Regional Analysis of Greenhouse Gas Emissions from Milk Production in the US

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Goal and Scope

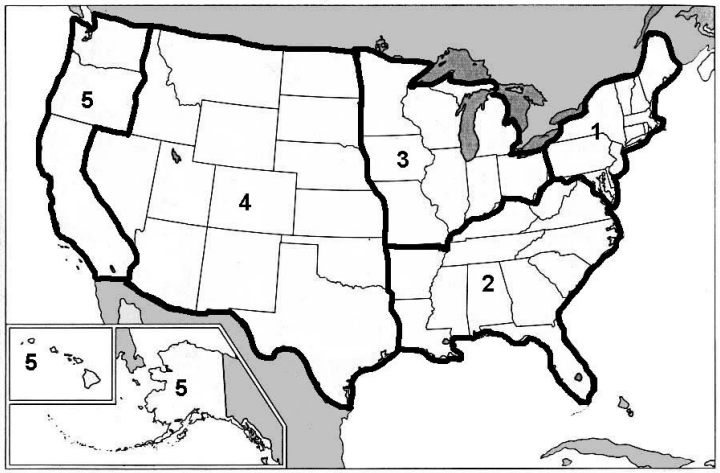
Goal: Regional analysis of GHG emissions associated with production of 1 kg milk

Scope: Cradle to farm gate.

Functional Unit: Production of 1 kg fat and protein corrected milk (4% fat and 3.3% protein)

ISO 14044 compliant, with external review

Regions for Analysis



Major Assumptions

- Attributional LCA
- Infrastructure excluded
- Biogenic carbon
  - CO_2 in air = 0; CO_2, biogenic = 0
  - Methane, biogenic = 25
- Regional averages used as surrogate for missing data
- Biological / causal model for milk : beef allocation
- Economic allocation for crop byproducts
- Enteric methane and manure from literature models

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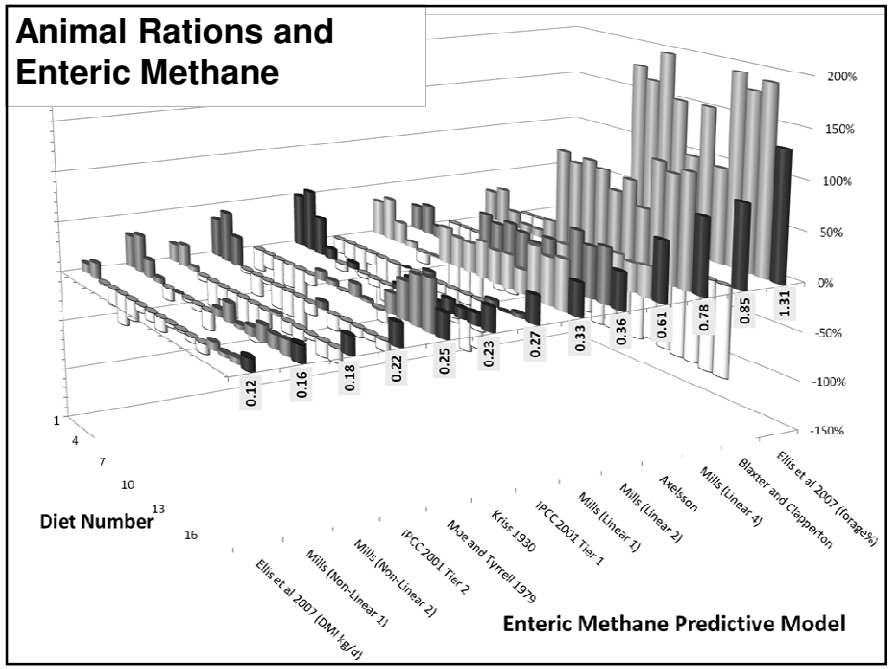
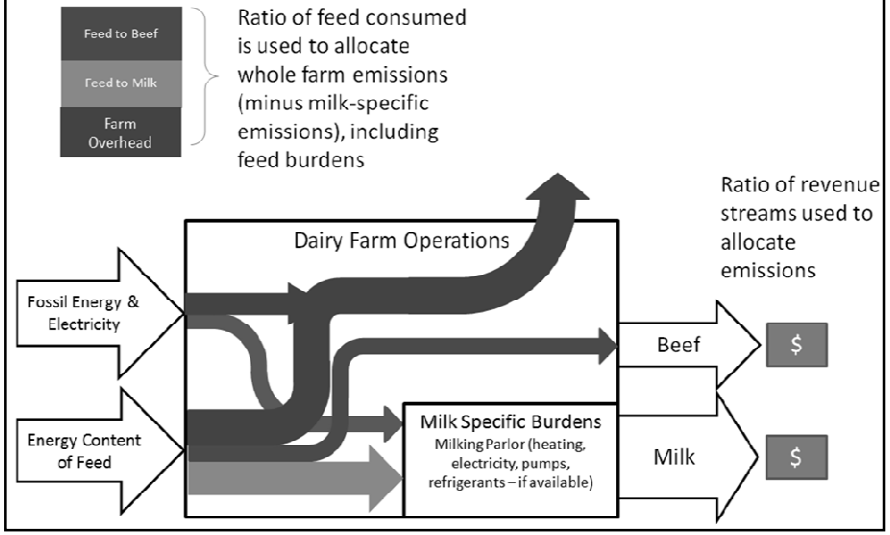
Animal Rations and Enteric Methane



Schematic of energy flow accounting for allocation



Life Cycle Inventory Sources

Survey:

1) Dairy Producer (536; 9% response rate)

Published Literature:

1) Peer Reviewed Literature
   a) Enteric Methane, Nitrogen and Methane from manure management
   b) Life cycle inventory data for crop production (NASS, Budgets, USLCI)
2) Other Publications (e.g. IPCC, EPA)
3) Expert opinion (e.g., hay production budgets from Ag Extension)

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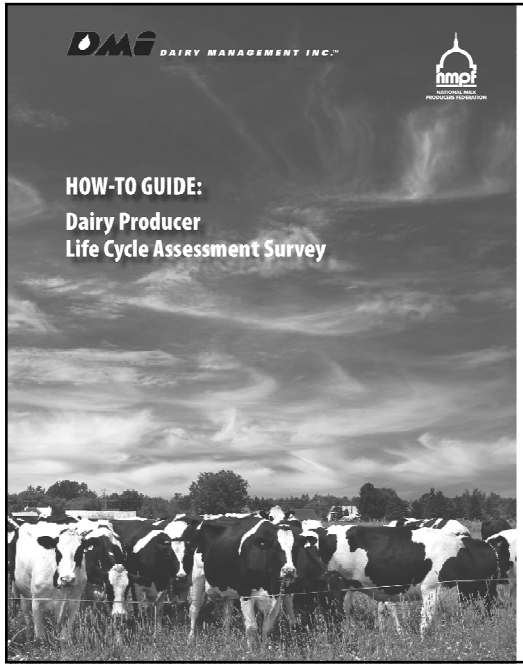

Collect representative data from U.S. dairy producers to establish a carbon footprint baseline relevant to conditions in the United States.

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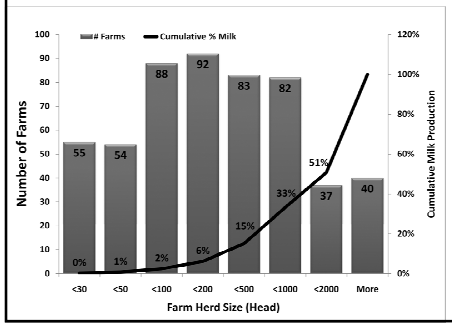
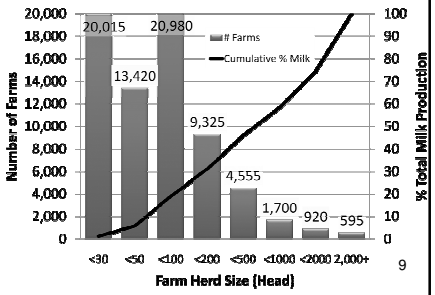
Producer Survey

- 43 questions in 9 areas
  - About Your Facility
  - On-Facility Crop Production
  - Manure Management
  - Energy Usage
  - Housing & Milking Information
  - Animal Rations & Grazing Practices
- 500+ usable surveys returned





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Farm Inventory Data

- Animal rations
  - Central determining factor
    - Upstream production burdens
    - Enteric
    - Manure
- On-farm fuels
  - Little extant data

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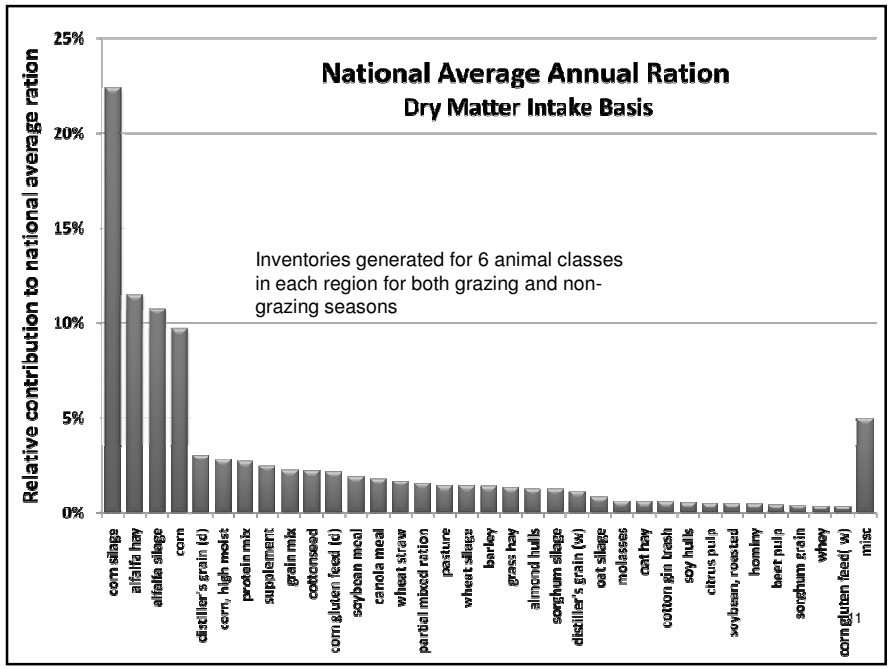
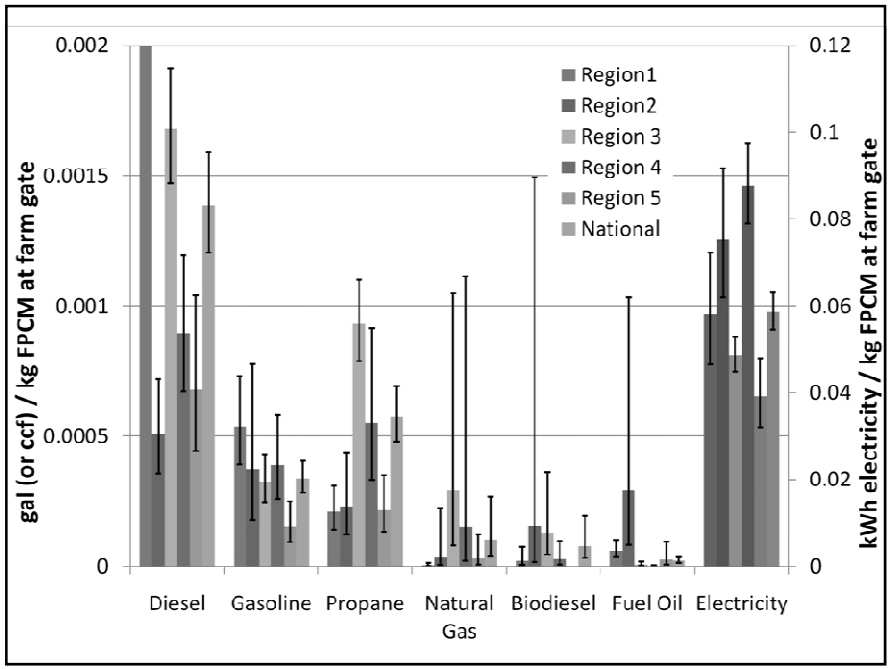
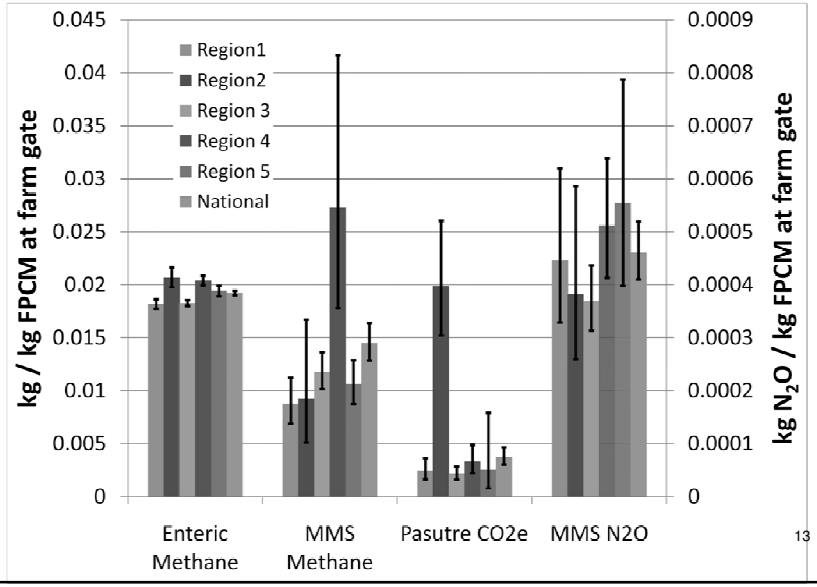

National Average Annual Ration
Dry Matter Intake Basis
Relative contribution to national average ration
25%
20%
15%
10%
5%
0%
Inventories generated for 6 animal classes in each region for both grazing and non-grazing seasons
corn silage
alfalfa hay
alfalfa silage
corn
distiller's grain (d)
corn, high moist
protein mix
supplement
grain mix
cottonseed
corn gluten feed (d)
soybean meal
canola meal
wheat straw
partial mixed ration
pasture
wheat silage
barley
grass hay
almond hulls
sorghum silage
distiller's grain (w)
oat silage
molasses
oat hay
cotton gin trash
soy hulls
citrus pulp
soybean, roasted
hominy
beet pulp
sorghum grain
whey
corn gluten feed(w)
misc


gal (or ccf) / kg FPCM at farm gate
kWh electricity / kg FPCM at farm gate
0.002
0.0015
0.001
0.0005
0
0.12
0.1
0.08
0.06
0.04
0.02
0
Region1
Region2
Region 3
Region 4
Region 5
National
Diesel
Gasoline
Propane
Natural Gas
Biodiesel
Fuel Oil
Electricity

Enteric and Manure Emissions



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GHG Emission Results

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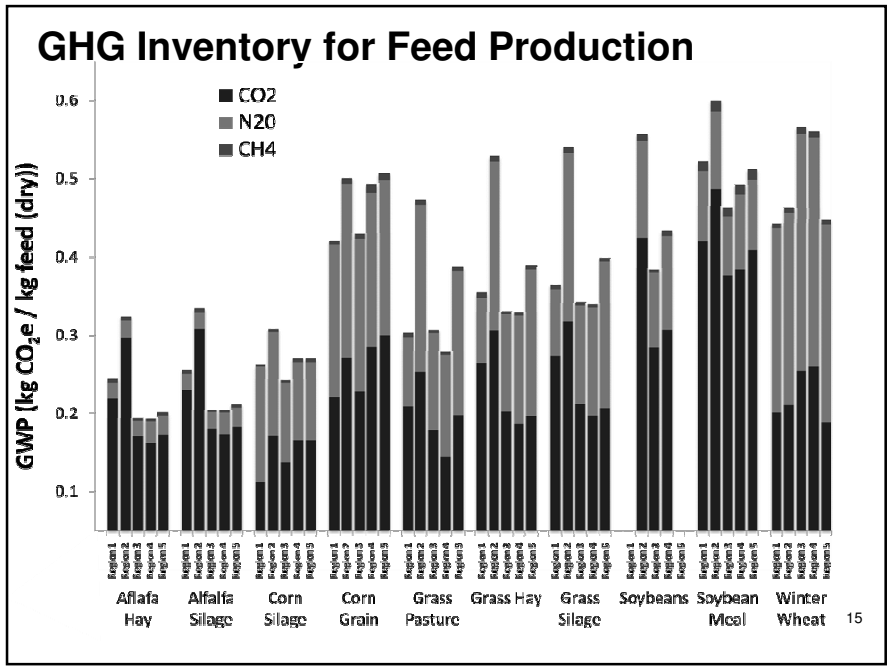
GHG Inventory for Feed Production
CO2
N20
CH4
GWP [kg CO2e / kg feed (dry)]
0.6
0.5
0.4
0.3
0.2
0.1
Aflafa Hay
Alfalfa Silage
Corn Silage
Corn Grain
Grass Pasture
Grass Hay
Grass Silage
Soybeans
Soybean Meal
Winter Wheat
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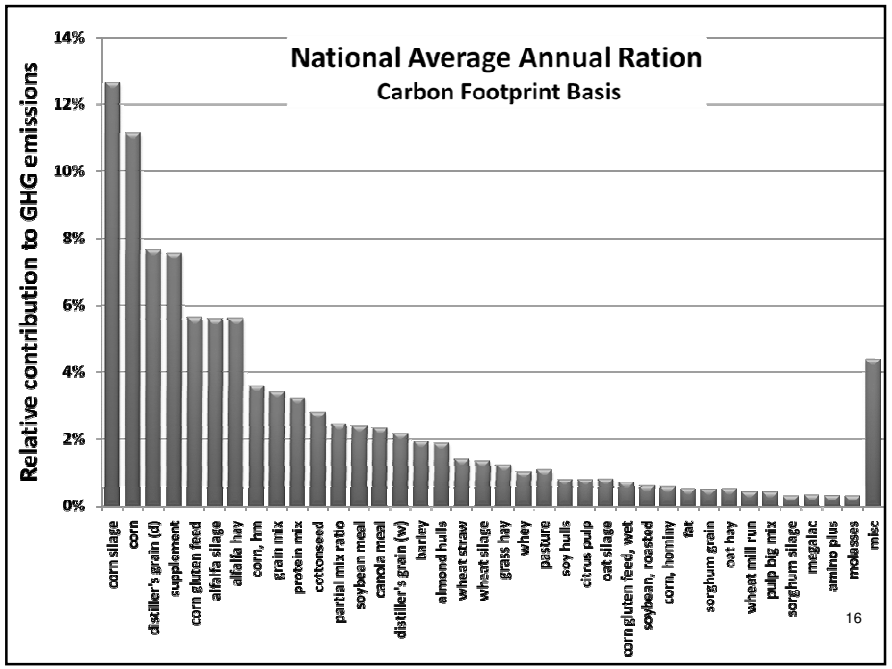
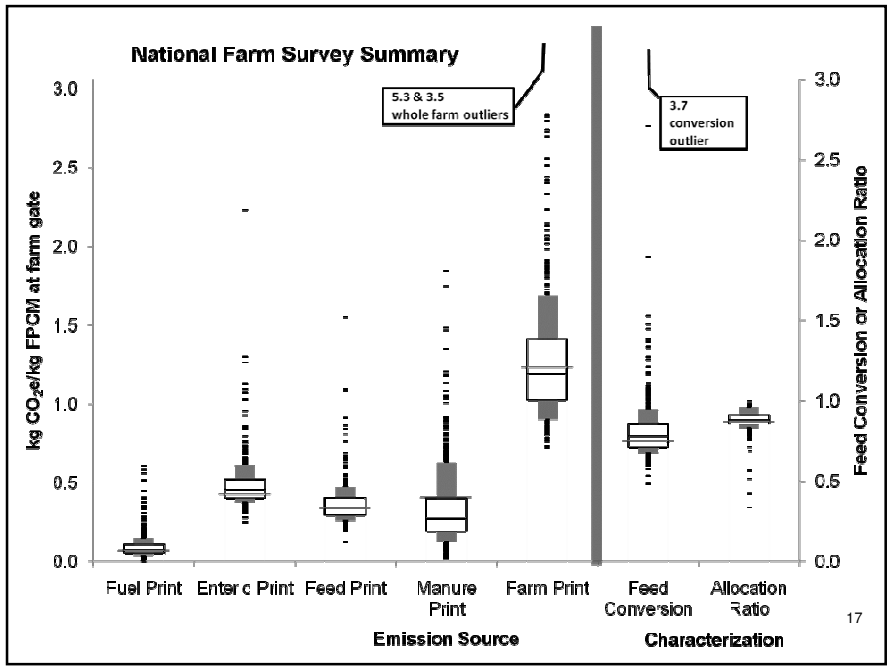

National Average Annual Ration
Carbon Footprint Basis
Relative contribution to GHG emissions
14%
12%
10%
8%
6%
4%
2%
0%
corn silage
corn
distiller's grain (d)
supplement
corn gluten feed
alfalfa silage
alfalfa hay
corn, hm
grain mix
protein mix
cottonseed
partial mix ratio
soybean meal
canola meal
distiller's grain (w)
barley
almond hulls
wheat straw
wheat silage
grass hay
whey
pasture
soy hulls
citrus pulp
oat silage
corn gluten feed, wet
soybean, roasted
corn, hominy
fat
sorghum grain
oat hay
wheat mill run
pulp big mix
sorghum silage
megalac
amino plus
molasses
misc
16


National Farm Survey Summary
5.3 & 3.5 whole farm outliers
3.7 conversion outlier
kg CO_2e/kg FPCM at farm gate
Feed Conversion or Allocation Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fuel Print
Enteric Print
Feed Print
Manure Print
Farm Print
Feed Conversion
Allocation Ratio
Emission Source
Characterization
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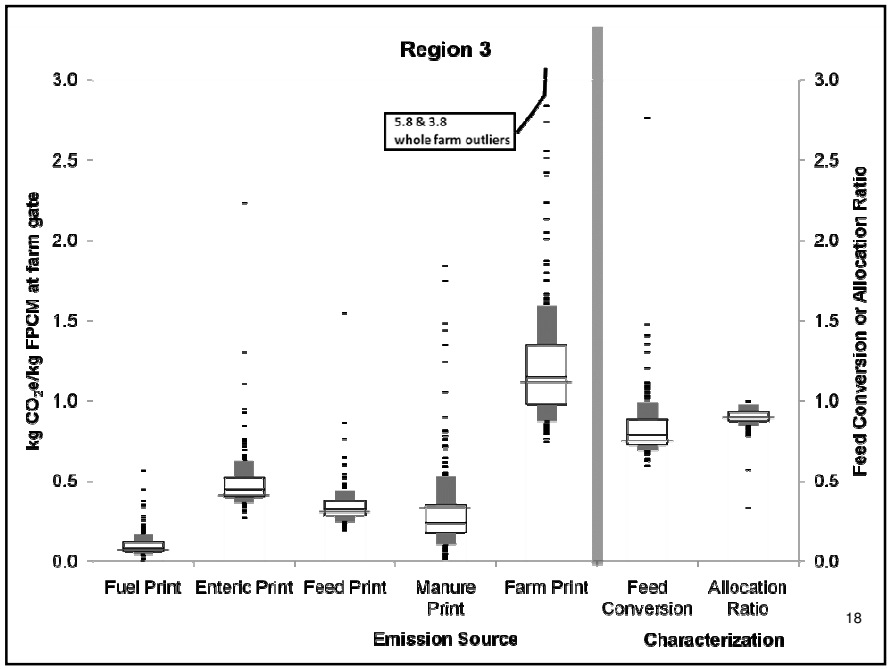
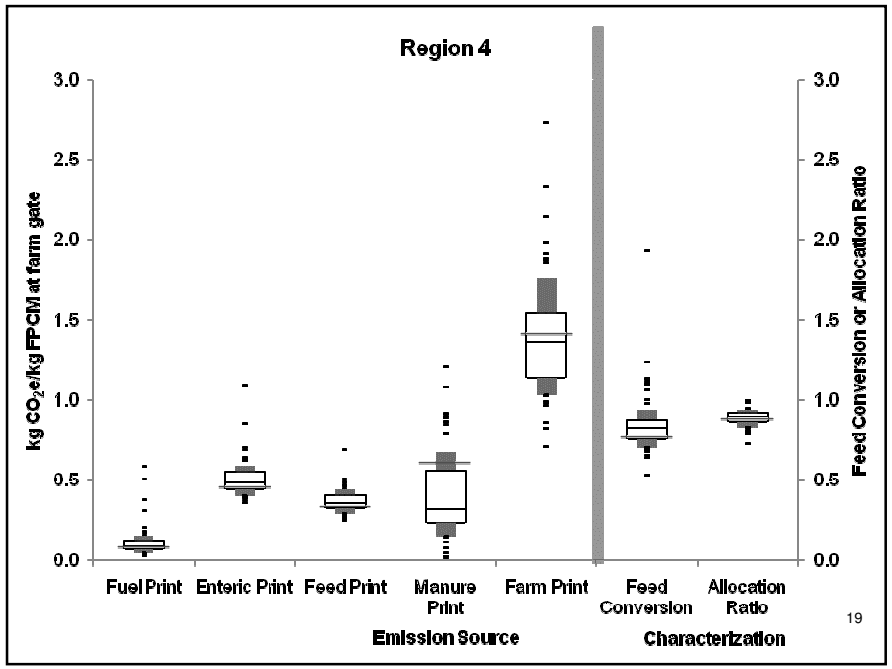

Region 3
5.8 & 3.8 whole farm outliers
kg CO_2e/kg FPCM at farm gate
Feed Conversion or Allocation Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fuel Print
Enteric Print
Feed Print
Manure Print
Farm Print
Feed Conversion
Allocation Ratio
Emission Source
Characterization
18


Region 4
kg CO_2e/kg FPCM at farm gate
Feed Conversion or Allocation Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fuel Print
Enteric Print
Feed Print
Manure Print
Farm Print
Feed Conversion
Allocation Ratio
Emission Source
Characterization
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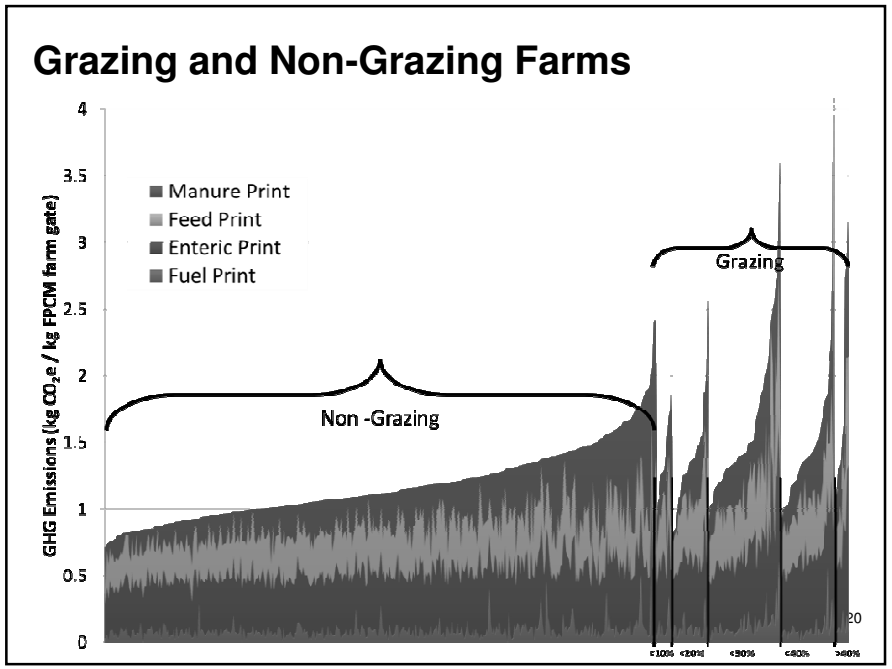
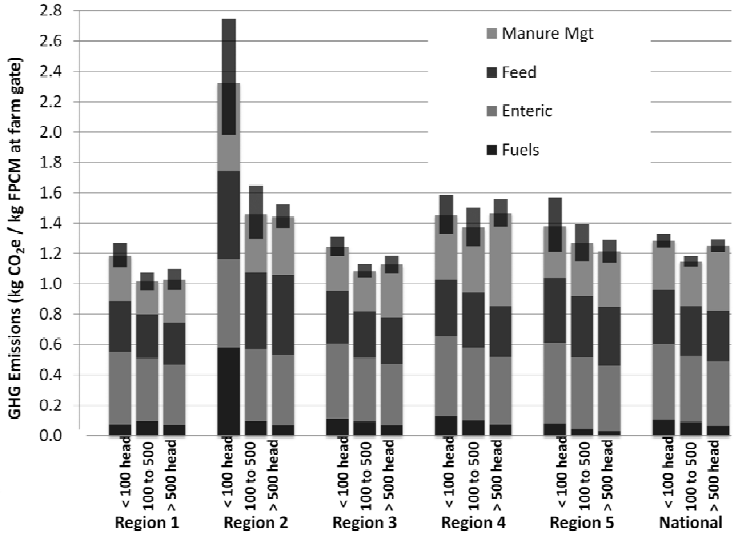

Grazing and Non-Grazing Farms
GHG Emissions (kg CO_2e / kg FPCM farm gate)
Manure Print
Feed Print
Enteric Print
Fuel Print
Non -Grazing
Grazing
4
3.5
3
2.5
2
1.5
1
0.5
0
20

GHG Emissions by Region and Farm Size



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Opportunities

- Feed conversion efficiency
  - Only 55% indicated production enhancement technologies
- Feed production
  - Precision agriculture (crop and dairy farm)
- Energy consumption
  - Relatively small contributor, but should not be overlooked
- Improved manure /nutrient management
  - Potential reduction is significant

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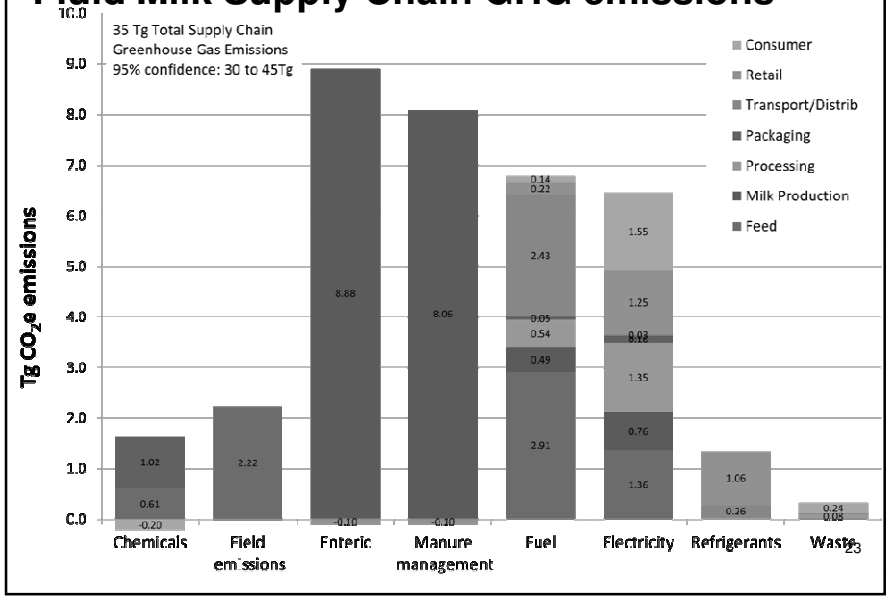
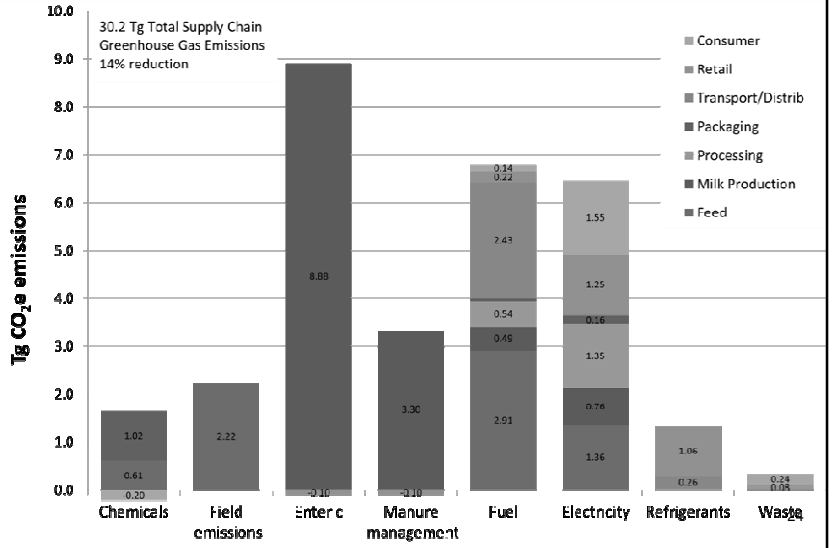
Fluid Milk Supply Chain GHG emissions



Manure management profile of 50 lowest CF farms



Overall Takeaways for the Dairy Industry

- **Operations with smaller carbon footprint have generally adopted better management practices and have higher feed conversion**
- **Do more with less**
  - **Improving efficiency**
  - **Innovation – manure and nutrient management**
  - **Technology transfer**
- **A 'one size fits all' solution does not exist**
  - **Improvement opportunities exist across the spectrum**

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Questions

This project was funded by:

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