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Sustainable Markets Initiative

Land and agriculture

BRIEFING NOTE (SMI)

LSEG

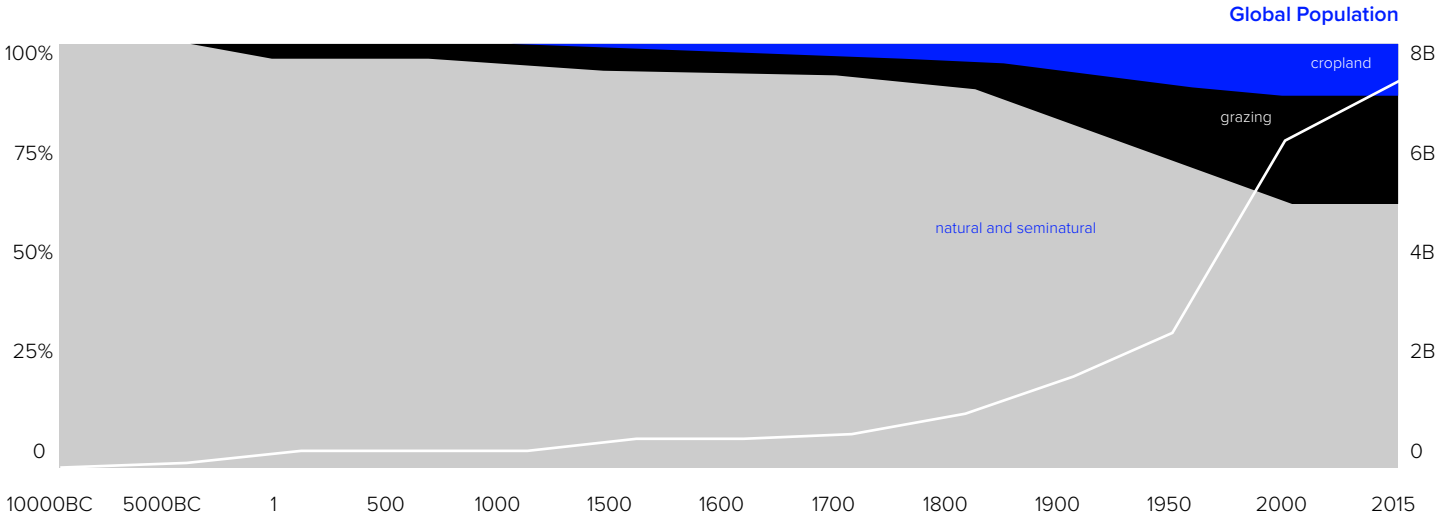
Summary

- Land use and agriculture together are responsible for about one-quarter of global GHG emissions.
- The sector faces a dual challenge – to reduce its impacts on climate and adapt to changing climatic conditions.
- Agriculture is one of the most difficult sectors in which to reduce emissions.
- It is also one of the most vulnerable sectors to climate change.

Background

- Fundamental changes in land use began in the 1800s (Figure 1).
- Today, approximately **two-thirds of the world's ice-free land** is now put to **human use.**
  - Ecosystems, both forested and unforested, account for only about 16% of land.[1]
- This development has been driven importantly by rapid growth of large-scale agriculture.[2]
  - This in turn has been driven by a dramatic rise in world population, rising real incomes, and the resulting rise in demand for food.

Figure 1: Global land use and population



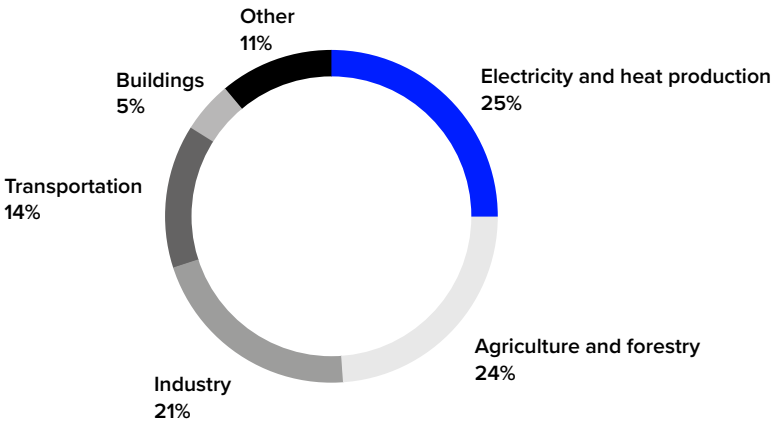
Source: Klein Golewijk et al., 2017

Full link: https://www.visualcapitalist.com/impact-on-climate-change-and-land-use/

GHG emissions

- These changes in land use have contributed to major increases in greenhouse gas (GHG) emissions.
  - Deforestation is taking place on an unprecedented scale: to date around one-third of the world's forest area has been destroyed.[3]
  - Converting forestry to agricultural land both releases carbon stored in the forest and eliminates future carbon storage.
  - Large-scale farming and more intense farming practises are major emitters of GHGs.
- Taken together these activities account for about a **quarter of total global GHG emissions** (Figure 2).

Figure 2: Main emitters by sector

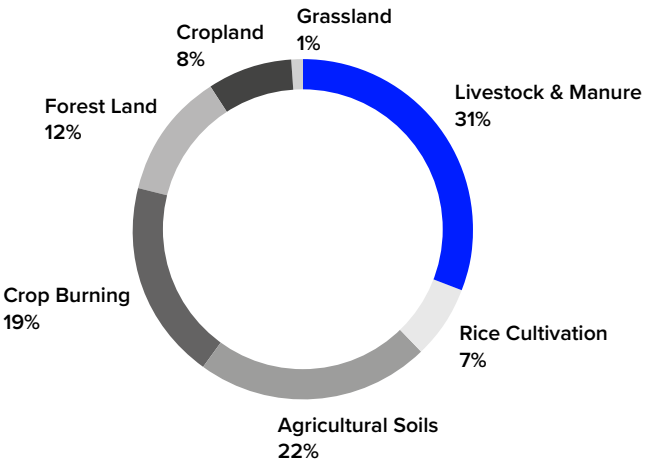


Source: EPA

Full link: https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

- **The main sources of GHG emissions from Agriculture, Forestry and Land Use are** (Figure 3):
  - **Livestock and manure** (31%): animals (mainly ruminants, such as cattle and sheep) produce GHGs through 'enteric fermentation', whereby microbes in their digestive systems break down food, and produce methane (CH_4) as a by-product.
    - Ruminant livestock is the single largest source of agricultural emissions, with a significant proportion of it being methane.
    - The meat industry in total emits the same amount of GHGs as all the vehicles in the world.[4]
    - Beef farming is environmentally particularly demanding. Relative to pork or chicken, beef production requires, per calorie: 28 times more land; 11 times more water; and 6 times more fertiliser – and produces five times more GHG emissions.[5]
  - **Agricultural soils** (22%): nitrous oxide (N_20) – a particularly potent GHG – is produced when synthetic nitrogen fertilisers are applied to soils.
  - **Crop burning** (19%): the burning of agricultural residues releases CO_2, N_20, and CH_4.
  - **Forest land** (12%): net emissions of carbon dioxide from changes in forestry cover (i.e. difference between deforestation and reforestation).
  - **Cropland** (8%): net emissions of carbon dioxide result when croplands are degraded or sequestered when they are restored.
  - **Rice cultivation** (7%): flooded paddy fields produce methane through 'anaerobic digestion'.
  - **Grassland** (1%): net balance of carbon dioxide from carbon losses (e.g., through degradation) and gains (e.g., through restoration) from grassland biomass and soils.

Figure 3: GHG emissions from Agriculture, Forestry and Land Use



Source: Our World in Data
Full link: https://ourworldindata.org/emissions-by-sector

- **Overuse of inorganic fertilisers** is another major environmental concern.
  - There has been a nearly eight-fold increase in the use of nitrogen-based fertilisers since the early 1960s.[6]
  - In some cases, intensive farming practices degrade soil more than 100 times faster than the time it takes for new soil to form. The resulting lack of nutrients is being compensated by fertilisers.
- **GHG emissions from land use changes and agriculture** include nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2):
  - These emissions represent 81% of global N2O emissions, 44% of CH_4, and 13% of CO_2.[7]
  - N_2O and CH_4 are particularly potent GHGs, with global warming potential of some 264-268x and 84-87x that of CO_2 over a 20-year horizon.[8]
- **Agriculture faces a dual challenge** – impacts work both ways:
  - Land use changes and mass-scale farming are major contributors to global GHG emissions;
  - At the same time, agriculture is also one of the most vulnerable sectors to changing climatic conditions, and practices will have to adapt.

Reducing emissions from agriculture

- **Agriculture is one of the most difficult sectors in which to reduce emissions** – along with aviation, and industries with high-temperature requirements (especially iron, steel, and cement).
- **Demand for meat globally is set to increase strongly** as the world population grows and consumers in the developing world become more affluent.
  - Feeding 9bn people by 2050 will require around a 70% increase in food production to meet the need of the populations in developed countries, and a doubling for those in in developing countries.[9]
  - Meeting this demand via 'traditional' large-scale farming would, almost certainly, be environmentally unsustainable, given the land, water, and energy requirements, as well as the production of GHGs.[10]
- **Change is overdue.** For change to occur quickly and efficiently, all economic agents have to face appropriate incentives – a carbon price plus regulations – in all countries, including especially China and developing countries. And to be fair and just, the developing countries would have to be compensated, out of the tax receipts in the developed countries.

To reduce emissions, demand for food production would have to fall and farming and land use become more sustainable.

These changes could be achieved through a combination of actions.

1. **Dietary changes.** Reducing production and consumption of high-GHG foods, such as meat (particularly beef and lamb) and dairy, instead consuming lower-GHG foods (e.g. legumes, vegetables, etc).
   - Carbon prices if applied appropriately would change the (relative) prices of meat and dairy products and thereby divert demand.
2. **Reducing food waste.** Currently about one-third of food produced globally is wasted.[11]
   - Overall, the GHG emissions associated with the full life cycle of waste is approximately equal to the total emissions of the EU.[12]
   - A combination of a more sustainable global mindset (along with the pricing of carbon emissions, and technology) will need to be part of the solution.
3. **Changing agricultural practices.** Global agricultural GHG emissions could be reduced by 10–20% through changes in land management or farming practices to decrease GHGs per unit of production.[13] This could be achieved by:
   - Livestock, soils, and waste manure management. The land released could be converted into forest, used for peatland restoration, or the growing of energy crops.
   - Cropland management, including through fertiliser management (e.g. fertilisers made from hydrogen, rather than hydrocarbons, as a feedstock).
   - More sustainable cultivation methods (e.g. for rice).
4. **Technological/scientific advances.**
   - **Precision agriculture** is a farm management approach that increases efficiency through enhanced observation, measurement, control, and response. Increasing efficiency in this way not only preserves resources but also often reduces environmental impacts, with some estimates suggesting that chemical use can be reduced by up to 90%. These techniques can be applied both to crop and livestock farming.[14]

- **Vertical farming** is a way of growing crops on inclined surfaces, often integrated into buildings and other structures such as shipping containers. Stacked layering systems make efficient use of both space and other inputs. Compared with traditional farming, VF methods can use 10-20 times less land, 50-100 times less water, reduce headcount by some 80%, and can offer 70-times-higher crop yields.[15]
- **Meat substitutes.** Cultured meat or 'in vitro meat', is grown from animal cell cultures, in a controlled environment, externally from any living organism. It uses 99% less land, 80-95% less water, 50% less energy, and produces 75-95% less GHG emissions than traditional farming methods.[16]

Adapting agriculture to climate change

Agriculture is highly vulnerable to changes in weather and climatic conditions.

- The increasing frequency of extreme weather events, such as drought and floods, will damage crop and livestock populations, as well as farming infrastructure and livelihoods.
- Globally, each 1°C rise in mean temperature will reduce yields of wheat by an estimated 6%, rice by 3.2%, and maize by 7.4%.[17]
- Further pressure will be placed on food production by increases in pests, weeds, and diseases. (Higher temperatures increase winter survival of existing insect pests, leading to increases in crop damage and pesticide use.)
  - Climatic changes and the resulting impacts on food production and security come at a time of increasing pressure from population and consumption growth.
- **Impacts will vary by region, and socioeconomic setting.**
  - Some countries stand to be particularly adversely affected, e.g., India, where temperatures are set to become unbearably high, and where agricultural activities are a particularly important share of the economy.
- **New technology and increased diversification** of crops can increase agriculture's resilience and help with its adaptation to climate change impacts.
  - **Cultivating new crop varieties** that are more heat- and drought-resistant and/or able to cope with increased salinity (e.g. innovations in rice production).
  - **Breeding new livestock varieties** that would be more tolerant of heat and/or disease.

Conclusion

- While 'green' technologies have helped to reduce GHG emissions from a number of sectors, emissions from land use changes and agriculture are known to be harder to abate.
- A recent study notes that if current emission trends from the global food system were to continue – even if fossil fuel emissions were eliminated immediately – it would be impossible to limit warming to 1.5°C and difficult even to realise the 2°C target.[18]
- Thus, major changes in which foods are consumed – and how they are produced – will be required if meaningful progress towards a more sustainable future is to be made.

Useful sources

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UK Parliament. Climate Change and Agriculture. https://post.parliament.uk/research-briefings/post-pn-0600/

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[6] IPCC (2019)

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[9] Jenkins, A., (2018). Why vertical farming isn't a miracle solution to food security. Available at: https://www.independent.co.uk/environment/vertical-farming-solution-food-security-hydroponics-aquaponics-urban-agriculture-a8547561.html

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[12] Ibid

[13] Ibid

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[15] For more, see Llewellyn Consulting (2018). Technologies series: Vertical farming. Available upon request.

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[17] UK Parliament (2019).

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