

## Greenhouse Gas Emissions and the Carbon Footprint of Dairy Production Systems

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## What do our Farms Emit?



Little good information exists on the net GHG emissions from our farms

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## Our Goal

Create a software tool for estimating individual emissions, the net total emission, and the carbon footprint of dairy production systems

- Cradle-to-farm gate Life Cycle Assessment (LCA)
- Includes all sources and sinks of carbon dioxide
- Enforces a carbon balance for the production system



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## Greenhouse Gases

- Carbon dioxide
- Methane
- Nitrous oxide



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## Carbon Dioxide Emissions

- Carbon fixation in plant growth
- Soil respiration
- Plant respiration
- Engine exhaust
- Animal respiration
- Manure respiration on barn floor
- Manure respiration in storage



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## Methane Emissions

- Enteric fermentation
- Manure storage
- Manure on barn floor
- Following manure application
- Feces from grazing animals



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## Nitrous Oxide Emissions

- Nitrification/denitrification processes in cropland
- Manure storage surface
- Manure in bedded pack or dry lot



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## Secondary Emissions

Emissions occurring during the manufacture or production of farm inputs

- Fuel
- Electricity
- Machinery
- Fertilizer
- Pesticides
- Seed
- Plastic
- Purchased replacement animals



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## Global Warming Potential

- Gases have different Global Warming Potentials relative to carbon dioxide
  - Methane (25 times CO<sub>2</sub>)
  - Nitrous oxide (298 times CO<sub>2</sub>)
- EPA reporting rules use 21 for methane and 310 for nitrous oxide

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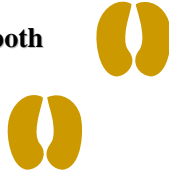
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## Carbon Footprint

- The net sum of all greenhouse gas emissions (CO<sub>2</sub>e) per unit of energy corrected milk production
- For a complete assessment, both primary and secondary emissions are included



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## DairyGHG

- Easy to use Windows program
- Available for Internet download



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## A Comparison of Production Systems

- Base: 100 cows plus replacements, free stall barns, slurry storage tank, fed alfalfa and corn silage, milk production of 19,800 lb/cow
- Increased production to 22,900 lb/cow through improved genetics and feed management
- Feed more corn silage and less alfalfa
- Use enclosed manure storage with flare

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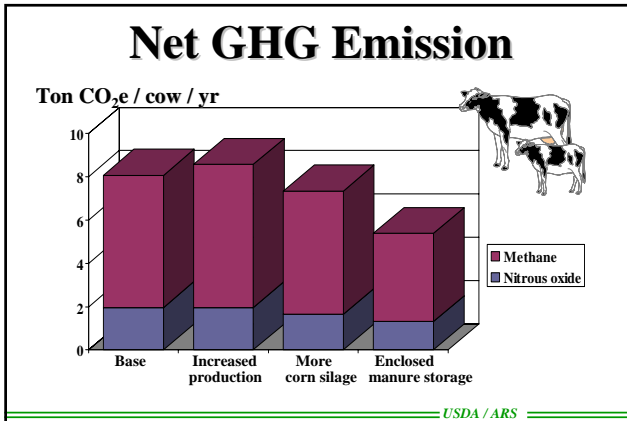
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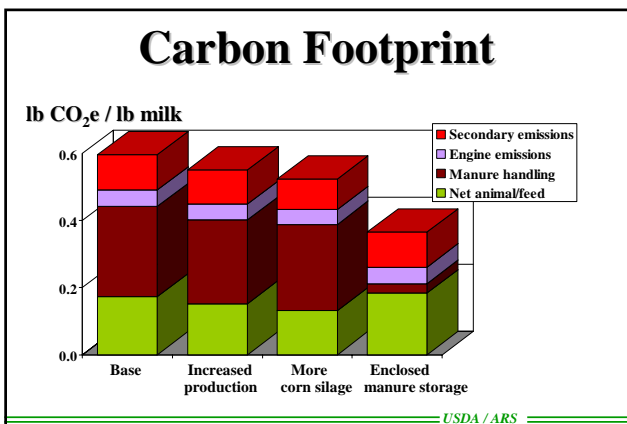
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## EPA Rules for GHG Reporting

*Includes only methane and nitrous oxide emissions from the manure management system*

- Housing facility (bedded pack and dry lot)
- Manure storage (solid, slurry or liquid)
- Treatment (solid separation, composting, anaerobic digestion)





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## Example: California Dairy

- > Holstein herd
- > 4000 cows plus 1500 replacement heifers and 1700 calves (less than one year old)
- > Milk production of 24,000 lb/cow
- > Housed in free stalls and dry lot
- > Six month manure storage



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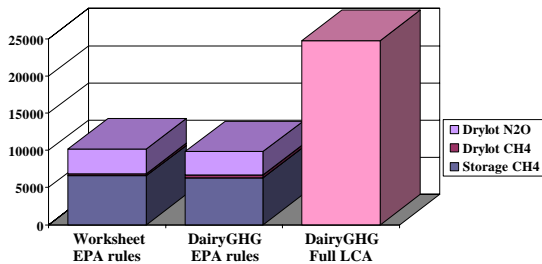
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## California Dairy

Ton CO<sub>2</sub>e / yr



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## What makes the difference?

LCA also includes:

- > Methane from enteric fermentation
- > All sources and sinks of carbon dioxide
- > Carbon dioxide from fuel combustion
- > Nitrous oxide emissions from crop production
- > All secondary emissions



DairyGHG uses newer global warming indexes

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## Summary

- DairyGHG provides a simple tool for estimating greenhouse gas emissions and the carbon footprint of dairy production systems
- DairyGHG uses process-level simulation to determine a cradle-to-farm gate LCA
- DairyGHG predicts manure management emissions similar to that required for EPA reporting, but primarily provides a more complete LCA of the production system

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## Model Availability



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# USDA

Agricultural Research Service

**Pasture Systems and Watershed  
Management Research Unit**

University Park, Pennsylvania

<http://ars.usda.gov/naa/pswmru>

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