Reducing Greenhouse Gases Can also Reduce Feed Costs

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Thanks!

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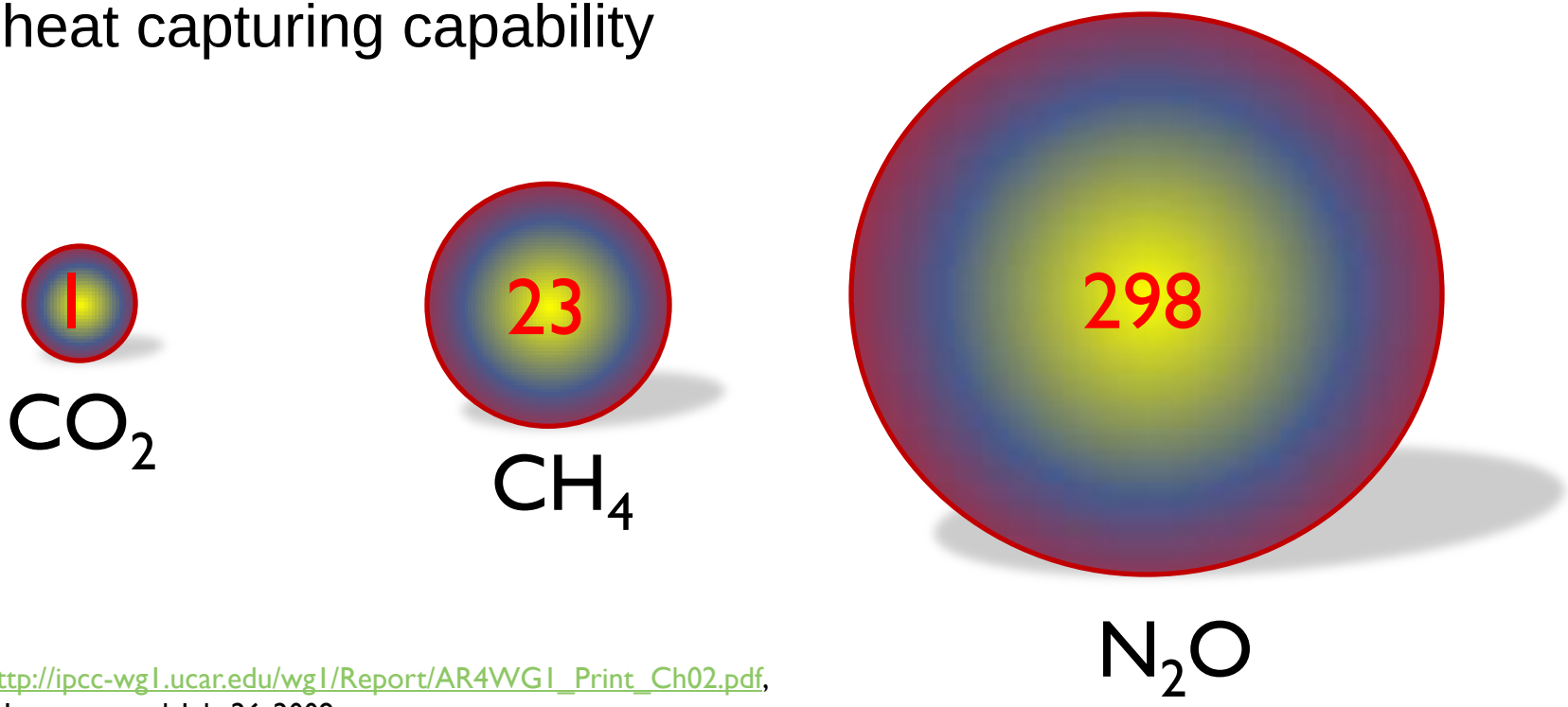
- Jude Capper – Washington State
- Innovation Center for U.S. Dairy

What is Carbon Footprint?

Total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization or state in a given time

- Measured in CO_2-equivalent in terms of environmental heat capturing capability

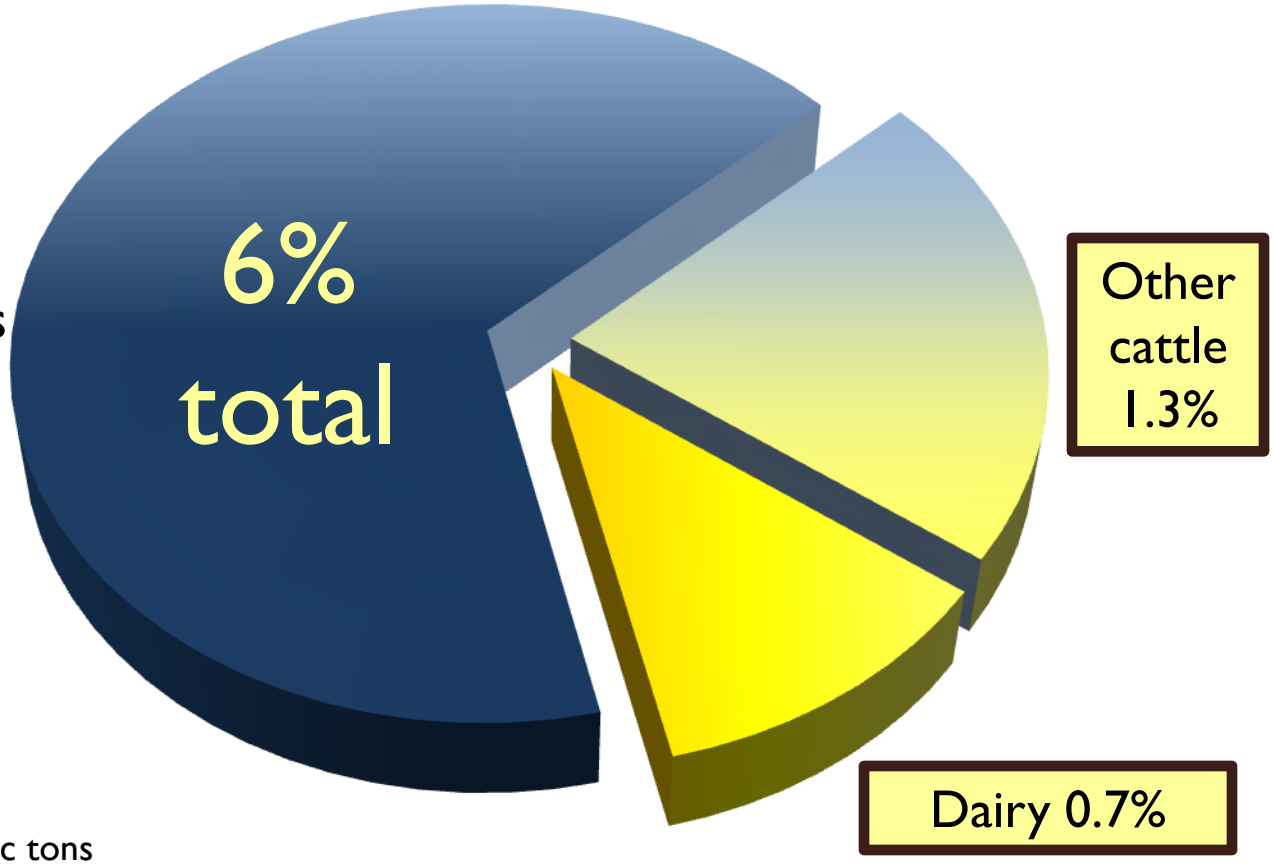


Source: http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch02.pdf, Last accessed, July 26, 2009

Agriculture Contributes <6% to the Total US Carbon Footprint – Animal Ag <3%

Total U.S. Agricultural Annual Greenhouse Gas Output:

- 454.1 Teragrams
- 6% of total US GHG



Note: 1 Teragram = 1 million metric tons

EPA (2008) Inventory of U.S. Greenhouse Gas Emissions and Sinks

Dairy Industry Carbon Footprint Study - 2010

- Commissioned by the Innovation Center for U.S. Dairy.
- Done at the Applied Sustainability Center at the University of Arkansas.
- Focused on the entire chain of milk production from crops, milk production, processing, packing and distribution.
- Random sample of 500 dairies, 50 processors and some trucking companies.

Dairy Industry Carbon Footprint Study - 2010

- Key results:

  - Total dairy GHG emissions are about 2% of the total U.S. emissions.

  - GHG emissions per gallon of milk = 17.6 lb CO_2e per gallon of milk consumed

Why is This Important?

- In 2009, the Innovation Center for U.S. Dairy stated a goal to lower GHG emissions for fluid milk by 25% by the year 2020.
- The current LCA analysis results provide the benchmark for the current baseline GHG emissions.

Executive Summary Comment

- "The single most important factor in explaining differences across all farms is feed conversion efficiency"

- "More efficient feed conversion results in a lower footprint"


AAHHHHH!

Nitrous Oxide

- Majority of N_2O emitted on dairy farms is from manure and soil.
- N_2O emitted directly by cows is small.
- 2010 paper from Japan = 5.2 mg N_2O/cow/day (range = 2 to 9.9 mg)
- California work reported a N_2O emission rate of 0.02 g/cow/hour (0.48 g/day)

Nitrous Oxide

- USDA whole farm simulation for a 100-cow herd, FS barn, slurry, spread 2x
- Yearly total was 1498 lbs. of N_2O
- 1067 lbs. = crops 433 lbs. = manure
- Total could be reduced to 926 lbs./year (38%) by improving N fertility program and using a cover crop on the corn land.

(Chianese and Rotz, 2009)

Carbon Dioxide

- Agriculture is not identified as a major source of CO_2 emissions by EPA in their 2010 report.
- CO_2 emissions do occur on farms due mainly to animal respiration and decomposition of soil organic matter.
- Animal respiration is about 90% of total CO_2 emissions on dairy farms.

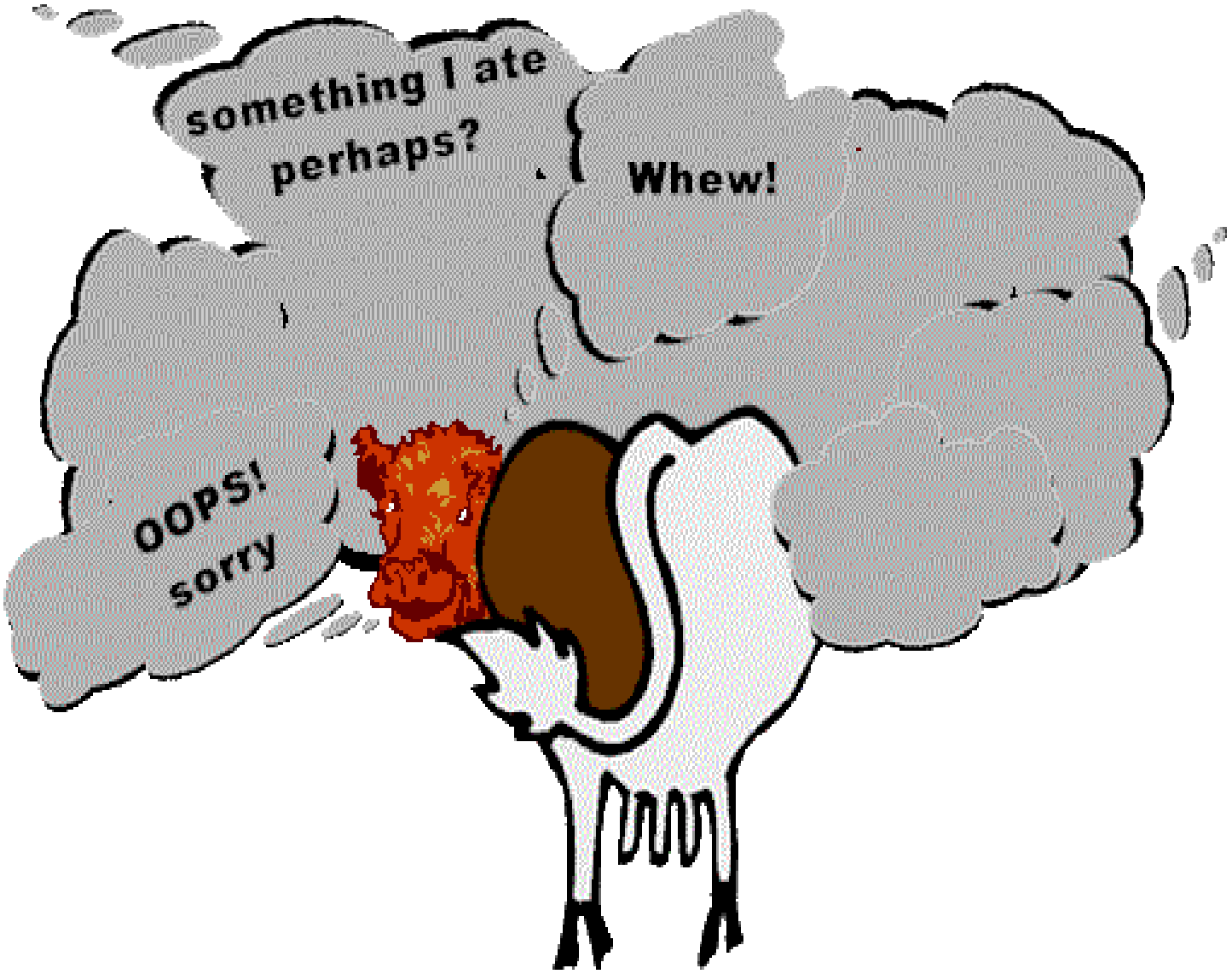
CO_2 Emissions, liters/cow/day

- Kinsman et. al., 1995
  - Cows producing 63 lbs. milk
  - 6,137 liters/day (5,042 – 7.247)
- Casper and Mertens, 2010
  - UDSA Energy Metabolism data
  - Milk = 11 to 125 lbs/cow/day
  - 5,309 liters/day (2.04 to 8.7)
  - 0.14 g/kg milk (0.06 to 0.54)
  - Lower per unit of milk in higher producing cows

CO_2 Emissions

- Daily CO_2 emissions increase with:
  - Higher dry matter intake
  - Higher milk production

- Daily CO_2 emissions/lb. of milk decrease in higher producing cows.


something I ate perhaps?
Whew!
OOPS! sorry

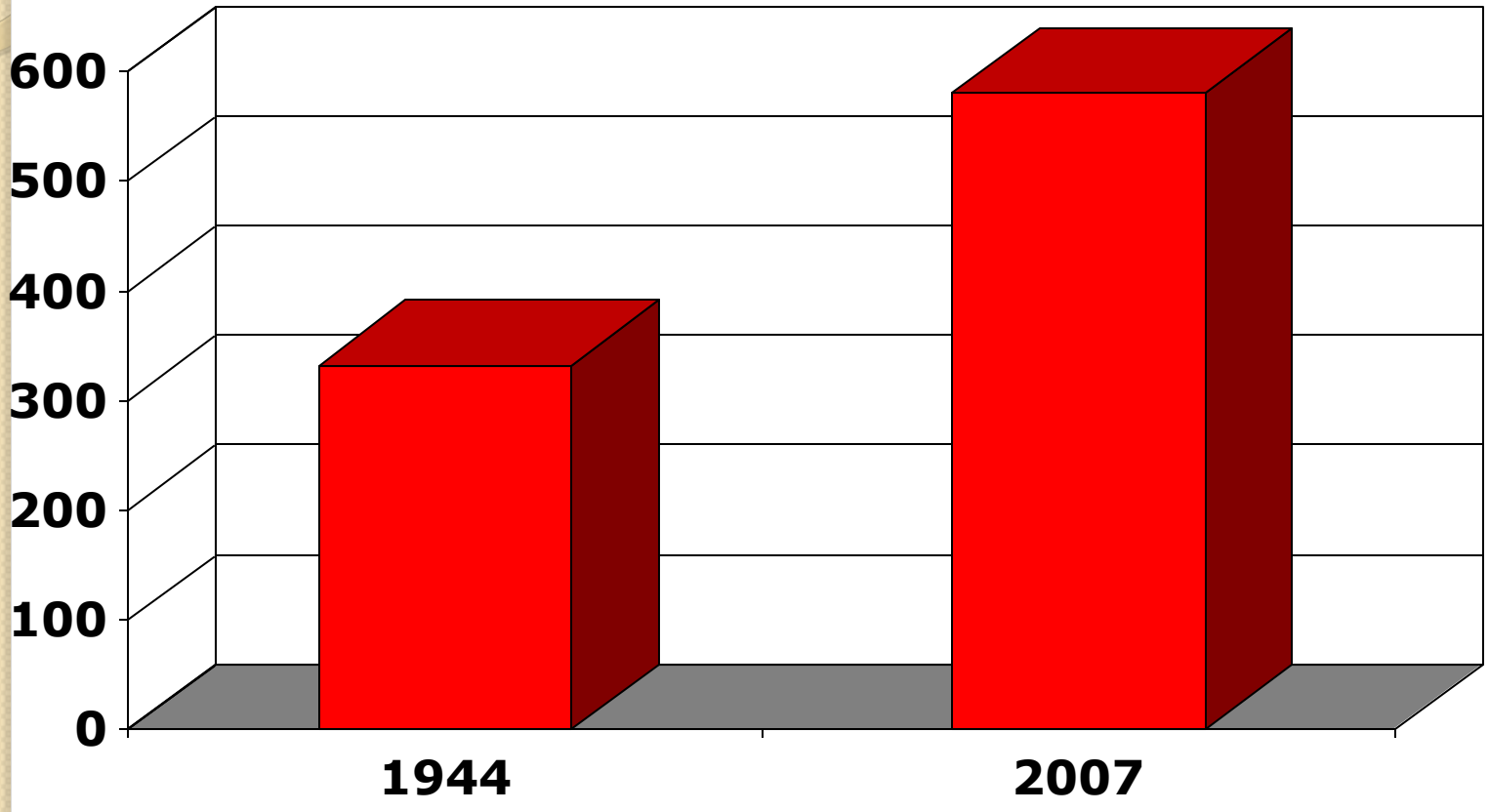
Methane Emissions on Dairy Farms

- Primary sources:
  - Enteric (about 75% of the total)
  - Manure
- 5.5% of gross energy intake using the USDA Energy Metabolism data (range was 2.5 to 7.8) for lactating cows.
- 7.9% for dry cows (3.47 to 10)
- What is the lower limit to maintain rumen function?

U.S. Dairy Cattle Statistics

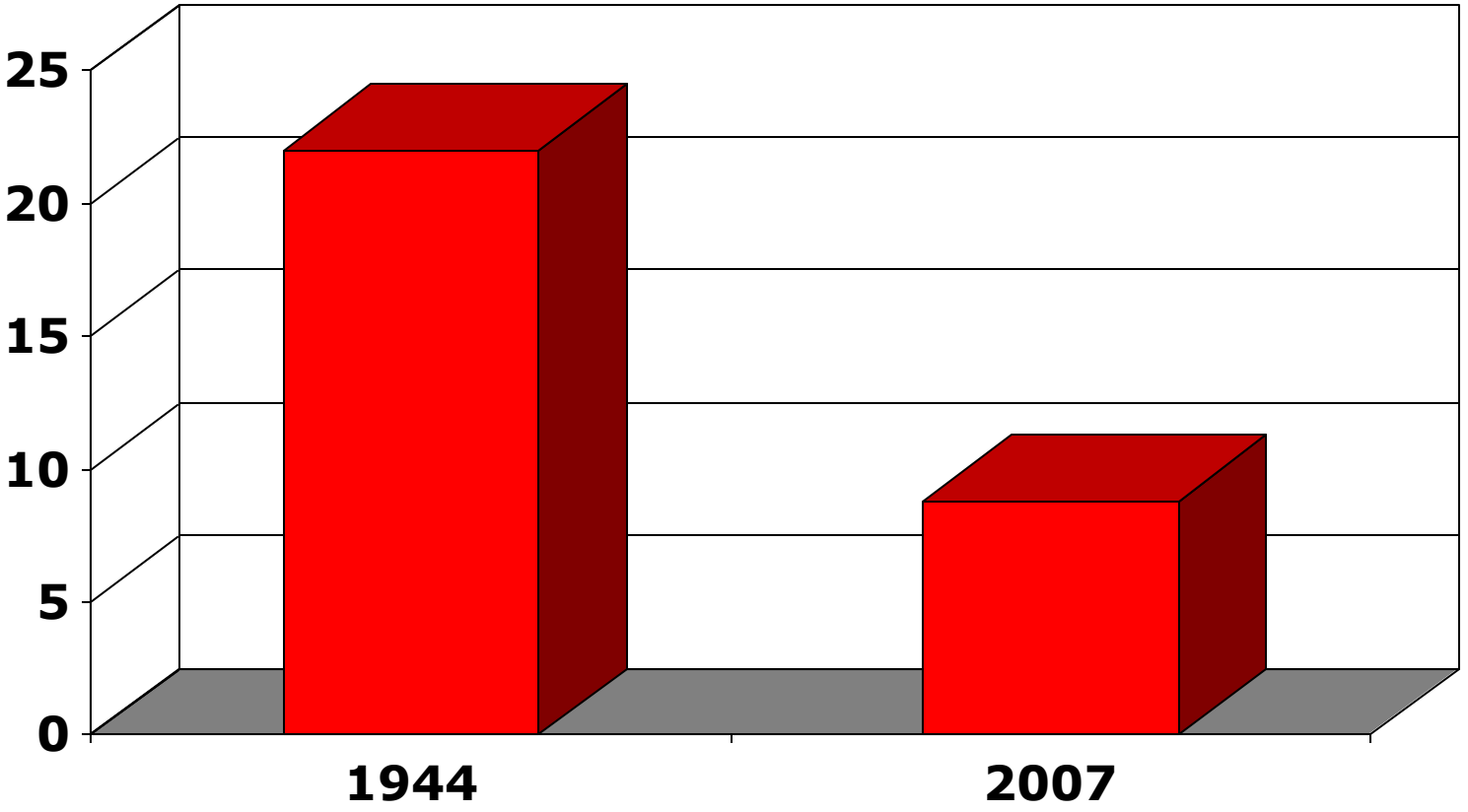
Item	1944	2007	2007, % of 1944
Cows, millions	25.6	9.1	35.5
Milk, lbs./yr./cow	4,572	20,267	443
Milk,lb/day	15	66	440
Total Milk, million lbs.	117,023	185,602	159

Methane Emissions from Dairy Cattle, l/cow/day



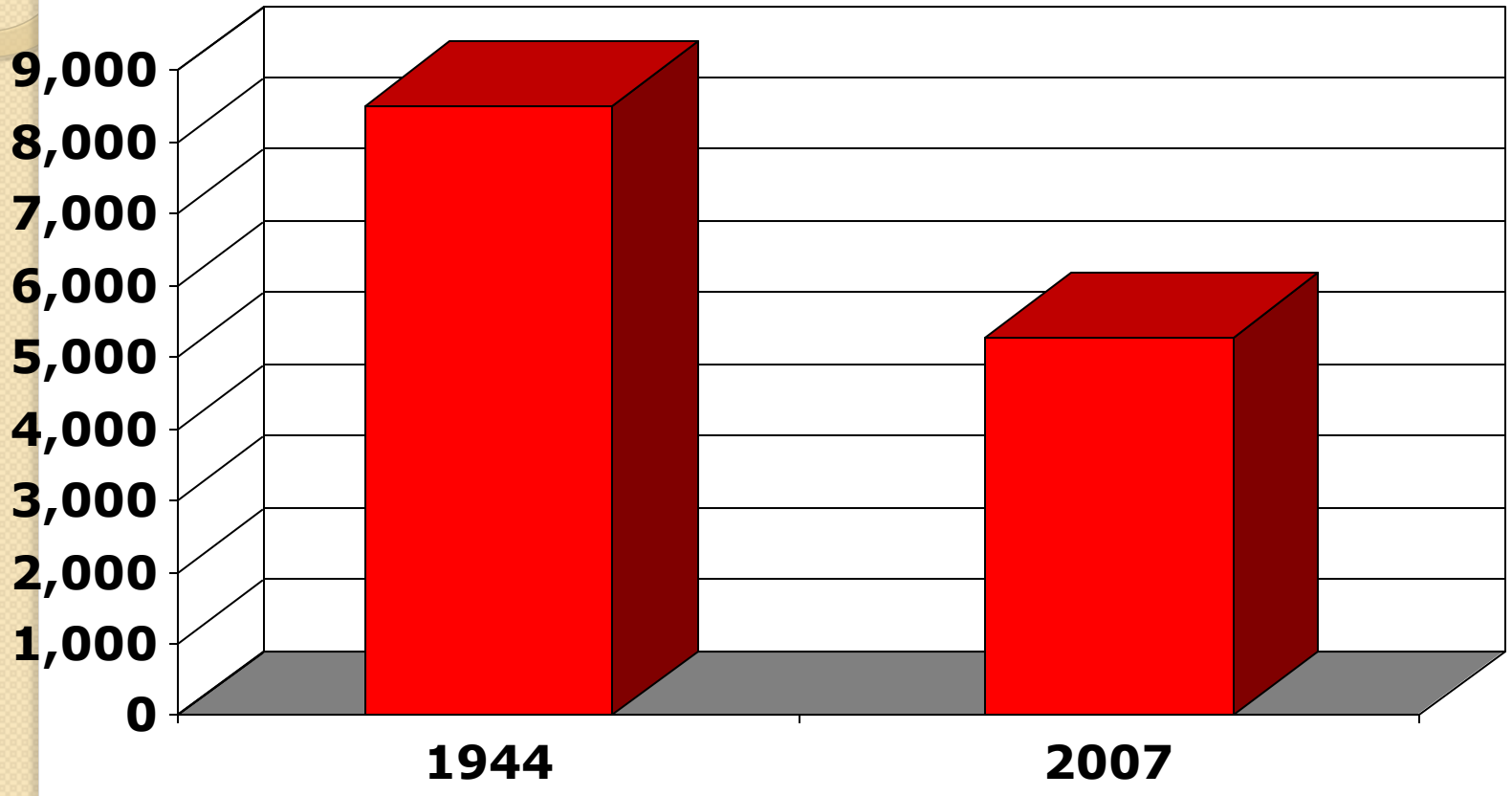
175% increase

Methane Emissions, l/lb of milk



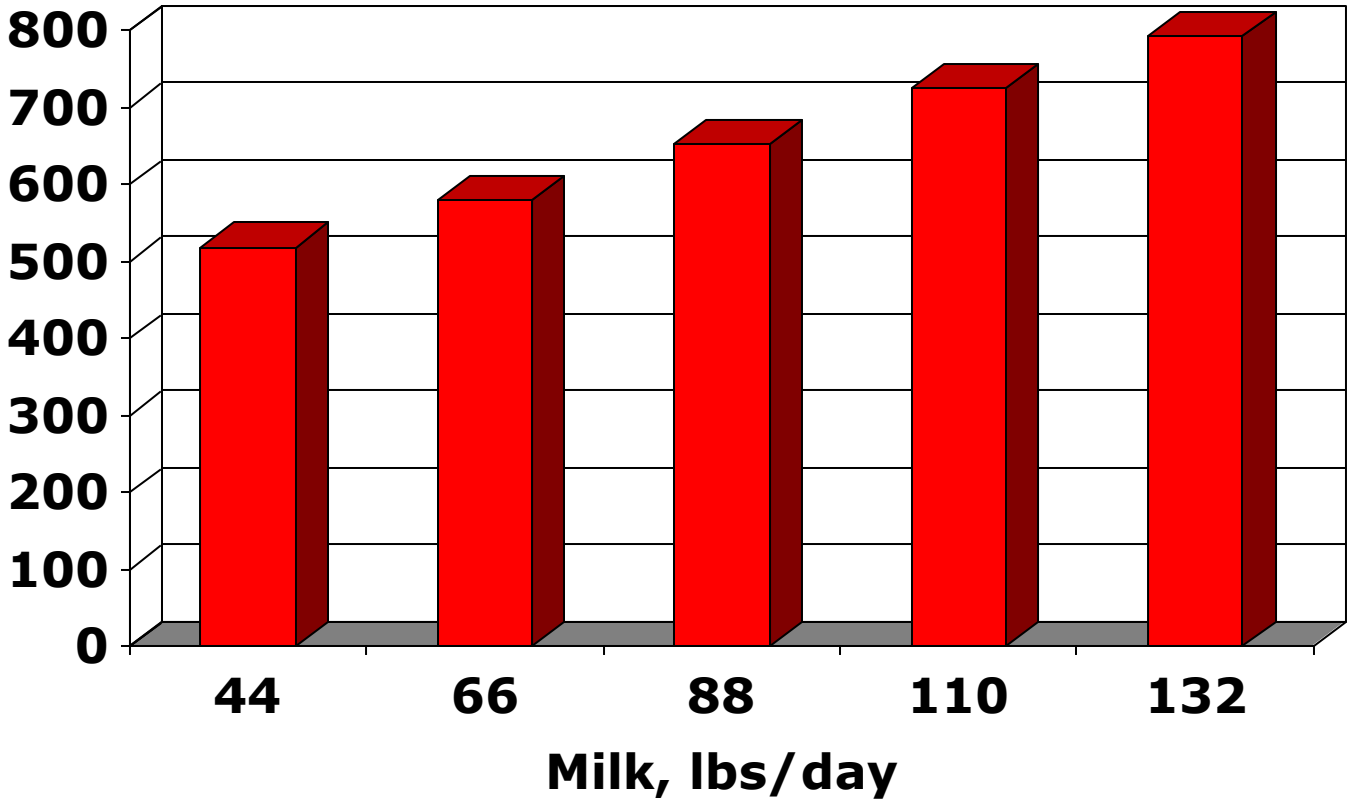
60% decrease

Total Methane Emissions from Dairy Cattle, l/day-millions

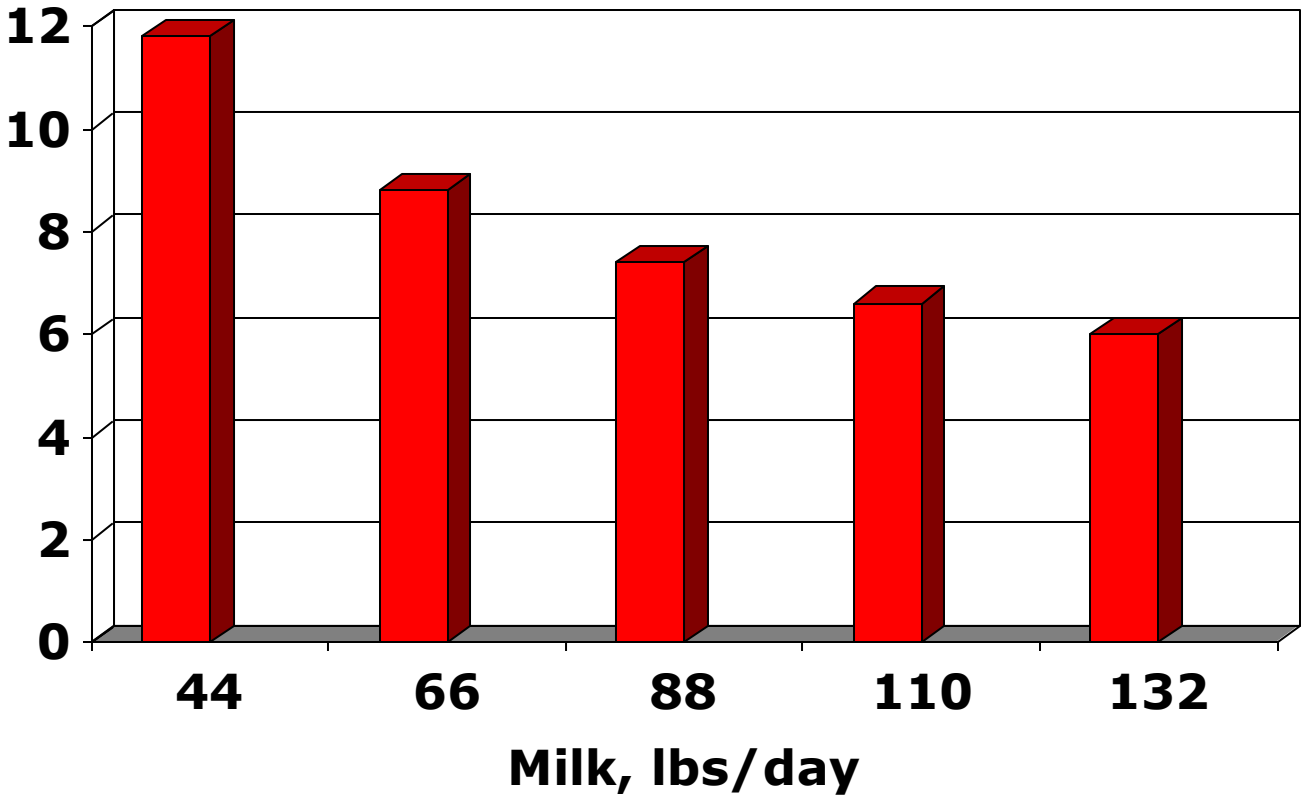


38% decrease

Milk Production and Methane Emissions, l/cow/day



Methane Emissions, l/lb. of Milk



How is Methane Produced in the Rumen?

- Rumen fermentation produces H_2
- Methane production is a sink for H_2
  - CO_2 is reduced to CH_4
- Acetate and butyrate are key H_2 sources.
  - Mainly from fiber and forages
- Propionate is a H_2 sink.
  - Mainly from starch sources

How Can We Reduce Enteric Methane Losses?

- Higher digestibility feeds
  - Higher versus lower quality forage
  - Grain and NFC sources
- Feed less forage and more grain!
- Use of ionophores
- Added fats or oilseeds
- Added fish oil
- Essential oils
- More efficient rumen fermentation
- Increase productivity and efficiency

We Need to Find the Balance!

- To really lower methane from dairy cattle:
  - Feed high starch, low forage rations
  - Use added fish oil
  - Use ionophores and other additives
  - Feed a cow like a feedlot steer

- Can you see a problem with this approach?

Is This More Practical?

- Maximize use of high quality, home produced forages.
- Take advantage of fibrous byproduct feeds that are available in the market.
- Have a healthy, productive and efficient cow.
- Take advantage of the rumen.
- Improve productivity and efficiency.

Diet Strategies to Reduce Enteric Methane Production

Strategy	Potential % Reduction
Higher grain diets	5 – 20
Use of corn and small grain silages	5 – 10
Use of legumes	5 – 10
Tannin-containing forages	10 – 20
Replace barley with corn	0 – 7
Using fats and oilseeds	5 – 25
Use of ionophores	0 - 10

Source: Beauchemin, McGinn and Grainger, 2008

Forage Quality

- Higher quality forages often have a higher daily methane emissions:
  - Higher digestibility
  - Faster rate of passage
  - More rumen fermentable carbohydrates
  - Higher feed intake
- However, the quantity of methane produced per pound of milk usually decreases.

Forage Type Considerations

- Using corn silage or small grain silages to replace grass or legume forages can lower methane.
- Using legumes in place of grasses may lower methane emissions.
- Tannin containing forages can lower methane emissions.
- These shifts are highly dependent on stage of maturity at harvest.
- You still need to grow forages that match your soil resources.

Concentrates

- Using higher starch grains (corn, barley, etc.) to replace some of the more fibrous byproduct feeds.
- Increasing rumen fermentable carbohydrates can improve rumen fermentation and lower methane.
- Need to be aware of potential rumen acidosis if pushed too far.

rBST

- Bovine somtatotropin
- Approved for use by FDA in 1994.
- Increases milk production and lactation efficiency.
- Decreases methane emissions by 7-9%.
- Use is restricted in some areas due to pressure from milk retailers.


Eww, what smells
like fish?

Additional Possibilities

- Defaunate the rumen (get rid of the protozoa).
- Added tannins.
- Yeast and direct fed microbials.
- Curry spices – decrease by 40%
- Oregano, garlic, etc.
- None of these have been fed long term.
- Will the rumen bugs adapt over time to these changes?

Herd Management Factors

- Genetic selection
- Lower calving interval
- Lower age at first calving for heifers
- Lower culling rate
- Ration formulation
- Feedbunk management
- Increased feed efficiency
- TMR's

What About Whole Herd Models?

- Many of the factors that are involved in determining methane production interact with other factors.
- One approach is the use of whole farm models to "estimate" the change in emissions with changes made at the farm.
- One example is the Dairy Gas Emissions model developed by Dr. Al Rotz and co-workers at USDA Pasture Research Lab.

Model Reports:

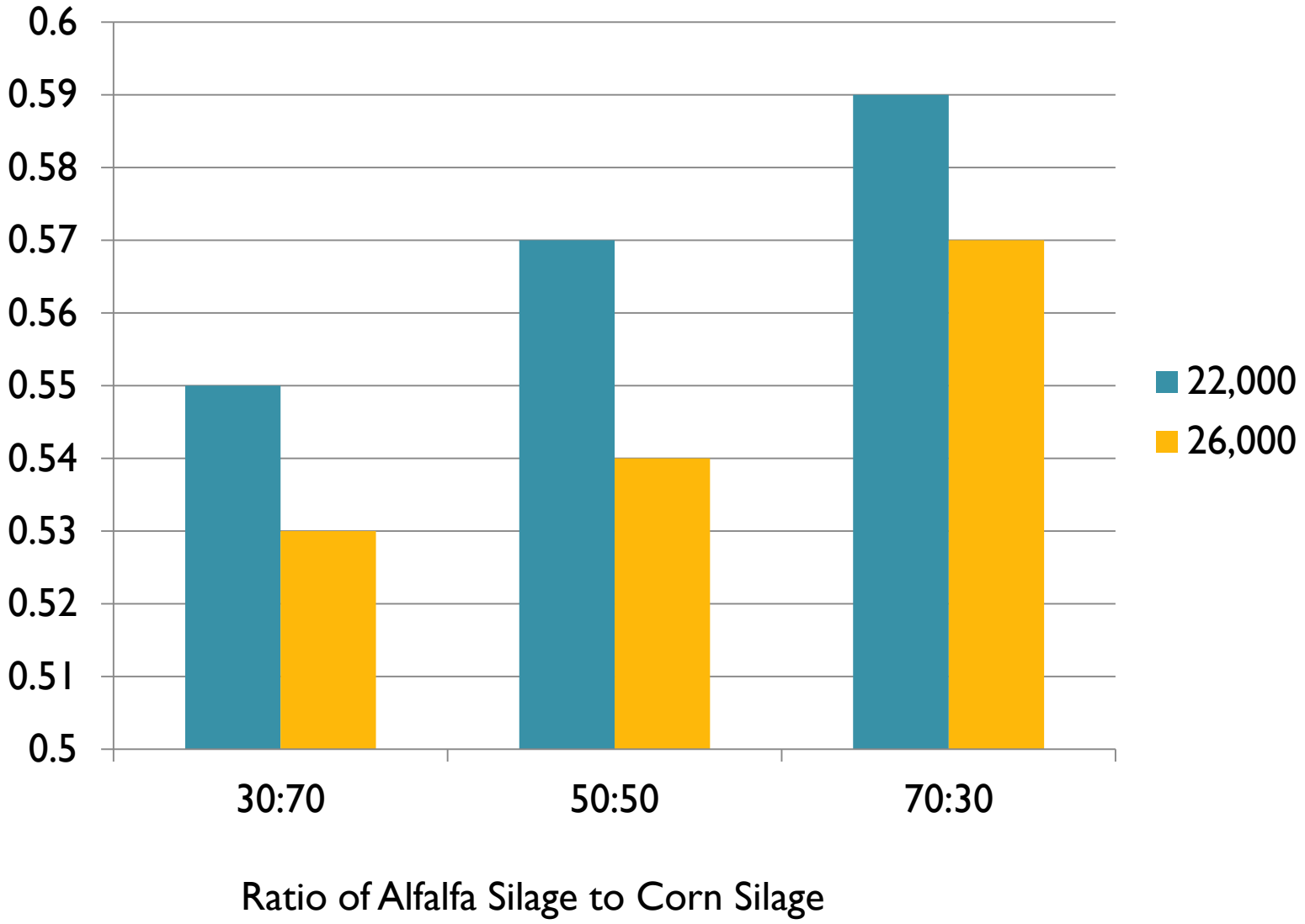
- Ammonia, hydrogen sulfide, methane, nitrous oxide and biogenic carbon dioxide.
- Also reports a total greenhouse gas emissions on a CO_2 equivalent basis.

- One reported result is lbs. of CO_2 equivalent/lb. of energy corrected milk.

Example Runs:

- Used a herd with 500 cows and 370 replacement heifers.
- Forages available:
  - Alfalfa silage – 22% CP, 40% NDF
  - Corn silage – 8.5% CP, 48% NDF
- 3 ratios of alfalfa silage to corn silage.
- 2 levels of herd milk production:
  - 22,000 lbs./cow
  - 26,000 lbs./cow

Results: lb. CO_2 Eq/lb. ECM



Results:

- On average, the herd producing 26,000 lbs. of milk/cow had 9.6% lower CO_2 equivalent emissions per lb. of energy corrected milk.
- The CO_2 equivalent emissions per lb. of energy corrected milk increased as the % of alfalfa silage in the ration increased.
- These results are to indicate what the model reports but should not be used to make any management decisions or changes.
- Specific runs would be needed for your farm situation.

Summary

- Dairy cows do emit large quantities of CO_2 and CH_4.
- There will be continuing pressure to reduce emissions.
- The dairy industry has already done a good job in lowering gaseous emissions.
- Ration balance (nitrogen, carbohydrates), forage quality and feed efficiency will be key factors in getting this done.

Summary - 2

- At the animal level, the key is to optimize rumen fermentation and improve productivity.
- At the whole farm level, a forage production and management program needs to be put together that matches the available resources (soil type, acres, etc.).
- Even though there are some differences in forage type, the key consideration is forage quality within forage type.

Scientific Efforts Have Focused on Reducing Animal and Farm Emissions

- ✓ Improve metabolic (feed) efficiency
- ✓ Improve nutrition
  - Ration balancing
  - Feeding management
- ✓ Improve cropping practices & technology
- ✓ Improve manure management
  - Storing
  - Processing
  - Application

Great Things to Do!