What are Greenhouse Gases (GHGs)?

GHG Fact Sheet Series

Greenhouse Gases (GHGs) are naturally occurring gases that trap some of the sun's warmth, making Earth a livable planet. Increased levels of GHGs caused by human activities can lead to detrimental changes to Earth's climate.

TYPES OF GHGS

- Carbon dioxide (CO_2): Carbon dioxide is released into the atmosphere when fossil fuels and solid waste are burned, and as land is tilled. CO_2 is removed from the atmosphere when it is absorbed by plants.
- Methane (CH_4): Methane is released into Earth's atmosphere in small, but potent quantities due to the production and transport of coal, natural gas, and oil. It is also emitted in dairy production primarily through enteric fermentation and manure decomposition.
- Nitrous oxide (N_2O): Sources of nitrous oxide emissions from agriculture include manure storage, treatment, and emissions after application of manure-based and synthetic fertilizer.
- Other: There are other GHGs including fluorinated gases, hydrofluorocarbons, and perfluorocarbons that come from industrial processes, transportation, and electricity transmission. [1]

Dairy farming contributes approximately 1.9% of U.S. GHG emissions.[2]

CLIMATE CHANGE

Climate change is a long-term change in the weather patterns that have come to define Earth's local and regional climates. [4] These changes pose threats like increased flooding, wildfires, and other erratic weather patterns that impact society, including dairy production.

Climate change is driven by the increase in greenhouse gas (GHG) levels in Earth's atmosphere primarily due to human activity. GHGs trap heat from the sun in the atmosphere, resulting in temperature increases commonly referred to as global warming.

U.S. dairy is on a journey to be GHG neutral by 2050, building on years of progress. The carbon footprint of milk production decreased by 63% between 1944 and 2007.[3]

1 "Overview of Greenhouse Gases." EPA, 8 Sept. 2020, www.epa.gov/ghgemissions/overview-greenhouse-gases.
2 Thoma, Greg, et al. "Greenhouse Gas Emissions from Milk Production and Consumption in the United States: A Cradle-to-Grave Life Cycle Assessment circa 2008." International Dairy Journal, 2012, www.sciencedirect.com/science/article/pii/S0958694612001975.
3 J. L. Capper, R. A. Cady, D. E. Bauman, The environmental impact of dairy production: 1944 compared with 2007, Journal of Animal Science, Volume 87, Issue 6, June 2009, Pages 2160–2167, https://doi.org/10.2527/jas.2009-1781
4 "Overview: Weather, Global Warming and Climate Change." NASA, NASA, 28 Jan. 2021, climate.nasa.gov/resources/global-warming-vs-climate-change/.

Due to climate change, Earth has already warmed by about 1°C, or 1.8°F. A warmer world, even by a half-degree Celsius, can put the dairy industry at risk.

Dairy farmers across the country are already feeling the pressures of a changing climate and its effects on weather, including more severe storms, rising average temperatures, extremes in precipitation, more forest fires, and more drought. As these risks continue and amplify, producers will be faced with the challenges of adapting.

GLOBAL WARMING POTENTIALS

Each GHG has a different impact on the atmosphere. Carbon dioxide equivalent (CO_2e) is used as a standard unit for measuring carbon footprints. It expresses the impact of each different greenhouse gas in terms of the amount of carbon dioxide (CO_2) that would create the same amount of warming over a 100-year period. CO_2 stays in the atmosphere for a long time once its emitted: 40% remains after 100 years, 20% after 1,000 years, and 10% for as long as 10,000 years later.

Methane (CH_4) persists in the atmosphere for significantly less time than CO_2, but its global warming impact is 25 times greater than that of CO_2 over 100 years, meaning 1 lb. of CH_4 emitted can be expressed as 25 lb. of CO_2e. Nitrous oxide (N_2O) molecules stay in the atmosphere for an average of 114 years, the impact of 1 lb. of N_2O on warming the atmosphere is almost 300 times that of 1 lb. of CO_2.[6]

Producing a gallon of milk in 2017 had a 19% smaller carbon footprint than in 2007.[5]

GHGS FROM DAIRY FARMING

GHG emissions during dairy farming come from cattle digestion, manure management, energy use, and feed production. Enteric fermentation and manure management are the largest sources. About 72% of GHG emissions from dairy production occur before leaving the farmgate.

ENTERIC FERMENTATION (35% OF FARMGATE EMISSIONS)

- Dairy cows are ruminants, meaning the structure of their digestive system allows for microbial fermentation of feed.
- This fermentation process releases methane**.** The level of methane emissions is influenced by animal health, ration composition, feed quality, and feed intake.

MANURE MANAGEMENT (33% OF FARMGATE EMISSIONS)

- During collection, transport, storage, treatment, and application of manure, biological and chemical processes result in the release of methane and nitrous oxide.
- Fuel used to transport and spread manure also impacts a farm's carbon dioxide footprint.

[5] Capper, Judith L, and Roger A Cady. "Effects of Improved Performance in the U.S. Dairy Cattle Industry on Environmental Impacts between 2007 and 2017." *OUP Academic*, Oxford University Press, 17 Oct. 2019, academic.oup.com/jas/article/98/1/skz291/5581976.

6 "Overview of Greenhouse Gases." EPA,, 8 Sept. 2020, www.epa.gov/ghgemissions/overview-greenhouse-gases.

FEED (26% OF FARMGATE EMISSIONS)

- Emissions associated with crop production and grazing come from fuel and electricity use, the manufacturing and use of inputs, and emissions from soil management and nutrient application.
- Crop production activities also reduce farm GHG emissions through carbon sequestration.

ENERGY USE (6% OF FARMGATE EMISSIONS)

- GHGs are emitted from the burning of fossil fuels (e.g. diesel, natural gas, gasoline, propane, etc.) for electricity, heat, and transportation.

OPPORTUNITIES

U.S. dairy has set ambitious goals to become GHG neutral, optimize water use while maximizing recycling, and improve water quality by 2050. The Net Zero Initiative (NZI) is an industry-wide effort that plays a key role in in helping U.S. dairy continue to make progress toward GHG emission reductions from field to farmgate through new technologies and practices in feed production, cow care, energy efficiency and manure management.

FARM Environmental Stewardship is an important part of the dairy community's sustainability efforts, including NZI. The program launched in 2017 to enable dairy farmers to measure their current footprint, track performance trends, and set a course for continuous improvement. Organizations participating in FARM Environmental Stewardship represent 80% of the U.S. farmgate milk supply.

There are a variety of management approaches, practices, and technologies that reduce GHG emissions while also aligning with positive business outcomes. Examples are captured within the FARM Environmental Stewardship Reference Manual (linked below) and this GHG Fact Sheet Series.

LEARN MORE

- FARM Environmental Stewardship Continuous Improvement Reference Manual https://nationaldairyfarm.com/producer-resources/environment/
- U.S. Dairy Net Zero Initiative https://www.usdairy.com/getmedia/89d4ec9b-0944-4c1d-90d2-15e85ec75622/game-changer-net-zero-initiative.pdf?ext=.pdf
- Livestock and Poultry Environmental Learning Community https://lpelc.org/sources-of-agricultural-greenhouse-gases/
- Texas AMU Extension: The Role of Animal Agriculture on Greenhouse Gas Emissions https://agrilifeextension.tamu.edu/library/ranching/the-role-of-animal-agriculture-on-greenhouse-gas-emissions/
- University of Missouri Extension: Agriculture and Greenhouse Gas Emissions https://extension.missouri.edu/publications/g310#:~:text=Nitrous%20Oxide%20(N2O,direct%20agriculture%2Drelated%20GHG%20emissions
- Sustainable Dairy: Science for Sustainable Production http://www.sustainabledairy.org/Pages/home.aspx