



Mitigation of greenhouse gas emissions from dairy facilities using anaerobic digestion technology

Jennifer Pronto: Cornell
University

November 6, 2013

PRO-DAIRY



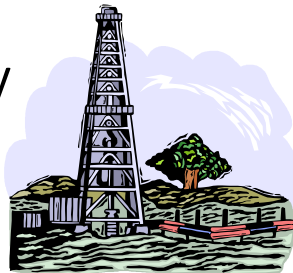
Cornell University

What is 'mitigation'?

Practices that reduce the net amount of heat trapping gases released into the atmosphere



- Fewer air miles
- Better fuel efficiency



- Cleaner burning fuels
- Energy conservation



- Carbon capture
- Production efficiency



- Carbon sequestration
- Fertilizer efficiency

Dairy Operations – Production efficiency



Increase production efficiency

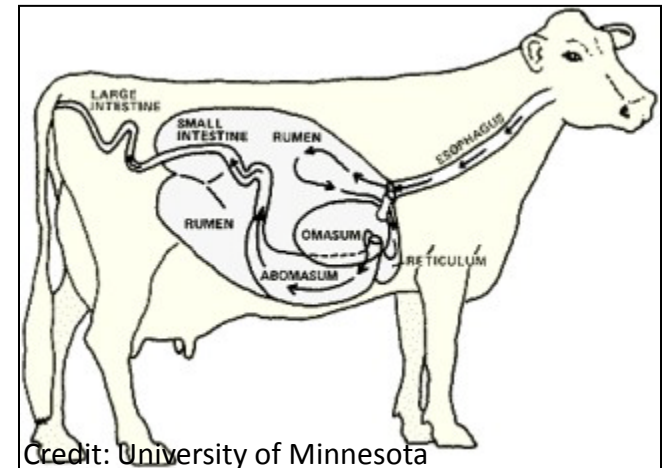
- Genetic selection
- Earlier calving
- Dietary change
- Better herd health
- Reduce cow stress

Agriculture and GHG emissions

Carbon Dioxide (CO₂)

Methane (CH₄)

Nitrous Oxide (N₂O)



PRO-DAIRY

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**



Methane Emissions

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



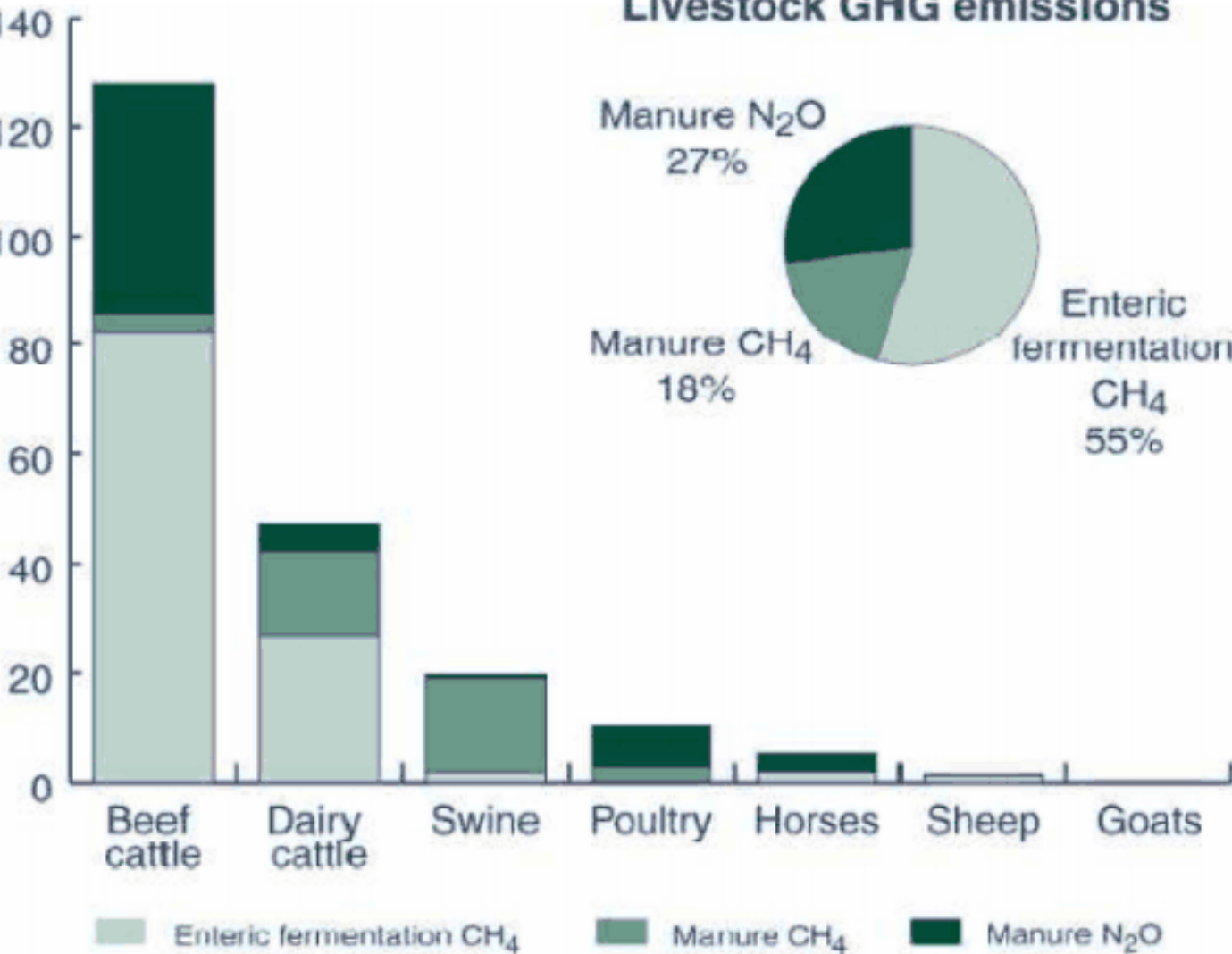
Nitrous Oxide Emissions

- **Nitrification/denitrification processes in cropland**
- **Manure storage surface**
- **Manure in bedded pack or dry lot**
- **[Enteric]**

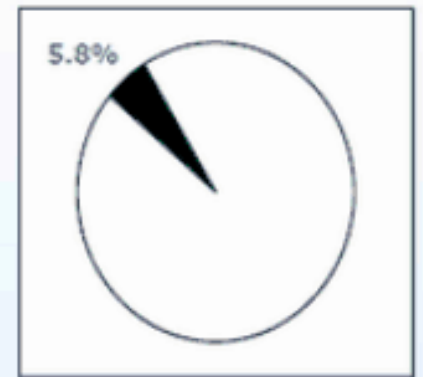


Tg CO₂ eq.

Livestock GHG emissions



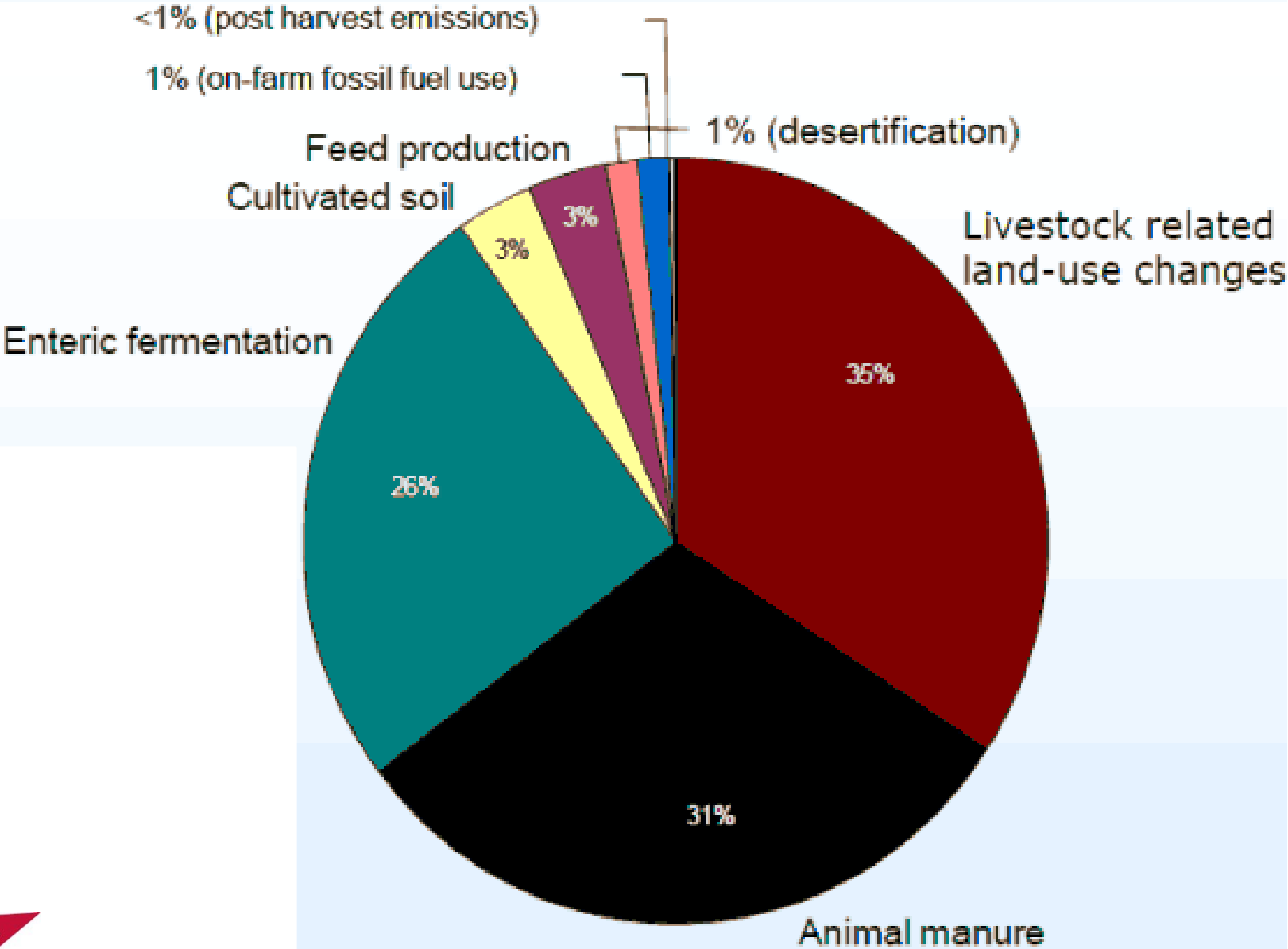
USDA, 2004



Agriculture as portion of emissions
414 Tg CO₂-eq yr⁻¹



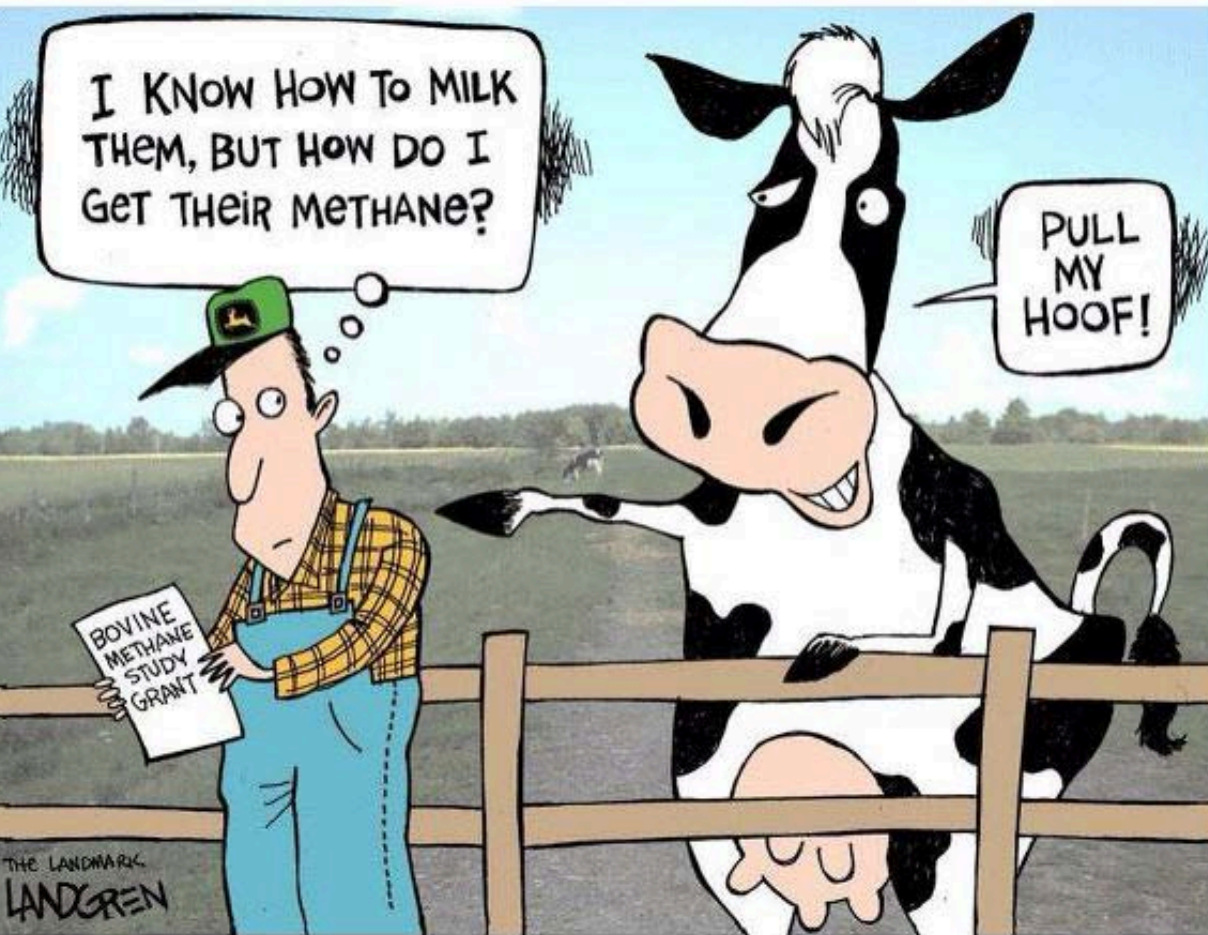
Sources of Livestock GHG emissions



PRO-DAIRY

FAO, 2006

Animal Agriculture primary mitigation opportunities



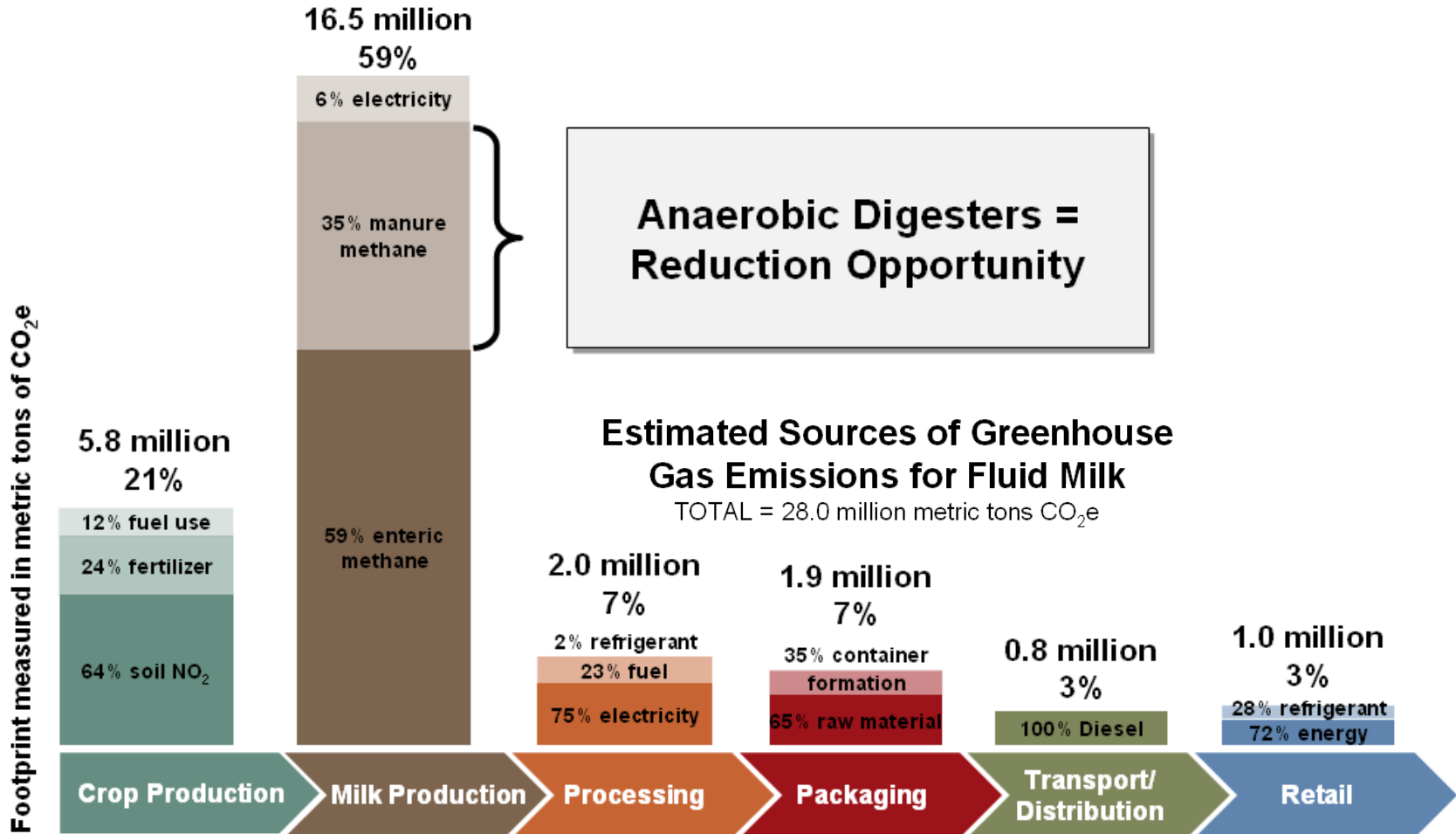
- Production efficiency
- Soil carbon
- Energy efficiency
- Manure management

How to Reduce the Carbon Footprint of our Farms

- Increase production per animal
- Feed more grain/less forage
- Use higher quality forage
- Eliminate manure storage
- Cover manure storage and flare gas
- Use digester to create biogas / electricity
- Improve carbon sequestration (short term)



Estimated Sources of Greenhouse Gas Emissions for Fluid Milk



REDUCTION OPPORTUNITIES

Conservation tillage
Fertilizer use
Pastured dairy
Manure nutrients

Enteric reduction
Methane capture
Renewable energy generation
Energy efficiency

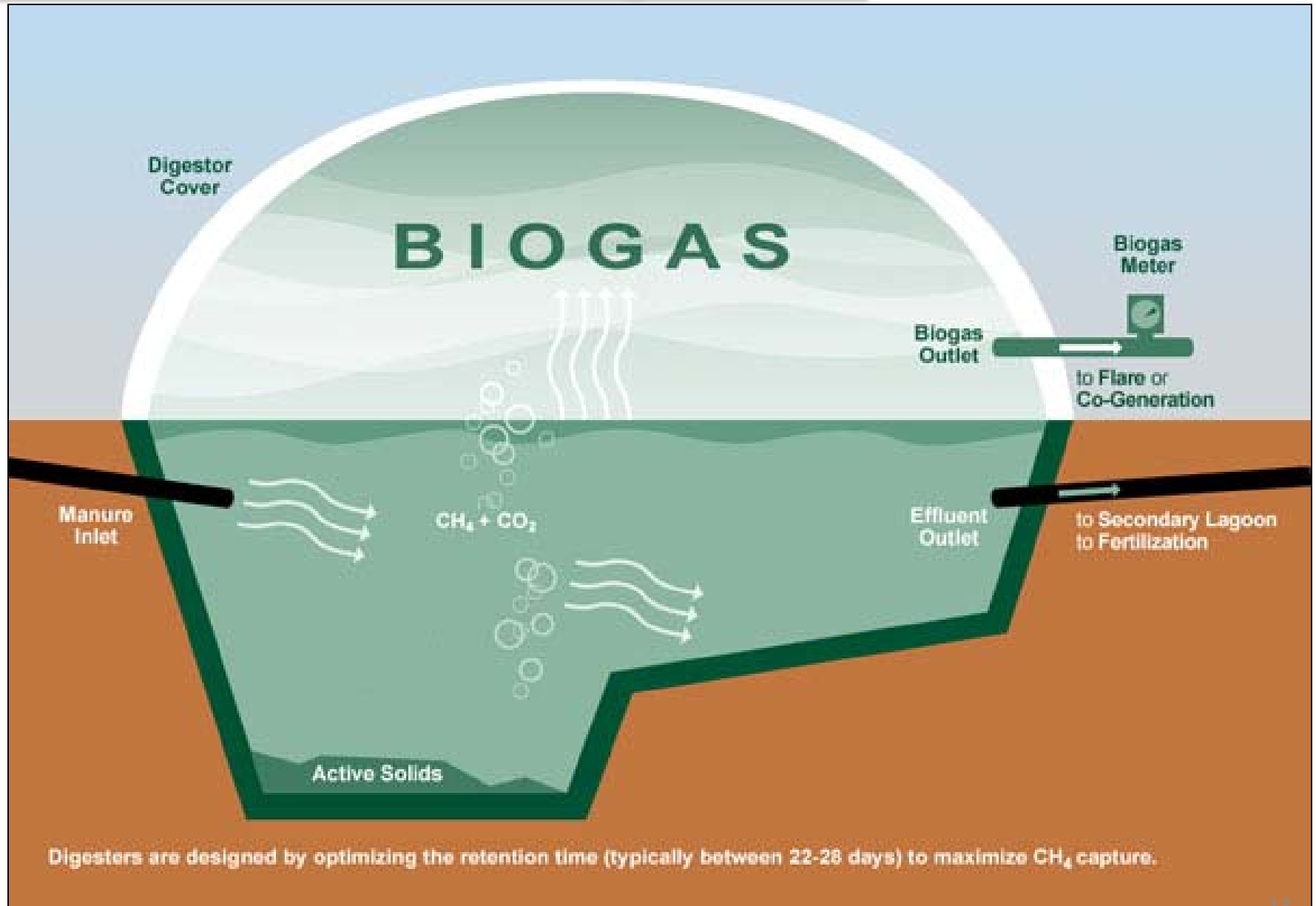
Energy efficiency
Process innovation
Cogeneration
Renewable energy

Energy efficiency
Materials reduction
Renewable/recycled materials

Truck efficiency
Route efficiency
Driver training

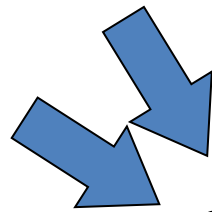
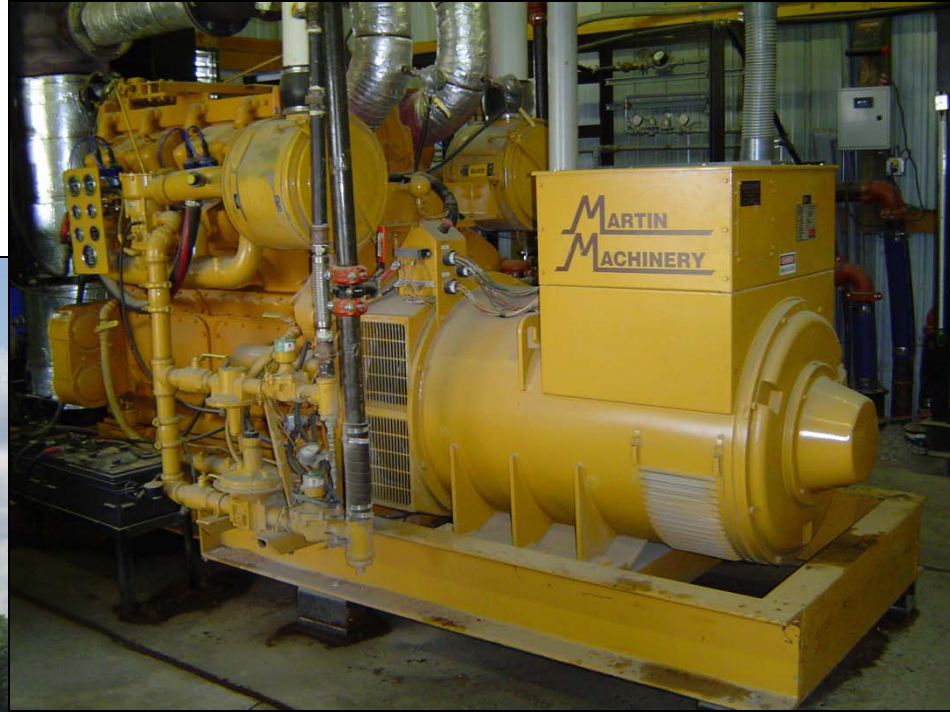
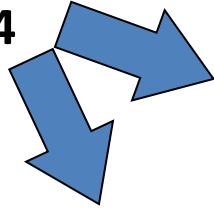
In-store energy efficiency (refrigeration and lighting)

What is anaerobic digestion?



Dairy and GHG emissions

CH₄



CO₂

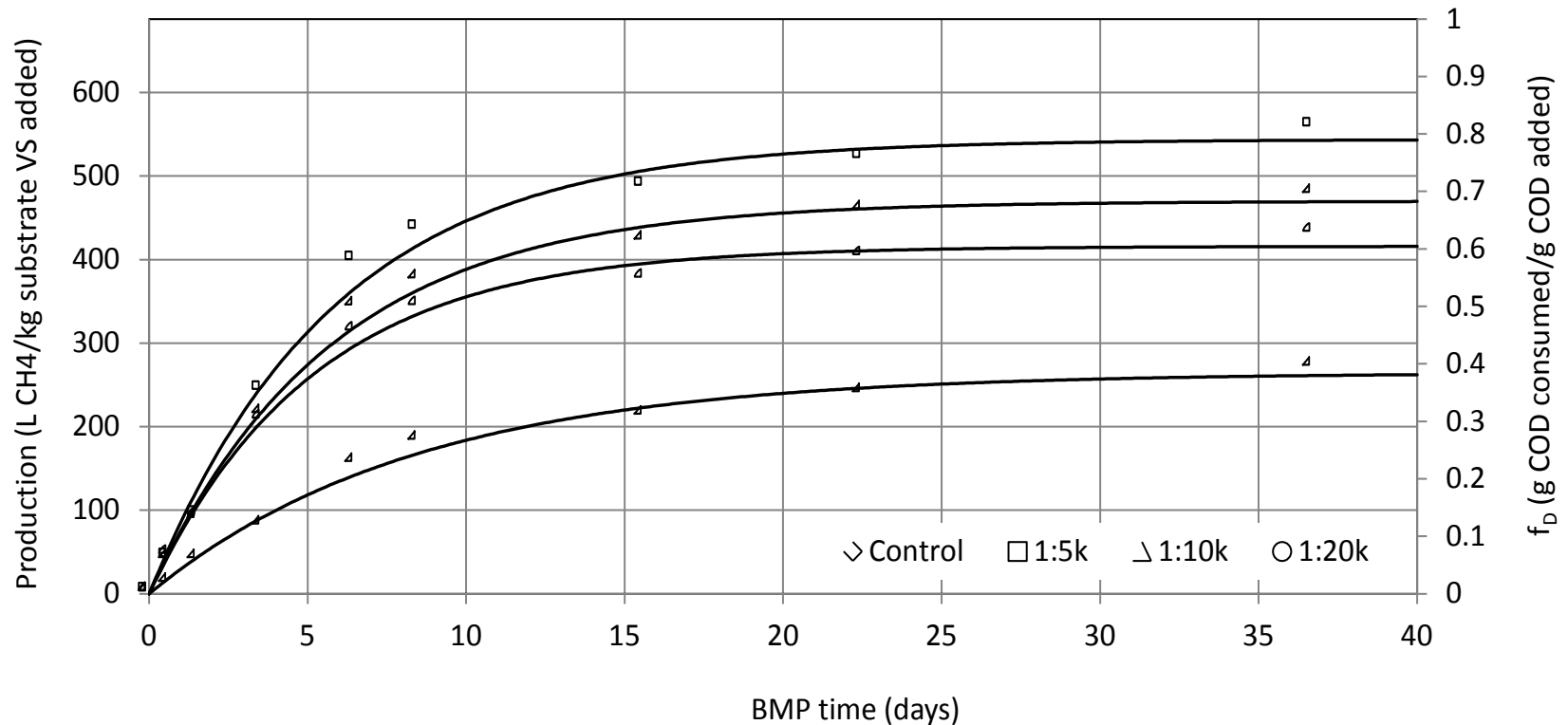
What is the effect of an AD system on CH₄ and CO₂ emissions?



Enhanced biogas production using specialized microbial cultures

Preliminary tests with swine manure:

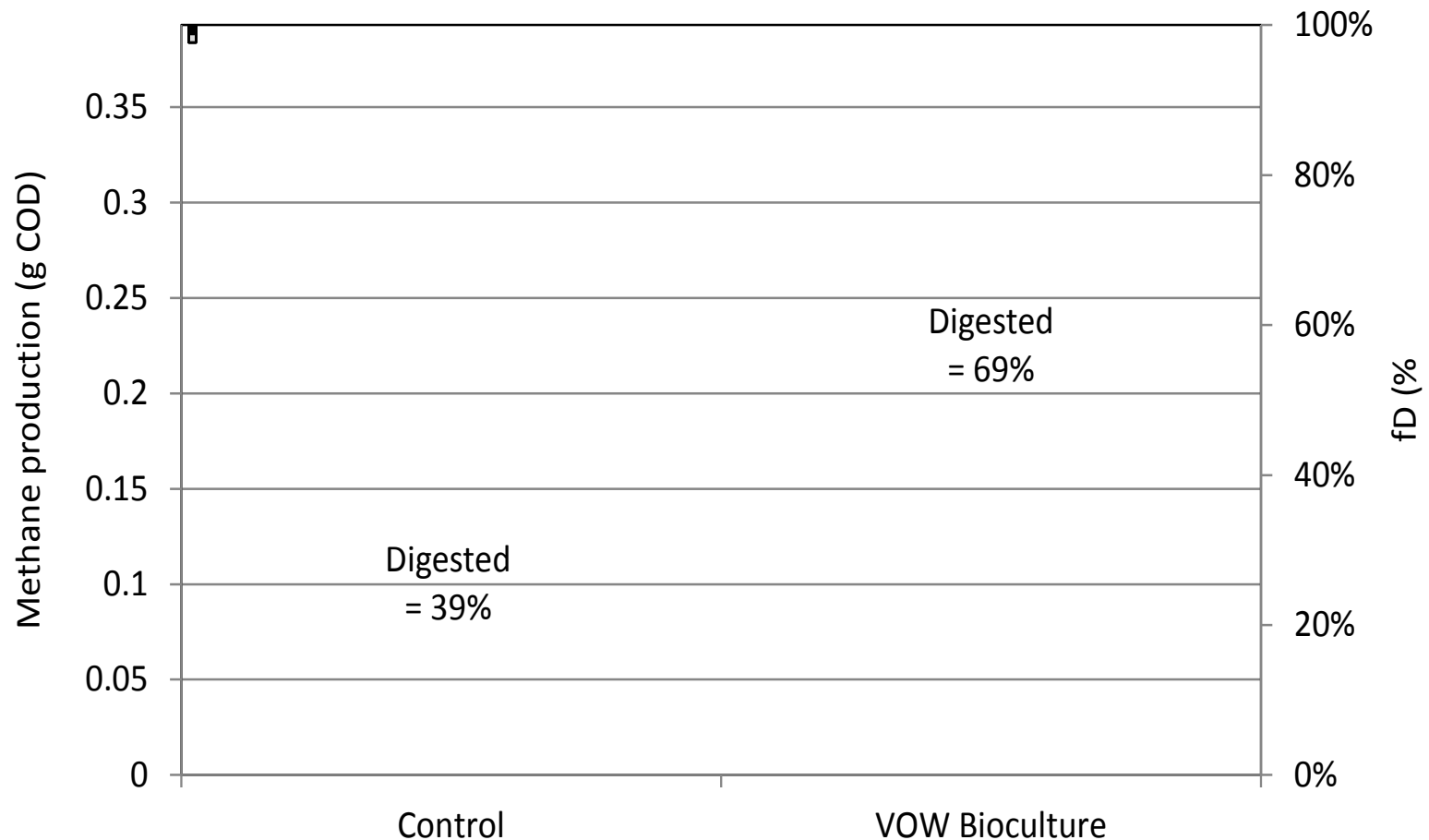
- Bioculture added to influent **24-h prior anaerobic digestion**
- **Increased biogas production** compared to the manure-only controls
- Only **traces amounts of bioculture** required

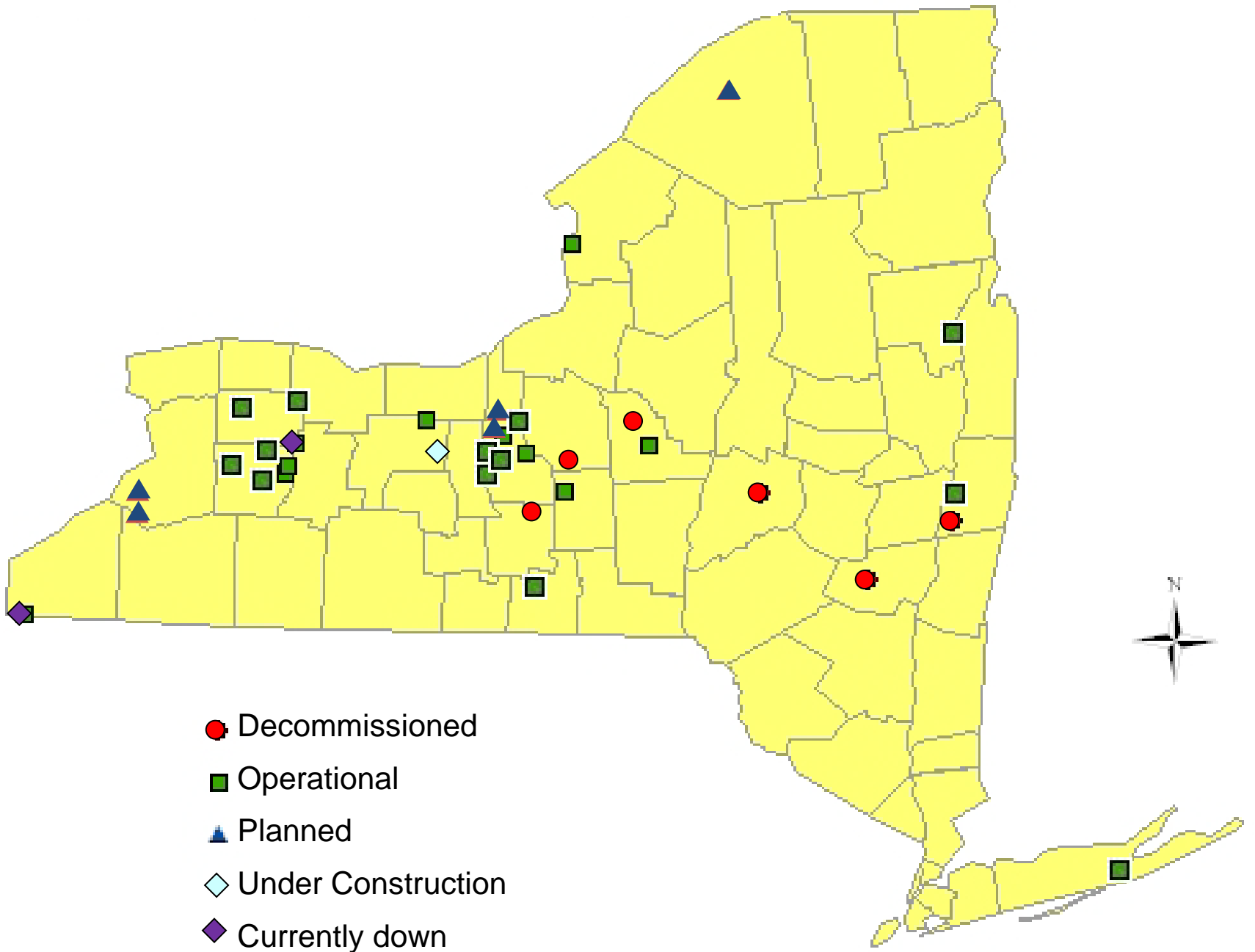




Enhanced biogas production using specialized microbial cultures

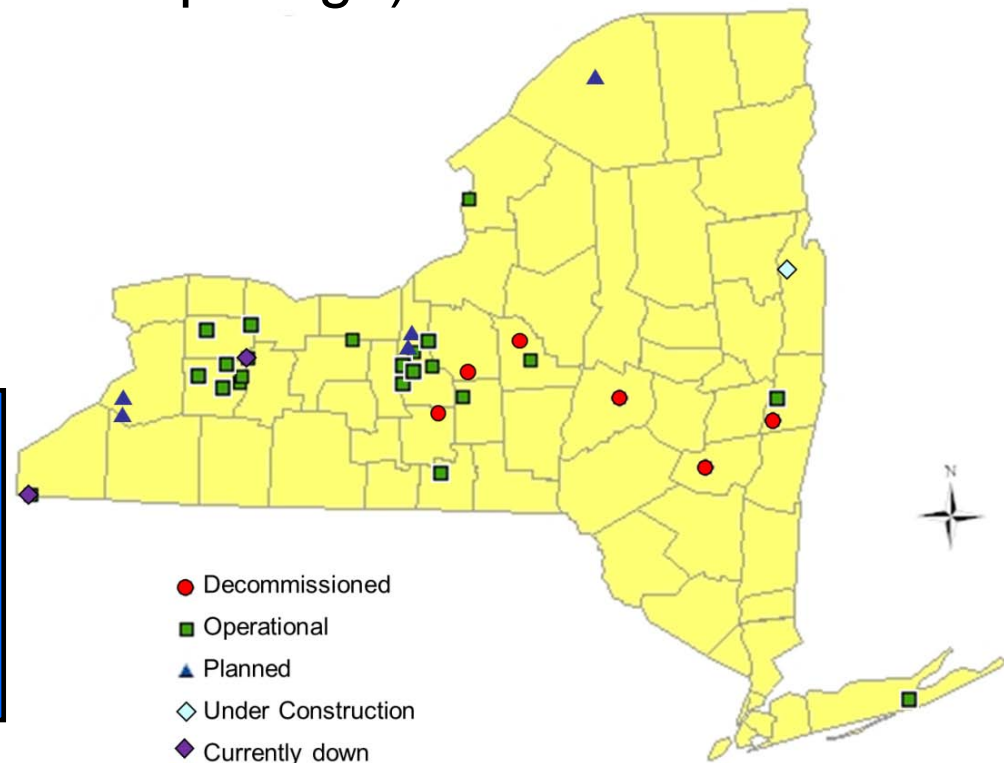
- ✓ Rate of biogas production doubled that of the Controls.
- ✓ Extent of biomethane production 76% higher than the Control
- ✓ 69% of manure was digested in bioculture-inoculated samples (compared to 39%)





On-Farm Anaerobic Digestion in New York State – Current Status

Operating and generating power: 17
Operating and not generating power: 2
Currently down for service: 2
Under construction: 3 (two in start up stage)
Planning/signed RPS: 15
Decommissioned: 5



Of the operating systems:

- 15 Eng-gen sets (5,395-kW)
- 0 Microturbines
- > 8 H₂S Scrubbing Systems









DANGER!
RADIATION
Hazardous materials
Keep away







	No. of cars removed per year	Cars removed/LCE
New Hope View Farm	438	0.46
Patterson Farms	514	0.24
Sunny Knoll	698	0.46
Emerling Farms	354	0.44
Ridgeline Dairy	214	0.25
AA Dairy	266	0.45
Noblehurst Farms	650	0.40
<i>Average</i>		<i>0.4</i>

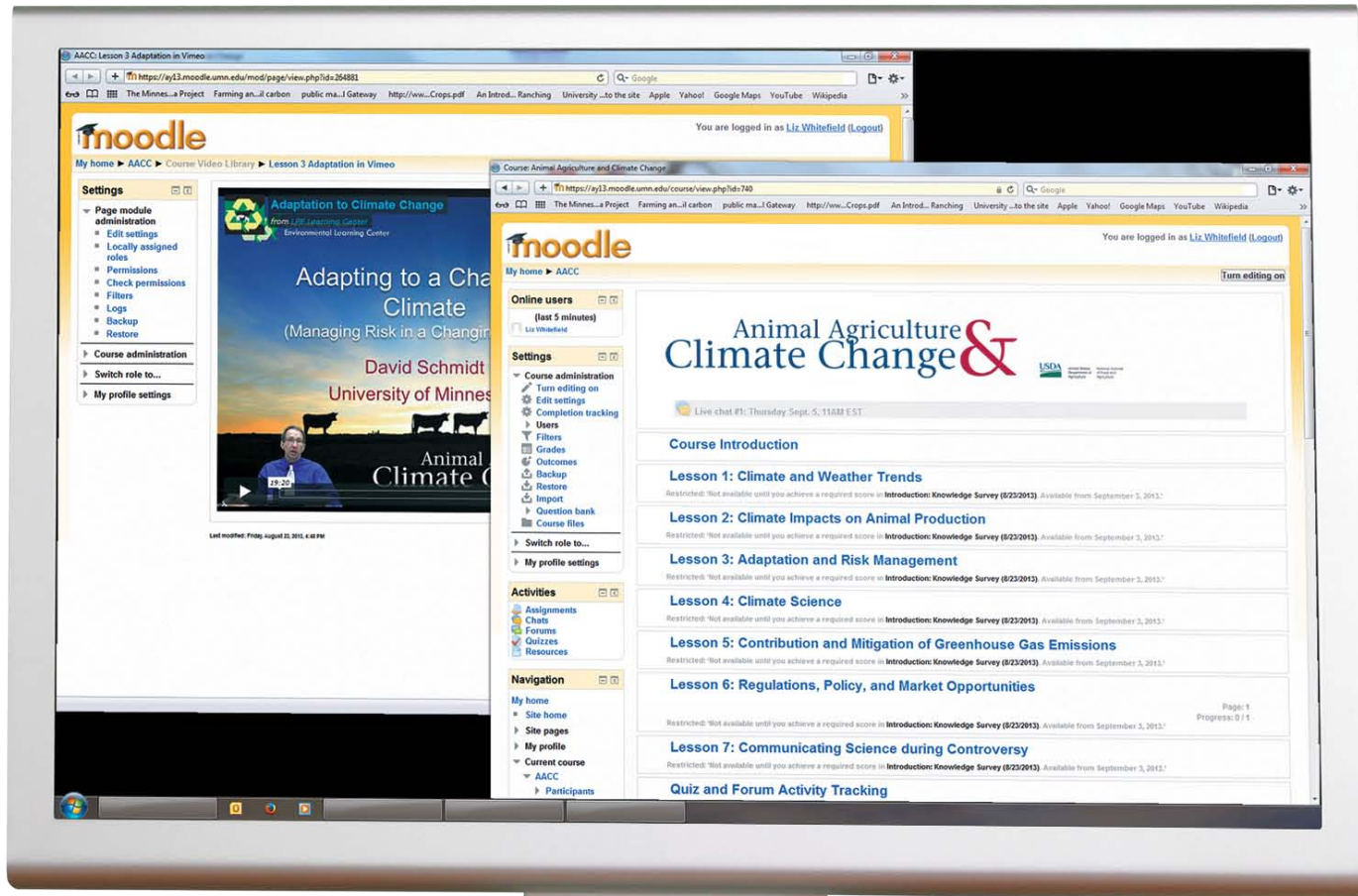
Total cars removed from the road in one year, averaged over 7 NYS dairy farms with on-farm anaerobic digester systems =

3,135

Potential number of cars removed per year from the 17 dairy farms in NYS with on-farm anaerobic digester systems =

10,862

Animal Agriculture Climate Change Online course



AACC Online course

The lesson titles are as follows:

1. The Climate is Always Changing: Global National, and Regional Trends
2. Climate Impacts on Animal Production
3. Adaptation and Risk Management
4. Climate Change Science
5. Contribution and Mitigation of Greenhouse Gas Emissions
6. Regulations, Policy and Market Opportunities
7. Communicating Science During Controversy

Types of Climate



West Virginia



Florida

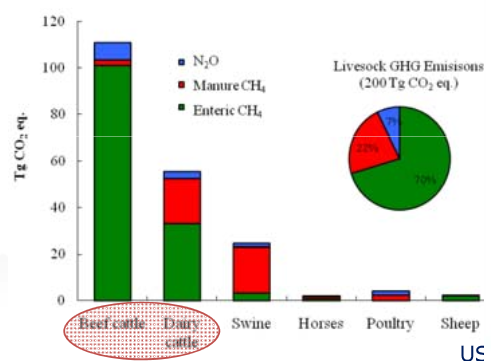


Colorado



Washington

Animal Agriculture GHG Emis



Terms that have different meanings for scientists and the public

Scientific term	Public meaning	Better choice
enhance	improve	intensify, increase
aerosol	spray can	tiny atmospheric particle
positive trend	good trend	upward trend
positive feedback	good response, praise	vicious cycle, self-reinforcing cycle
theory	hunch, speculation	scientific understanding
uncertainty	ignorance	range
error	mistake, wrong, incorrect	difference from exact true number
bias	distortion, political motive	offset from an observation
sign	indication, astrological sign	plus or minus sign
values	ethics, monetary value	numbers, quantity
manipulation	illicit tampering	scientific data processing
scheme	devious plot	systematic plan
anomaly	abnormal occurrence	change from long-term average



 Cornell University


The University of Georgia


UNIVERSITY OF MINNESOTA

UNIVERSITY OF
Nebraska
Lincoln

TEXAS A&M
AGRILIFE
EXTENSION

WASHINGTON STATE
 UNIVERSITY

For more information on the course, and to register:

www.animalagclimatechange.org



Livestock and Poultry
Environmental Learning Center



United States
Department of
Agriculture

Animal Agriculture Climate Change &

This project was supported by Agricultural and Food Research Initiative Competitive Grant No. 2011-67003-30206 from the USDA National Institute of Food and Agriculture.

Thank you

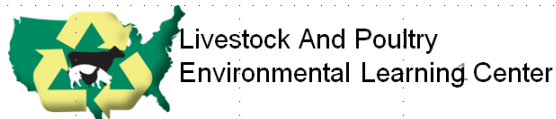
Jenny Pronto: jlp67@cornell.edu

Curt Gooch: cag26@cornell.edu

www.manuremanagement.cornell.edu



- Some content was taken from the USDA funded LPELC Animal Ag and Climate Change online course module on mitigation www.animalagclimatechange.org



Animal Agriculture Climate Change &