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Agricultural Emissions

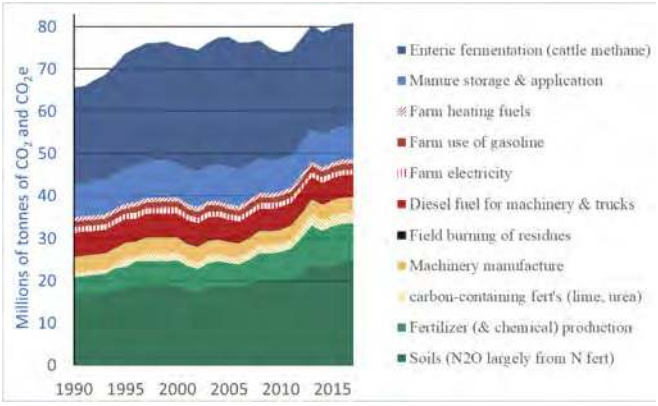
Farmers farmed for 9,900 years and GHG levels did not rise. Farming did not alter the atmosphere or the climate. Now, however, our high-input, high-energy-use system is a huge source of climate-destabilizing emissions.

Agricultural emissions make up about 12% of total Canadian emissions.[1] Canada's farms produce three main greenhouse gases: [2]

⇒ Carbon dioxide (CO_2) from combustion of farm fuels; production of the electricity used on farms; and production of farm inputs (fertilizers, chemicals, machinery, etc.);

⇒ Nitrous oxide (N_2O) from nitrogen chemistry in our soils (and this mostly from the application of synthetic nitrogen fertilizer), with some from manure; and

⇒ Methane (CH_4) emitted from the mouths of cows as they digest grass, with some from manure decomposition.



Canadian agricultural greenhouse gas emissions, 1990–2017
Sources: Environment and Climate Change Canada, "Canada's Official Greenhouse Gas Inventory"; and calculations of emissions from fuel use, electricity production, and fertilizer manufacture based on reports by Dyer et al. 2015.

Agricultural emission are rising

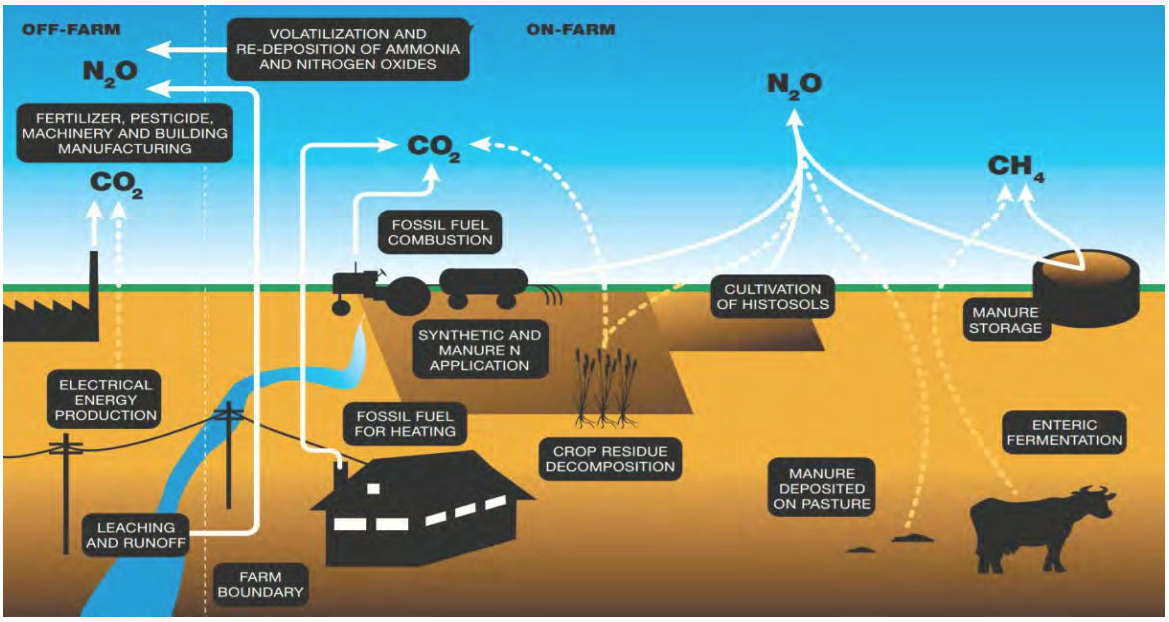
Agricultural emissions are rising -- up about 20% since 1990. The 11 categories of emissions shown can be grouped into 3 main classes: nitrogen fertilizer related (shown in green); fossil fuel consumption (red); and livestock-related (blue).

Nitrogen fertilizer emissions from "Soils," are mainly nitrous oxide from nitrogen fertilizer application[3] and "Fertilizer and chemical production," and from CO_2 emitted during nitrogen-fertilizer manufacturing. This also includes emissions from the production of other fertilizers and pesticides.

Fossil fuel consumption emissions are from on-farm use of gasoline, electricity, heating fuels, and diesel.

Emissions from "Manure storage and application" are nitrous oxide and methane emissions from wet or dry storage and application of hog, poultry, sheep, and cattle manure (pasture-dropped manure is excluded). "Enteric fermentation" is methane emitted from the mouths of ruminants (mostly cattle) when they digest grass.

Emissions related to the production and use of nitrogen fertilizer are driving the increase, increasing faster than overall emissions. Emissions associated with nitrogen fertilizer increased by more than 50% between 1990 and 2017. The tonnage of nitrogen fertilizer used in Canada doubled since 1993; in Saskatchewan, it has quadrupled since 1991.



A graphic of the sources of agricultural GHG emissions
Source: Reprinted from H.H. Janzen et al., *Better Farming, Better Air: A Scientific Analysis of Farming Practice and Greenhouse Gases in Canada* (Ottawa: AAFC, 2008)

The diagram above is another way of showing agricultural sources described above. Factories and mines that produce fertilizers (nitrogen, potassium and phosphorus), pesticides, or machinery emit CO_2. The generation of electricity also emits CO_2, except in jurisdictions where much of the electricity comes from hydroelectric dams. Heating the house and powering the tractor releases CO_2 as fuels are combusted. Nitrogen fertilizers and manure applied to the land give off N_2O, as does manure storage and handling and manure dropped in pastures. Cattle give off CH_4, as does manure storage.

To produce, transport, and apply one tonne of nitrogen fertilizer requires energy equivalent to nearly two tonnes of gasoline.[4] Nitrogen-fertilizer factories have a natural gas pipeline feeding into one end and an ammonia pipe coming out the other. The ammonia is used directly or as feedstock for granular nitrogen fertilizers. Nitrogen fertilizer creates emissions in its manufacture (mostly CO_2) and when applied to fields (mostly N_2O). Roughly 28% of all Canadian agricultural emissions come from the manufacture and application of nitrogen. As we double and redouble its use, agricultural emissions rise.

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During the 20th century, we broke open the circular flows of energy, fertility, seeds, etc. that were the basis of agriculture for 9,900 years. Today, our food systems are high-output, high-throughput, *linear* systems. Nearly all the inputs we push into one end must come out the other. The more fertilizer and other inputs we push into our food systems, the more emissions we push out.

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1 This percentage does not include transport of farm inputs and products by non-farm trucks or by rail. Including those emissions from transport, however, would leave the 12% figure largely unchanged.

2 In addition to these main sources, agricultural land use also creates emissions from the conversion of forests to farmland; the destruction of shelterbelts, bluffs, and other trees; and the destruction of wetlands. The removal of trees and wetlands is often driven by farm economics and the imperative to farm ever more land to makes ends meet. In this and other ways the challenging farm income situation contributes to rising emissions.

3 Approx. 57% of the "soils" category is attributable to nitrogen fertilizer. See Environment and Climate Change Canada, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada: Part 1 (Ottawa: ECCC, 2016), 121.

4 Clark Gellings and Kelly Parmenter, "Energy Efficiency in Fertilizer Production and Use," in Efficient Use and Conservation of Energy, in Encyclopedia of Life Support Systems (Oxford, UK: EOLSS Publishers, 2004), 9. It takes 78,230 kJ/kg to make, package, transport, and apply nitrogen. This energy density is just less than double the density of gasoline: 44,000 kJ/kg.