Annex 7.g Emissions from the agriculture sector

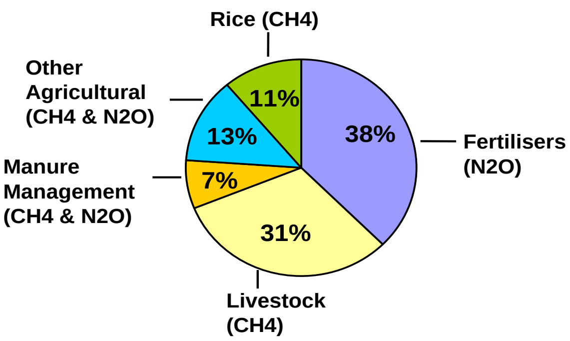
This annex describes emissions from agriculture now, historical and projected business as usual trends, drivers behind emissions growth, and prospects for emission cuts.

Now

Agriculture was responsible for 14% of global greenhouse gas (GHG) emissions in 2000[1]. Agriculture emissions are from the following sources, as shown in figure 1:

- Fertilisers are the largest single source (38%) of emissions from agriculture. Agricultural soils release nitrous oxide (N_2O) during the natural processes of nitrification and denitrification. Fertilisers (both man made and natural) increase the output of nitrous oxide from these processes.
- Livestock is the second largest source of emissions, accounting for 31% of agriculture emissions. Methane (CH_4) is produced as a waste product of digestion by ruminants, particularly cattle, and this process is known as enteric fermentation. Cattle, buffalo, sheep, goats and camels account for the majority of methane emissions produced.
- Wetland rice cultivation emits 11% of agricultural emissions. The flooded rice fields mean that the organic matter cannot decompose in the presence of oxygen (i.e. anaerobic decomposition takes place) and methane is produced as a result. The level of emissions from rice cultivation is dependent upon the specific water management practices and quantity of organic matter involved.
- Manure management methods, including the handling, storage and treatment of livestock waste, causes 7% of agricultural emissions. Methane is emitted when the manure is not stored in a sufficiently oxygenated environment, leading to anaerobic decomposition, while the nitrogen in livestock manure and urine encourages nitrification and denitrification, releasing nitrous oxide.
- Burning of savannah and agricultural residues, and open burning from forest clearing contribute to other non-CO_2 emissions from agriculture (accounting for 13% of emissions from the sector).

Figure 1 Sources of non-CO_2 emissions from the agriculture sector (2000)[2]



- Agriculture is a producer of CO_2 emissions via soil and biomass management practices that disturb the natural carbon sinks. This effect could be significant, but there are no robust global estimates of it. This effect is considered in annex 7.f: emissions from land use change and forestry sector.
- The agriculture sector is also indirectly responsible for emissions in other sectors. Agriculture is a key driver for land use change such as deforestation, which generates emissions (as discussed in annex 7.f). Also, production of fertiliser, use of agricultural equipment that requires an energy source, and transportation of agricultural inputs and outputs leads to

[1] Data for 2000, sources: WRI (2006) and EPA (forthcoming).
[2] Data source: EPA (forthcoming).

emissions from the industry, power, and transport sectors respectively. These effects are not included in the emission estimates quoted in this annex.

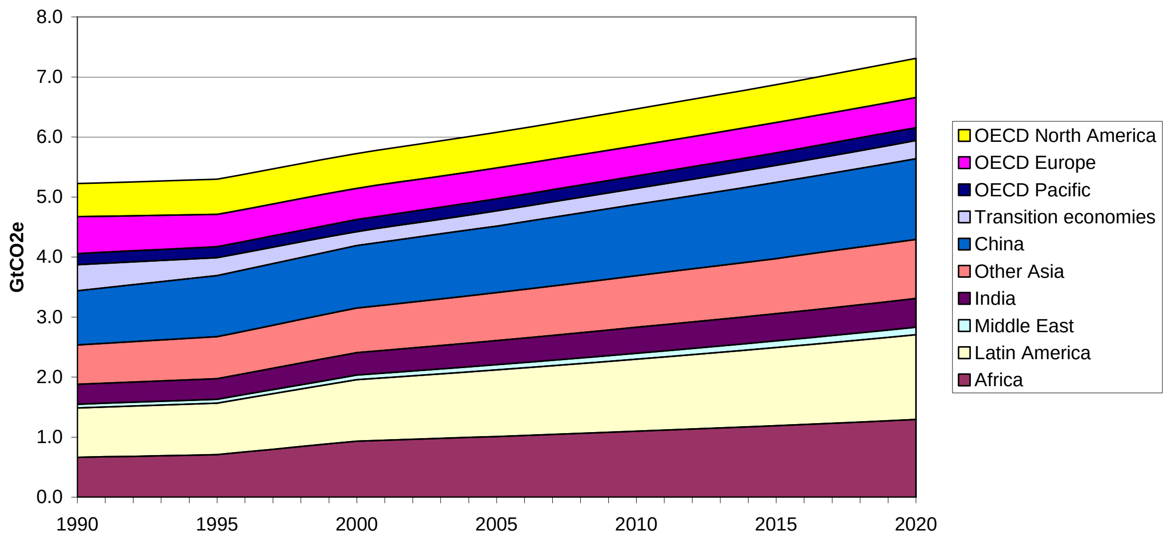
Developing countries account for the majority (almost three quarters) of agricultural emissions. In the case of rice, almost 90% of emissions currently come from China and South East Asia. Much of agricultural output is traded, such that agricultural output accounted for 9% of the value of all world trade in 2003 (totalling $674bn)[3]. Therefore, if the environmental footprint of agriculture emissions was calculated according to consumption, the developed / developing country split would look quite different.

Historic and Business as Usual Projected Trends

Agriculture emissions increased 10% between 1990 and 2000, most of which came from increased emissions from other agricultural sources (such as burning agricultural residues)[4].

Agriculture emissions are expected to rise almost 30% in the period to 2020; almost two thirds of this increase is expected to come from Africa, Latin America and China. Around half of the projected growth in emissions is expected to come from the use of fertiliser on agricultural soils. There are no available estimates of agriculture emissions to 2050. In recent years, developing countries have accounted for an increasingly large share of agricultural emissions: from two thirds in 1990, to three quarters in 2000, to a projected four fifths in 2020.

Figure 2 Agriculture non-CO_2 emissions by country (1990-2020)



Drivers behind emissions growth

Income and population growth are the key drivers behind growth in agriculture emissions. For example, between 1983-2003, world population rose by 35%, world GDP by 90% and global agricultural output by 52%.[5] Also, as developing countries become richer, more meat is likely to be demanded to the extent that livestock numbers are expected to double by 2020[6]; and livestock production is associated

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[3] WRI (2005).
[4] EPA (forthcoming).
[5] FAOSTAT (2006)
[6] IPCC (2001)

with higher emissions than other forms of agriculture. For example, emissions from livestock (enteric fermentation) in China are expected to triple between 1990 and 2020[7].

Increased productivity in agriculture is another driver behind emissions growth. In the last 40 years, the area of global agricultural land has grown by 10% but in per capita terms, agricultural land area has been in decline.[8] This trend is expected to continue because there is only limited additional land available (just 11% of world land can be farmed without improvements such as irrigation[9]). Also, agriculture will face competition with other potential uses, such as growing of biocrops. This will make it necessary to intensify production by making more use of inputs such as fertilizers. For example, in Asia, synthetic nitrogen fertiliser use increased by a factor of c.19 and nitrous oxide emissions rose around 250%.[10] Requirements for greater productivity and the increased commercialization of production in Asia and Latin America[11] make it likely that upstream CO_2 emissions from electricity and other energy consumption may increase. Note that it can be possible to increase agricultural productivity and reduce emissions at the same time using sustainable farming practices; this is discussed in chapter 25, box 25.4 and annex 7.f on land use change.

Prospects for cutting emissions

Compared to the other sectors, relatively little work has been done on how to cut emissions from the agriculture sector. The IPCC has identified around 1 $GtCO_2e$ of non-CO_2 emission savings from the sector by 2020 at $\$25/tCO_2e$ [12], but more recent work suggests this could be lower, around 0.2 $GtCO_2e$ per annum in 2030 at $\$20/tCO_2e$[13]. The means of achieving these non-CO_2 emission reductions are discussed below:-

- Methane emissions from rice can be cut by reducing the levels of decomposition occurring in anaerobic conditions. This can be done using measures such as controlled irrigation and better nutrient management. In the next decade or so exploitation of new, higher yielding, crop varieties could also contribute to methane reductions. The IPCC identified about 0.5 $GtCO_2e$ per annum savings from rice by 2020 at $\$27/tCO_2e$[14].
- Nitrous oxide emissions from fertilisers could be reduced by making more efficient use of fertilisers.
- Methane emissions from livestock could be cut using nutritional supplements, preventing over-grazing, different feeding patterns (such as smaller but more frequent feeding), and research into different livestock breeds[15].
- Methane emissions from manure could be cut by switching to waste management practices that favour aerobic decomposition. Alternatively, capturing methane emissions by storing wastes in an anaerobic environment can be a particularly good way of making emissions savings because the methane (biogas) can be used as an energy source (see chapter 17, box 17.7).[16]
- Stopping burning of crop residues would reduce methane and nitrous oxide emissions from this practice.

Agricultural land management practices (e.g. crop tilling practices) could be an important source of CO_2 emission savings. The IPCC estimate that savings here could amount to 1 to 2 $GtCO_2$ in 2020 at up to $\$27/tCO_2$[17].

The contribution of agriculture to climate change can also be reduced by tackling its indirect effect on emissions from the power, industry and transport sectors. For example, more efficient machinery and more efficient use of fertiliser will reduce upstream emissions from the power and industry sectors.

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[7] EPA (forthcoming).
[8] FAOSTAT (2006)
[9] FAO (2003).
[10] Mosier and Zhu (2000)
[11] EPA (forthcoming)
[12] IPCC (2001). As quoted in chapter 9, table 9.1.
[13] Smith et al (forthcoming).
[14] IPCC (2001).
[15] IPCC (2001) and FAO (2003).
[16] ECI (2002).
[17] IPCC (2001) estimated that 1 GCO_2 per annum could be saved from land management practices at $\$27/tCO_2$ in 2020. Smith et al (2006, forthcoming) estimated it could save 1.8 $GtCO_2$ per annum at $\$20/tCO_2$ in 2030.

Also, giving consumers more information about their food and how far it has travelled to reach them may change their preferences towards buying locally sourced produce, and so reduce upstream transport emissions.

By-products from agriculture can also contribute to emission reductions. For example, biomass can be used directly in agriculture as a fertiliser, or it can be used as a source of energy for the power, buildings, industry or transport sectors (as discussed in chapter 9, box 9.5). Biogas from animal wastes could also be used as an energy source (as discussed in chapter 17, box 17.7). Agricultural by-products could also potentially displace some fossil-fuel based inputs for the chemicals, pharmaceuticals, manufacturing and buildings industries.

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