Farm Greenhouse Gas (GHG) Inventory

Introduction
Greenhouse gases (GHGs) contribute to warming of the earth’s atmosphere and can be released from both natural and anthropogenic (human) activities. Because GHGs accumulate in the atmosphere, they contribute to rising temperatures and more frequent occurrence of extreme weather events. This factsheet describes the main sources of GHGs from dairy farm activities, carbon sequestration as a way to reduce emissions, and the role of software tools for GHG inventory assessments for dairy.

Greenhouse Gases and CO₂e
The three main GHGs from dairy farms are: carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄). To account for differences in potency to warm the atmosphere, each GHG is assigned a global warming potential (GWP). Inventories can differ in what is used as GWP. New York law has chosen to use the “20-year GWP”, established by the Intergovernmental Panel on Climate Change (IPCC), where CH₄ is 84 times more potent than CO₂ and N₂O is 264 times more potent than CO₂ (which has a value of 1). The GWP of each GHG is expressed as “carbon dioxide equivalent” or CO₂e, because the other gases are compared to CO₂. To convert from a ton of CH₄ to ton of CO₂e, simply multiply by 84.

Major Emissions sources from Dairy Farms
Dairy farms are a large source of CH₄, mostly from enteric emissions from the cows themselves, and from manure management (Figure 1). Therefore, these areas are the primary target for reducing CH₄ emissions with milk production efficiency and manure management.

Carbon Sequestration
Carbon can be captured from the atmosphere and added to soil or trees in a process called carbon sequestration. When this process is not easily reversible, it can reduce carbon in the atmosphere and hence reduce the farm’s GHG footprint. A good example of more permanent carbon sequestration is carbon stored in a tree for 100 years which is then used as building material for another 200 years. Improving soil carbon storage through soil health practices is less permanent but important too as it can increase soil fertility, improve water storage during drought, as well as increase infiltration and reduce erosion during extreme precipitation events. Soil health activities that help farms adapt to extreme weather include reduced tillage and planting cover crops to increase soil organic matter, or having woody habitats such as hedgerows, riparian buffers or forest surrounding production fields.

Figure 1: The main sources and potential sinks of greenhouse gases (GHGs) used to calculate the carbon footprint on a dairy farm. These include carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O).
GHG Inventory of Dairy Farms
A farm’s GHG inventory (also referred to as footprint) is determined by adding all GHGs emitted from the farm (on a CO2e basis) and subtracting the carbon sequestered by systems that store carbon for a long time such as forests.

A first step in calculating GHG emissions is to set the boundary of the assessment. A dairy inventory includes emissions and sequestration resulting from all activities on the farm, including crop production, grazing of animals, feeding of animals, manure storage and treatment, and energy and fuel use associated with these activities, and may or may not include the “upstream emissions” which come from the production and transport of products such as feed and fertilizer imported onto the farm. Once a product (such as milk or a crop) leaves the farm, the emissions are the responsibility of the next stakeholder in the supply chain.

Looking at on-farm GHG emissions from agriculture in the United States (which is estimated at 10% of the total emissions), 58% are from N2O, 41% from CH4 and 1% from CO2 (Figure 2).

![Figure 2: U.S. Agricultural greenhouse gas emissions according to the U.S. Annual Greenhouse Gas Inventory for 2019 (USEPA 2021). This does not include farm energy use.](image)

Feed production, manure management and enteric fermentation from cows are the major sources of CH4 and N2O on a dairy. Farms can improve their inventory by improving milk production efficiency, reducing methane from manure storage and improving nitrogen use efficiency. Additionally, carbon sequestration by improved management of woodlands can lower the inventory.

In Summary
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Additional Resources
- Intergovernmental Panel on Climate Change (IPCC). https://www.ipcc.ch/

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