Panel on Climate Change (IPCC).**

FAOSTAT EMISSIONS FROM AGRICULTURE AND FOREST LAND

BACKGROUND

Agriculture is a significant contributor to climate change, in addition to being one of the economic sectors most at risk from it. Greenhouse gas (GHG) emissions due to agriculture are generated both within the farm gate by crop and livestock production activities, and through land use change processes at the conversion boundary between natural ecosystems and agricultural land. Together they contribute about 20 percent of total emissions from all human activities (IPCC, 2019a; Tubiello *et al*., 2021).

The FAOSTAT Emissions database provides estimates at the country, regional and global levels, including methane (CH_4) and nitrous oxide (N_2O) emissions from crop and livestock production, as well as carbon dioxide (CO_2) emissions and removals from land use, land use change and fossil fuel energy use. This analytical brief extends previous FAO analyses to the period 1990–2019, mapping relevant

emissions within and across the farm-gate/land use production boundaries. The new mapping provided is useful to compare the Food and Agriculture Organization of the United Nations (FAO) estimates to the country data officially reported to the United Nations Framework Convention on Climate Change (UNFCCC) under the ‘’agriculture’’ and ‘’land use, land use change and forestry (LULUCF)’’ sectors of national GHG inventories. To this end, the 2021 FAOSTAT update allows for the first time to visualize jointly FAO and UNFCCC data, the latter sourced from the most recently available greenhouse gas national inventories (NGHGI), national communications and biennial update reports (BURs). The IPCC (2019b) guidelines, which regulate country reporting to the UNFCCC, already promote the use of FAOSTAT emissions data for quality assurance/quality control (QA/QC) and validation processes in support of NGHGI development. Furthermore, a recent meeting of UNFCCC Annex I Lead Reviewers highlighted the “usefulness of the [FAO] data sources for supporting GHG inventory reviews, and requested the secretariat to explore ways of incorporating the FAO data resources as an authoritative supporting data source for reviews in the 2021 cycle and beyond.”

In the following analyses, emissions from agriculture are divided into emissions generated within the farm gate and those generated at the land use change boundary between farms and natural ecosystems. The same are mapped to categories used for UNFCCC reporting of NGHGI and IPCC categories, with a mapping provided in the explanatory notes section of this report (see Figure 13).

RESULTS: GLOBAL TRENDS, 1990-2019

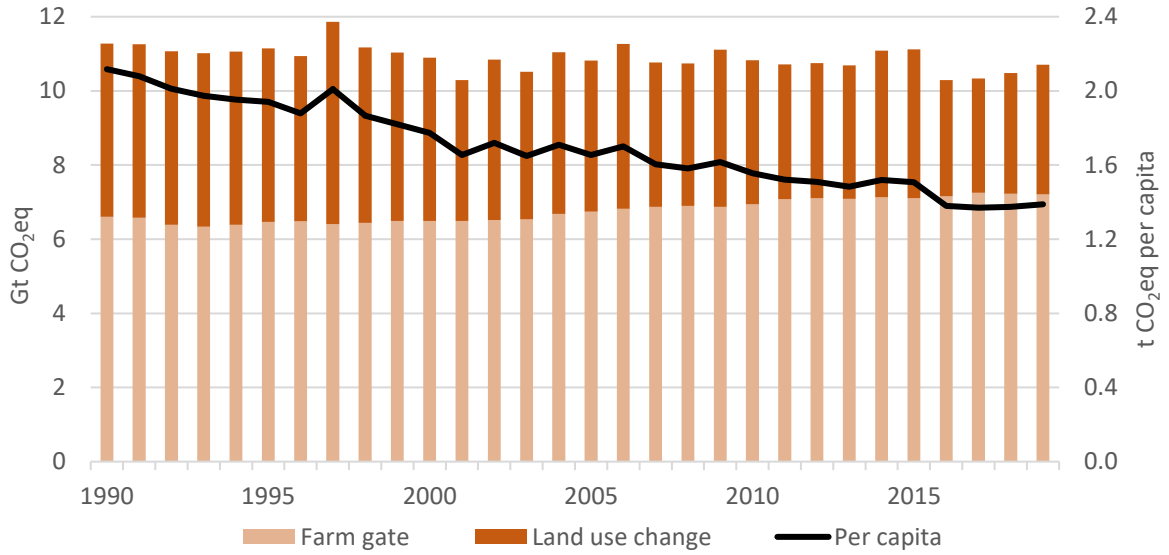
In 2019, total emissions from agriculture, i.e. generated within the farm gate and at the farm boundary with natural ecosystems, were 10.7 billion tonnes of carbon dioxide equivalent (Gt CO_2eq). These emissions remained fairly constant over the entire 1990–2019 period, with no statistically significant trend (Figure 1), considering that the underlying data uncertainty is around 30 percent[1] (Tubiello *et al*., 2013).

Emissions generated within the farm gate and those associated to land use change were nonetheless characterized by opposite trends, which tended to cancel each other out. Specifically, the former increased by about 10 percent over the period 1990–2019, from 6.6 to 7.2 Gt CO_2eq, while the latter decreased by 25 percent, from 4.7 to 3.5 Gt CO_2eq.

Whereas total emissions from agriculture remained virtually unchanged over the last 30 years, they decreased on a per capita basis, by nearly 35 percent, from 2.1 to 1.4 t CO_2eq per capita, as a result of improvements in the efficiency of agricultural production processes and of reductions in land conversions, especially deforestation (Figure 2).

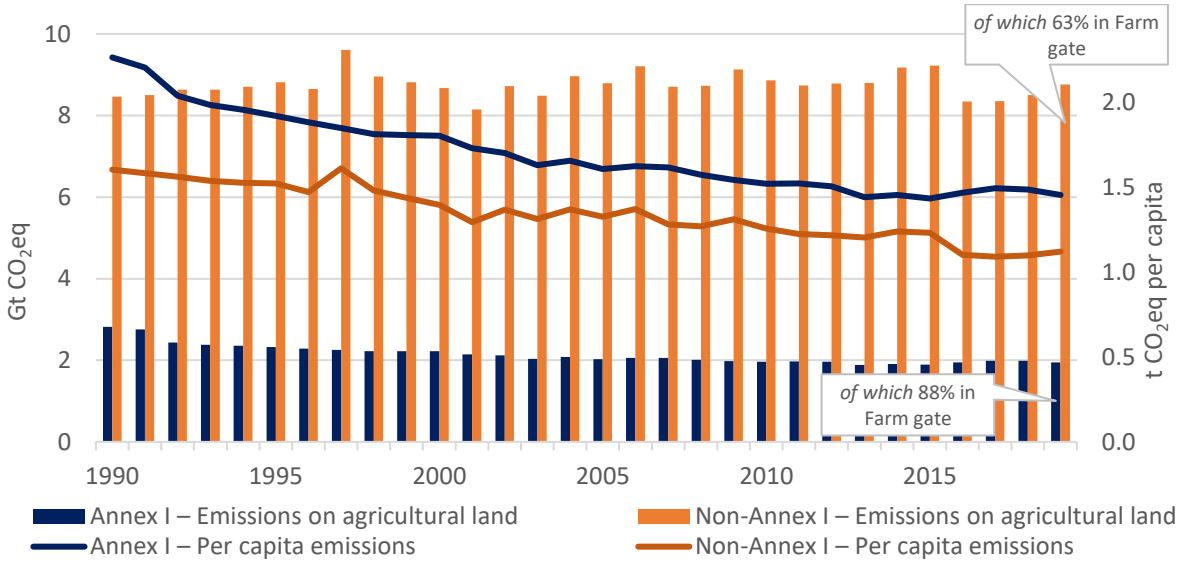
[1] Overall uncertainty stems from uncertainties in both the activity data and in the emissions factors coefficients applied for the emissions estimates.

Figure 1. Global absolute and per capita emissions from agriculture, detailing farm-gate and land use change components, 1990–2019



Source: FAOSTAT, 2021.

Figure 2. Emissions in absolute and per capita levels from agriculture, by Annex I (developed countries, according to the UN Climate Convention) and Non-Annex I countries (developing)[2] 1990–2019



Source: FAOSTAT, 2021.

[2] The list of the type of parties reporting to the UN Climate Convention is available at https://unfccc.int/process/parties-non-party-stakeholders/parties-convention-and-observer-states.
For corresponding FAOSTAT area codes, please see the tab 'Country Group' in the FAOSTAT Definitions and Standards http://www.fao.org/faostat/en/#definitions.

Of the 7.2 Gt CO_2eq generated within the farm gate in 2019, methane (CH_4) emissions from enteric fermentation in digestive systems of ruminant livestock were the largest contributor (2.8 Gt CO_2eq), followed by emissions from the use of fertilizers on agricultural soils. The latter were in the form of nitrous oxide (N_2O) emissions, totalling 1.5 Gt CO_2eq arising from applications of livestock manure (0.9 Gt CO_2eq) – either left on pasture by grazing animals or used as organic fertilizer – and of synthetic fertilizers (0.6 Gt CO_2eq). The third most important process was the drainage of organic soils and peatlands (Conchedda and Tubiello, 2020), generating 0.8 Gt CO_2eq in 2019, largely as CO_2 gas, followed by methane emissions from rice (0.6 Gt CO_2eq) and CO_2 emissions from fossil fuel energy use (0.5 Gt CO_2eq) for farm operations (Figure 3).

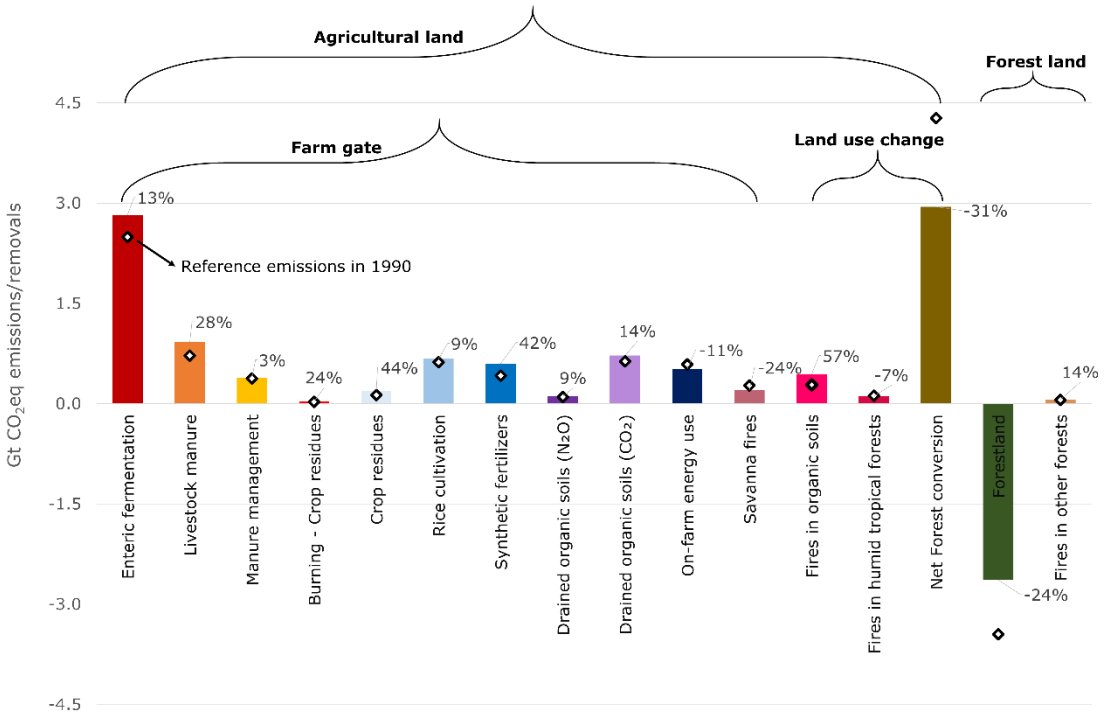
Forest conversion (a proxy for deforestation) generated 2.9 of the 3.5 Gt CO_2eq emissions from land use change (Figure 3). Fires in tropical peatlands in South-eastern Asia, part of a cycle of drainage and deforestation processes, were the second largest source of land use change emissions (0.4 Gt CO_2eq) in 2019.

Overall, the new estimates show that enteric fermentation and net forest conversion alone, each emitting about 3 Gt CO_2eq in 2019, represented more than 50 percent of all emissions on agricultural land. Together with emissions from fertilizers and drained organic soils, these four components emitted over three-quarters of the total emissions on agricultural land.

While agriculture generated net emissions into the atmosphere, forest land instead generated net removals in 2019 and in general over the entire 1990–2019 study period (see also: Tubiello *et al.,* 2021). Specifically, removals on forest land were about 2.9 Gt CO_2eq in 2019, nearly counterbalancing emissions from net forest conversion. At the same time, fires in other forests added a relatively small amount of non-CO_2 emissions, in the order of 0.2 Gt CO_2eq in 2019.

Of the emissions components discussed above, nitrogen-related emissions from synthetic fertilizers and crop residues showed the largest growth since 1990 (+44 and +42 percent respectively), reflecting growth in crop production over the same period. At the same time, emissions from deforestation saw significant decline (-31 percent), in connection with more stringent regulation in key countries. In terms of land use change, emissions from fires in organic soils increased strongly (+31 percent), reflecting the ongoing conversion of these natural ecosystems to agriculture, especially in South-eastern Asia. Results also indicate that removals of CO_2 by forests, i.e. their sink strength in partially counterbalancing emissions, decreased significantly in the past 30 years, by 24 percent, albeit forests remain an overall carbon sink today (Figure 3).

Figure 3. Emissions from agriculture and forest land for the year 2019, by component. Percent values represent changes with respect to reference emissions levels in 1990 (except for energy use, set to 1992)



Source: FAOSTAT, 2021.

REGIONAL

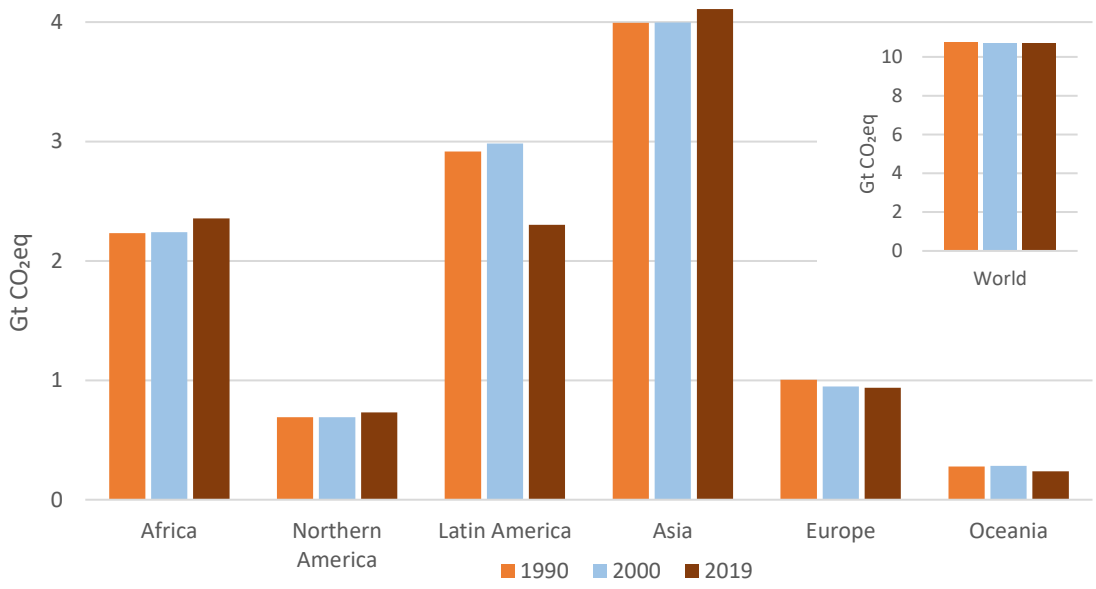
The global trends discussed above mask significant differences among regions (Figure 4).

First, results show that in the last decade 2010–2019, global emissions from agriculture were dominated by Asia (4 Gt CO_2eq), followed by Latin America (comprising of Central and South America) and Africa (2.3 Gt CO_2eq each), Europe (0.9), Northern America (0.7) and Oceania (0.3).

By comparing the most recent decade to the early 1990s, in **Asia** and **North America** total emissions from agriculture have remained rather stable over the last 30 years. Conversely, and while showing similar values in the most recent decade, emissions in **Africa** increased by a significant 30 percent since the 1990s, while they decreased in **Latin America** by more than 20 percent – the latter largely in relation to well-documented decreases in deforestation particularly in South America (FAO, 2020).

The most significant decreases in emissions over the study period were computed for **Europe** (-25 percent), linked to reductions of farm-gate emissions, and **Oceania** (-15 percent).

Figure 4. Trends in regional emissions from agriculture (1990, 2000, 2019)

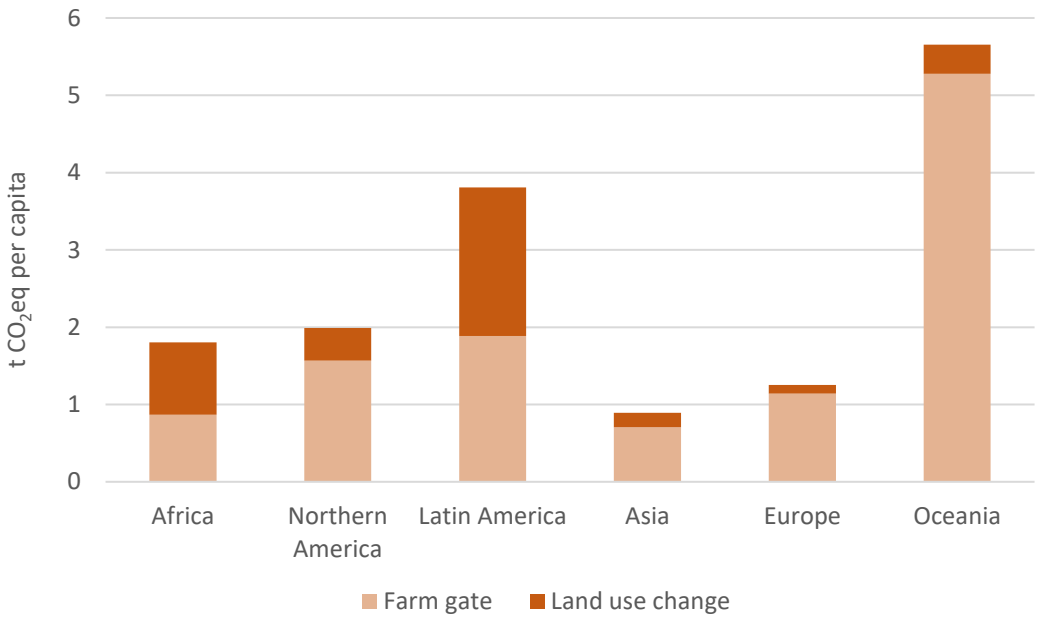


Source: FAOSTAT, 2021.

Furthermore, farm-gate production and land use change processes contributed differently to total emissions in the regions analysed (Figure 5). In 2019, emissions within the farm gate contributed more than two-thirds of the agriculture total in **Oceania** (78 percent), **Europe** (74 percent), **North America** (67 percent) and **Asia** (67 percent). Emissions from land use change processes were conversely the largest contributor of emissions from agriculture in **Africa** (55 percent) whereas farm-gate and land use change emissions contributed equally in **Latin America**.

In 2019, global per capita emissions due to agriculture averaged 1.4 t CO_2eq per person, down nearly 35 percent from 2.1 t CO_2eq per capita in 1990. Per capita emissions varied significantly across regions, although they declined consistently over time (Figures 5 and 6). Per capita emissions in Latin America and Oceania, at 3.8 and 5.6 t CO_2eq per capita respectively in 2019, were two and three times the world average, despite having both more than halved from 1990 values. Per capita values for North America and Africa (1.6–1.7 t CO_2eq per capita) were slightly higher than the global average and remarkably similar, with no significant trend over the period 1990–2019. The same similarity and lack of trends characterized per capita emissions in Europe and Asia, albeit with values about half of the global average (0.7–0.9 t CO_2eq per capita).

Figure 5. Regional per capita emissions from agriculture, detailing farm-gate and land use change components, 2019



Source: FAOSTAT, 2021.

Figure 6. Trends in regional per capita emissions from agriculture, 1990–2019