The Dairy Greenhouse Gas Model: A tool for estimating the greenhouse gas emissions and carbon footprint of dairy production systems

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The Problem

Animal agriculture is a recognized source of greenhouse gas (GHG) emissions, but good information does not exist on the net emissions from our farms.

What are Greenhouse Gases?

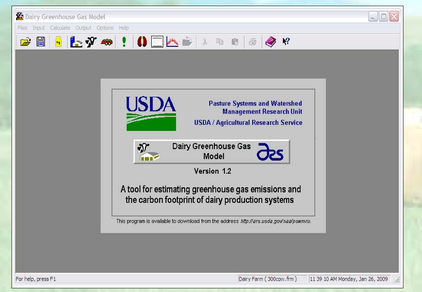
GHGs include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Dairy cows emit CH_4 through enteric fermentation in the rumen and CO_2 through respiration. Microbial processes in manure release CO_2, CH_4, and N_2O during storage and handling, and microbial processes in the soil release CO_2 and N_2O as crops are produced.

What Affects Greenhouse Gas Emissions?

Many management factors on farms affect these gas emissions such as breed, milk yield, fiber level in animal diets, type of manure storage, cropping strategy, and pasture productivity.

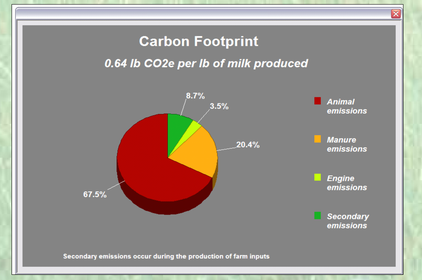
Estimating Emissions

A software tool called the Dairy Greenhouse Gas Model or DairyGHG estimates GHG emissions and the carbon footprint for various farm management strategies.



What is a Carbon Footprint?

This is a term that has evolved to represent the net total GHG emission associated with a product or service. For our model, this is the net exchange of the three important GHGs per unit of milk produced. Carbon footprints for dairy farms typically range from 0.4 to 0.9 lb CO_2e per lb of milk depending upon the management of the farm.



Model Availability

DairyGHG can be downloaded from the internet and installed on computers that use a Microsoft Windows® operating system. [http://www.ars.usda.gov/Main/docs.htm?docid=17355]

A Comparison of Production Systems

DairyGHG was used to compare the emissions of the following dairy production strategies:

1. Full confinement system. 100 large framed Holstein cows; 80 heifers; high grain:forage diets; milk production of 22,000 lb/cow; housed in free-stall barns.

2. Winter confinement and summer pasture system. 100 average-sized Holsteins; 80 heifers; high forage:grain diets; milk production of 18,700 lb/cow; housed and fed in free-stall barns when not on pasture; rotational grazing of older heifers and all cows during the growing season.

3. Year-round outdoor system. 120 Holstein-Jersey crossbred cows; 96 heifers; high forage:grain diets; milk production of 13,200 lb/cow; spring calving cycle; all farmland is rotationally-grazed perennial pasture with excess forage harvested, stored, and fed as bale silage.

Conclusions

1. Use of a well managed rotational grazing system may reduce the net GHG emission per animal, but the emission per unit of milk produced (carbon footprint) will likely increase.

2. A transition from cropland to perennial grassland will stimulate carbon sequestration, which will greatly reduce GHG emissions and the carbon footprint for 20 years and maybe more.

Results

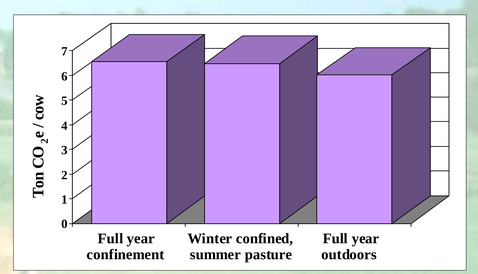


Figure 1. Net greenhouse gas emissions per cow for three dairy production systems (including replacement heifers).

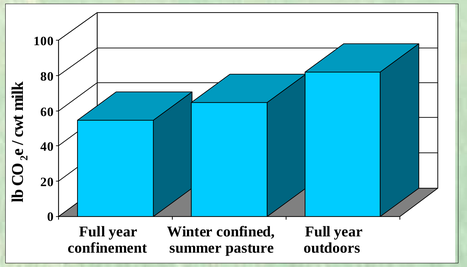


Figure 2. Carbon footprint for the three production systems.

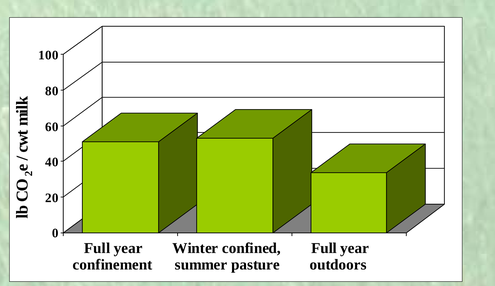


Figure 3. Carbon footprint for the three dairy production systems including the soil carbon sequestration that can occur for 20 years or more after cropland is converted to perennial grassland.