Carbon Footprint of Agriculture

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What is a carbon footprint

- Total greenhouse gas emissions (both direct and indirect) caused by an individual, event, organisation, or product, expressed as carbon dioxide equivalent.
- Are used as a direct measure of the quantum of gases emitted into the atmosphere causing climate change.
- Expressed in terms of the amount of carbon dioxide, or its equivalent of other GHGs, emitted.
- Often, the total carbon footprint cannot be exactly calculated because of inadequate knowledge of, and data about, the complex interactions between contributing processes, and their influence on natural processes of storing or releasing carbon dioxide.

OTHER FOOTPRINTS

- WATER FOOTPRINT,
- LAND FOOT PRINT
- ECOLOGICAL FOOTPRINT
- TRAVEL FOOTPRINT

Importance of Carbon Accounting

- Emissions accounting can provide the numbers and data that are important to solid decision making.
- It helps identify management practices and opportunities that reduce GHG emissions while also providing improved food security, more resilient production systems, and better rural livelihoods.
- Emissions data can support farmers in adopting less carbon-intensive practices, guiding low-emissions development, assessing product supply chains, certifying sustainable agriculture practices, and informing consumers on the carbon footprint of their choices.

- It is only through a robust and shared understanding of how much carbon can be stored or how much CO_2 is reduced from mitigation practices that informed decisions can be made about how to identify, implement, and balance a suite of mitigation practices.
- Only by selecting a portfolio of options adapted to regional characteristics and goals can mitigation needs be best matched to also serve rural development goals, including food security and increased resilience to climate

Emissions from Agriculture and Food

- The Agriculture, Forestry and Other Land Use (AFOLU) sector contributes about 25% of human-generated GHG emissions, mainly from deforestation and agricultural emissions from livestock, soil and nutrient management (IPCC AR5).
- The global food system, from fertilizer manufacture to food storage and packaging, is responsible for up to one-third of all human-caused greenhouse-gas emissions (CGIAR report).
- Reducing agriculture's carbon footprint is central to limiting climate change.
- Moving to sustainable agricultural practices will play a key role in limiting global warming to no more than 2˚C.

Estimates of the relative contributions of different stages of the food chain to global greenhouse gas emissions			
Stage of food chain	Activities	Emissions ($MtCO_2e$)	Year of estimate
Preproduction	Fertilizer manufacture	282–575	2007
	Energy use in animal feed production	60	2005
	Pesticide production	3–140	2007
Production	Direct emissions from agriculture	5,120–6,116	2005
	Indirect emissions from agriculture	2,198–6,567	2008
Postproduction	Primary and secondary processing	192	2007
	Storage, packaging, and transport	396	2007
	Refrigeration	490	2004

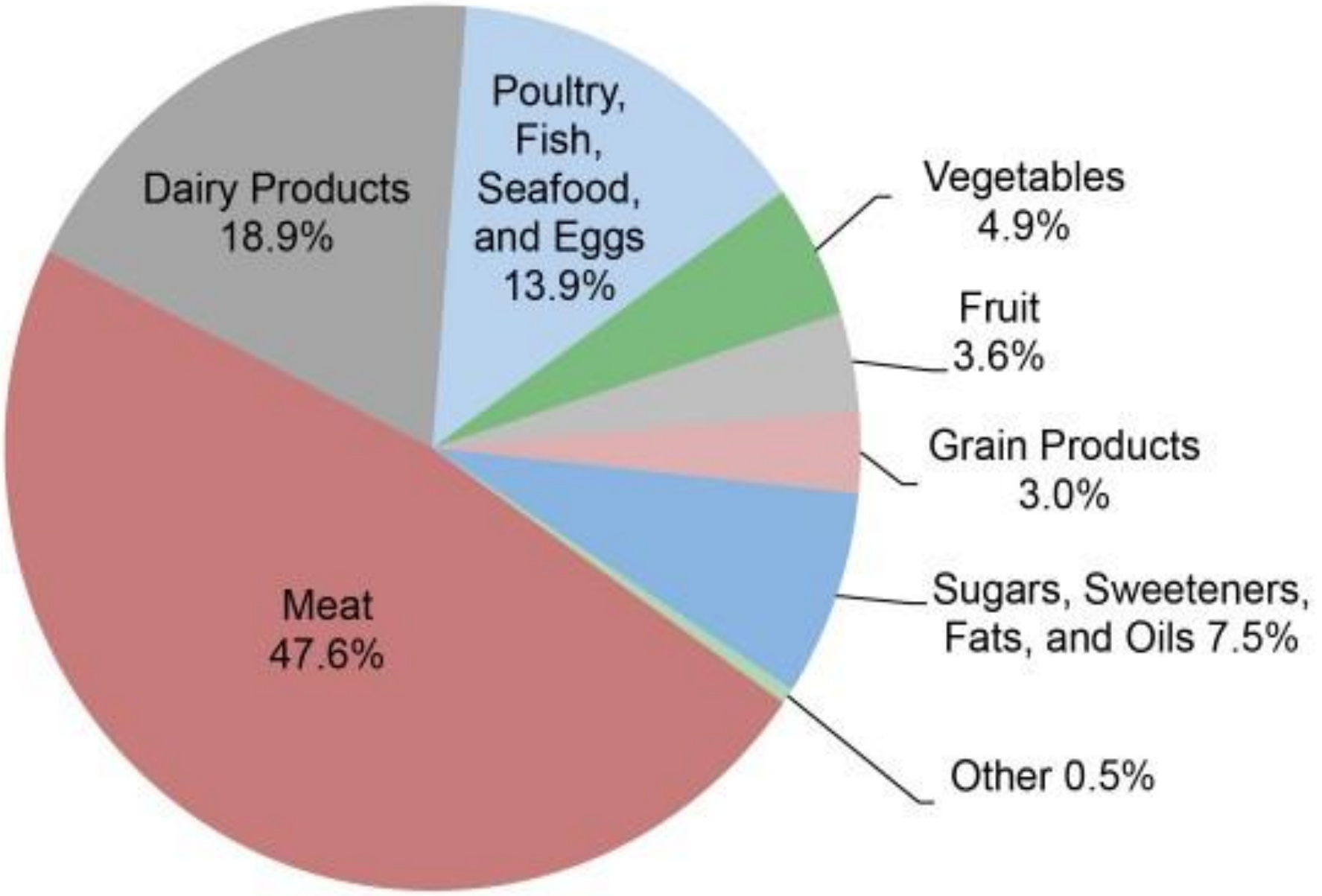
- Agricultural production provided the lion's share of greenhouse-gas emissions from the food system, releasing up to 12,000 megatonnes of carbon dioxide equivalent a year — up to 86% of all food-related anthropogenic greenhouse-gas emissions.
- Next was fertilizer manufacture, which released up to 575 megatonnes.
- Next was refrigeration, which emitted 490 megatonnes.
- Overall, the whole food system released 9,800–16,900 megatonnes of carbon dioxide equivalent into the atmosphere in 2008, including indirect emissions from deforestation and land-use changes.

Source: Vermeulen et al, 2012

- Reducing agricultural emissions and increasing carbon sequestration in the soil and biomass has the potential to reduce agriculture's contribution to climate change by 5.5–6.0 gigatons (Gt) of carbon dioxide equivalent (CO2eq)/year.
- Economic potentials, which take into account costs of implementation, range from 1.5 to 4.3 GT CO2eq/year, depending on marginal abatement costs assumed and financial resources committed, with most of this potential in developing countries (Smith et al 2007).
- The opportunity for mitigation in agriculture is thus significant, and, if realized, would contribute to making this sector carbon neutral.

- Meat products have larger carbon footprints per calorie than grain or vegetable products because of the inefficient transformation of plant energy to animal energy.
- Ruminant animals such as cattle, sheep, and goats produced 167 million metric tons (mmt) in CO_2e of methane in the U.S. in 2015 through digestion.
- Eating all locally grown food for one year could save the GHG equivalent of driving 1,000 miles, while eating a vegetarian meal one day a week could save the equivalent of driving 1,160 miles.
- A vegetarian diet greatly reduces an individual's carbon footprint, but switching to less carbon intensive meats can have a major impact as well. For example, replacing all beef consumption with chicken for one year leads to an annual carbon footprint reduction of 882 pounds CO_2e.
- Organic food typically requires 30-50% less energy during production but requires one-third more hours of human labor compared to typical farming practices, making it more expensive.

GHGs From Average Food Consumption



- In a 2014 study by Scarborough et al., the real-life diets of British people were studied and their average dietary GHG emissions per day (in kg of CO_2e) were estimated to be:
- 7.19 for high meat-eaters
- 5.63 for medium meat-eaters
- 4.67 for low meat-eaters
- 3.91 for fish-eaters
- 3.81 for vegetarians
- 2.89 for vegans

Methods of Calculating the Carbon Footprint

- The traditional way of estimating a carbon footprint – so-called 'lifecycle assessment' – involves adding up as many of the emissions pathways as is feasible.
- An alternative approach is to use so-called 'input-output' analysis. This aims to avoid missing out pathways by taking the total emissions of a country or region, dividing it into relevant sectors, and estimating the total emissions that each sector accounts for. Those figures can then be used to estimate the footprint of, say, each rupee spent in each activity in each sector.

EX- Ante Carbon Accounting Tool (EX-ACT)

- The World Bank partnered with the FAO to develop the EX- Ante Carbon Accounting Tool (EX-ACT) and an e-learning course for greenhouse gas accounting in agricultural landscapes.
- EX-ACT is a land-based accounting system used to measure and to project changes to the carbon balance over time.
- Carbon balance refers to the amount of carbon released into the atmosphere through emissions, relative to the amount of carbon stored in the soil and plant material of an area, and relative to the carbon that soil and plant material is actively removing or "sequestering" from the atmosphere.
- The measurements are expressed in terms of tons of carbon dioxide-equivalent (tCO2-e) per hectare over a period of one year.
- In addition to spatial, area-based measurement, EX-ACT can also be used to measure changes to the carbon balance per unit of produce.

Agriculture (crops and livestocks)

- Agriculture is central to feeding the world and reducing poverty.

  But conventional forms of agriculture are often unsustainable and drive land degradation.
- Agriculture is the world's leading anthropogenic source of methane (52 percent) and nitrous oxide (84 percent) emissions, and the principal driver of deforestation worldwide.
- Agriculture and agriculture-driven land-use change contribute 24 percent of global greenhouse gas emissions

What is Climate-Smart Agriculture?

- Climate-Smart Agriculture (CSA) is a relatively new approach to developing the technical, political and financial conditions for the achievement of sustainable development goals. It helps address food security and climate challenges through three pillars:
- Sustainably increasing agricultural productivity and incomes
- Adapting and building resilience to climate change
- Reducing and/or eliminating GHG emissions
- CSA is a harmonized way of addressing the multiple challenges faced by agricultural systems. Often based on existing practices, policies and institutions, it focuses on achieving the desired outcomes without being prescriptive about practices or technologies. CSA involves making site-specific assessments to identify the best agricultural production technologies and practices for

LANDSCAPE APPROACH TO CSA

A Landscape Approach is a framework to integrate policy and practice for multiple land uses, within a given area, to ensure equitable and sustainable use of land while strengthening measures to mitigate and adapt to climate change. It also aims to balance competing demands on land through the implementation of adaptive and integrated management systems. These include not only the physical characteristic features of the landscape itself, but all of the internal and external socioeconomic and socio-political drivers that affect land use, particularly related to conservation, forestry and agriculture (Sayer et al.2009). In short, landscape approaches seek to address the increasingly complex and widespread environmental, social and political challenges that transcend traditional management boundaries. Landscape approaches are primarily rooted in conservation and the science of landscape ecology (Lindenmayer et al., 2008)

climate-smart agriculture key to Paris Agreement goals

- Attendees at the annual Global Landscape Forum conference in Bonn, Germany, this week sought approaches for implementing "climate-smart" agricultural practices to help keep global temperature from rising more than 2 degrees Celsius (3.6 degrees Fahrenheit) by 2100.
- Some 40 percent of the earth's surface is used for food production, with 400 million small farmers worldwide, plus industrial agribusiness, so policymakers understand that climate-smart agriculture, practiced broadly, could play a significant role in reducing carbon emissions and helping nations meet their Paris carbon-reduction pledges.
- Numerous agricultural management practices to reduce carbon emissions, enhance food security, productivity and profitability, are available now. They include wider use of cover crops, low and no till techniques, increased application of organic fertilizers such as manure, judicious use of chemical fertilizers, and the growing of crops bred for climate resiliency.

Funding of CSA

- Climate-smart agricultural projects will be eligible for billions in finance that the World Bank will provide to national agricultural ministries, which in turn will be passed down to individual farms and farmers.
- Considering that some 40 percent of the earth's surface is used for food production, and that there are some 400 million small farmers worldwide, it becomes clear that climate-smart agriculture, practiced broadly, could play a significant role in reducing carbon emissions.

4 per 1000 Initiative (COP 21, Paris)

- **An annual growth rate of 0.4% in the soil carbon stocks, or 4‰ per year, would halt the increase in the CO2 concentration in the atmosphere related to human activities.**
- This growth rate is not a normative target for each country, but is intended to show that even a small increase in the soil carbon stock (agricultural soils, notably grasslands and pastures, and forest soils) is crucial to improve soil fertility and agricultural production and to contribute to achieving the long-term objective of limiting the temperature increase to the +2°C threshold, beyond which the **IPCC** (Intergovernmental Panel on Climate Change) indicates that the effects of climate change are significant.
- The "4 per 1000" initiative is intended to complement those necessary efforts to reduce greenhouse gas emissions, globally and generally in the economy as a whole. It is voluntary; it is up to each member to define how they want to contribute to the goals.

Some CSA Practices for Reducing Carbon Footprint

- Integrated nutrient management can lead to a number of benefits, including a 40-60% reduction in total nitrogen fertilizer use, increased crop yield by 35-50%, and net profit by 70-120% – while decreasing GHG emission intensity (per unit yield) by 50%.
- Other CSA practices that can reduce emissions include enhancing soil organic matter, increasing the digestibility of feed for cattle, and increasing the efficiency of nitrogen fertilizer applications.
- Precision crop production, including a more efficient use of fertilizer, will lower carbon dioxide and nitrous oxide emissions and reduce the consumption of fossil fuels.
- Methane emissions can be reduced by using manure for biogas, which may also improve access to energy on farms and reduce the use of fossil fuels.
- Growing trees on farms for energy purposes can also sequester carbon and provide an alternative to fossil fuels.

Some CSA Practices for Reducing Carbon Footprint

- Conservation Agriculture (no-till) increases energy efficiency, and together with crop rotation, provides and recycles part of the nutrients and contributes to sustainable intensification.
- Conservation Agriculture also enhances crop cover, soil water retention and Soil Organic Matter, increasing resilience to drought and extreme weather events.
- Intercropping with leguminous crops or agroforestry can sustainably increase farm productivity and also provide energy.

Conclusion

- About 40% of the earth's surface is used for food production, and there are some 400 million small farmers worldwide.
- Therefore, climate-smart agriculture, practiced broadly, can play a significant role in reducing carbon emissions.
- Climate-smart agricultural projects will be eligible for billions in finance that the World Bank will provide to national agricultural ministries, which in turn can be passed down to individual farms and farmers.

Thank You for Your Attention!