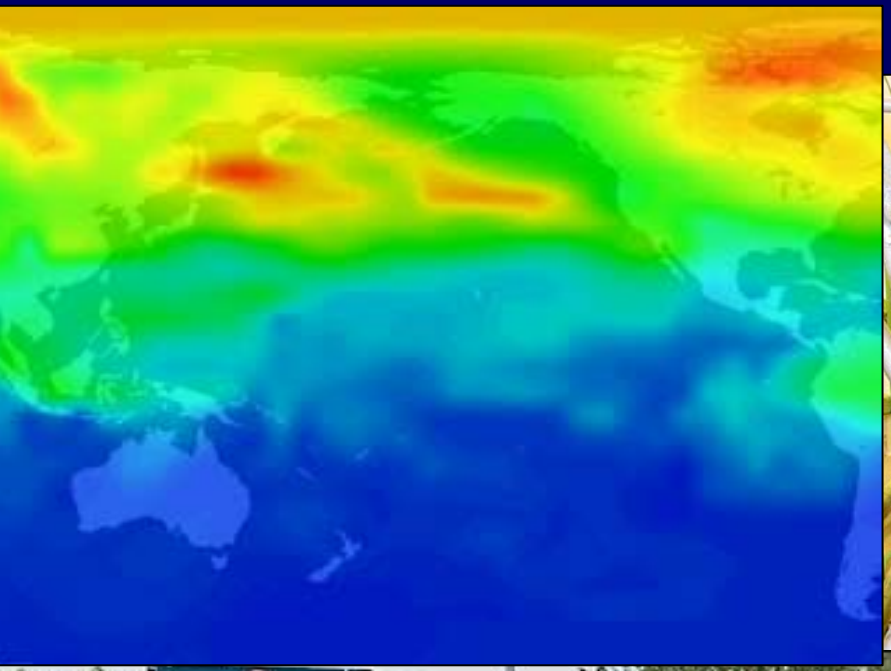
Mitigation Solutions for Nitrous Oxide Emissions from Animal Waste

International Symposium on Near-Term Solutions for Climate Change Mitigation in California
March 5-7, 2007



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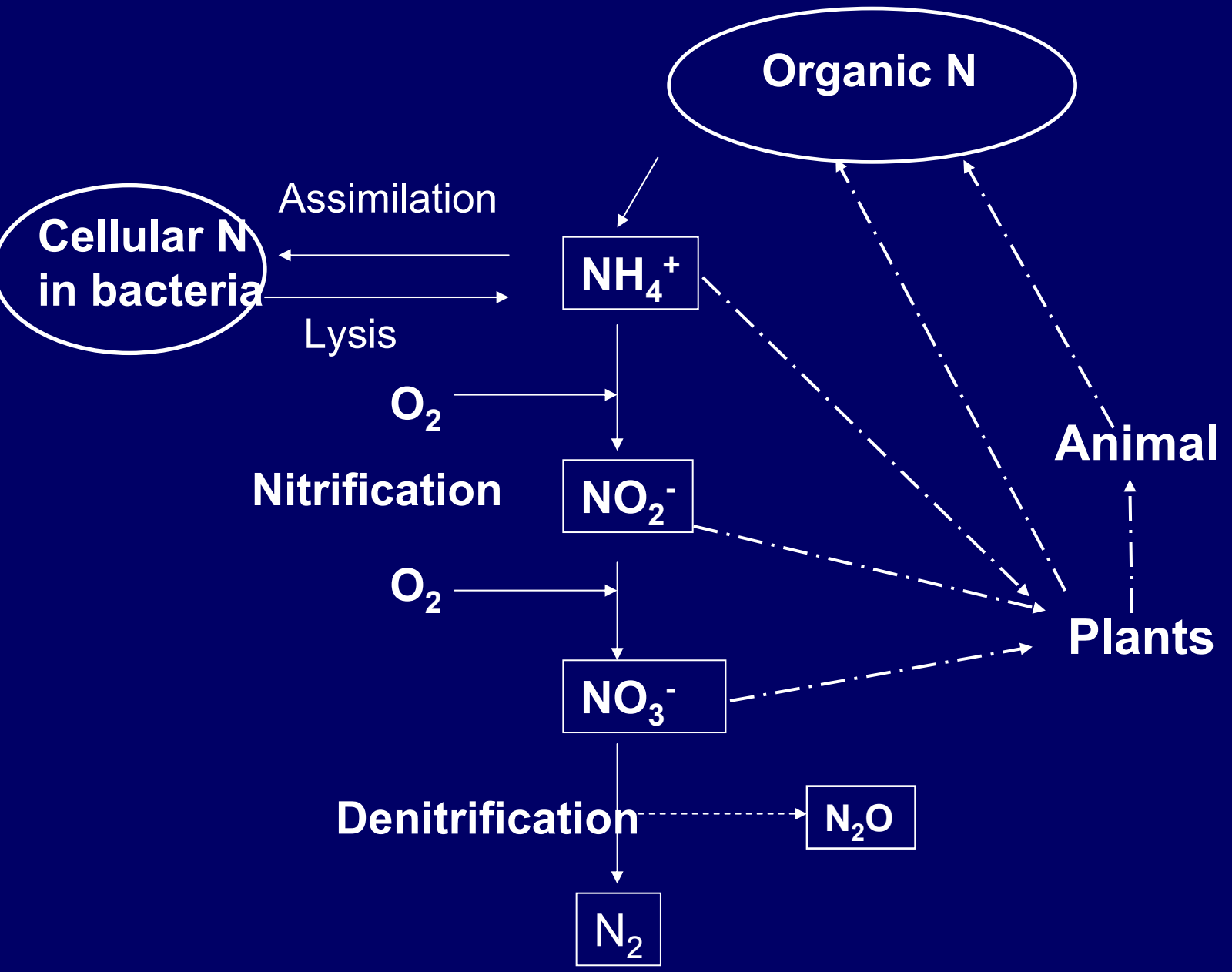
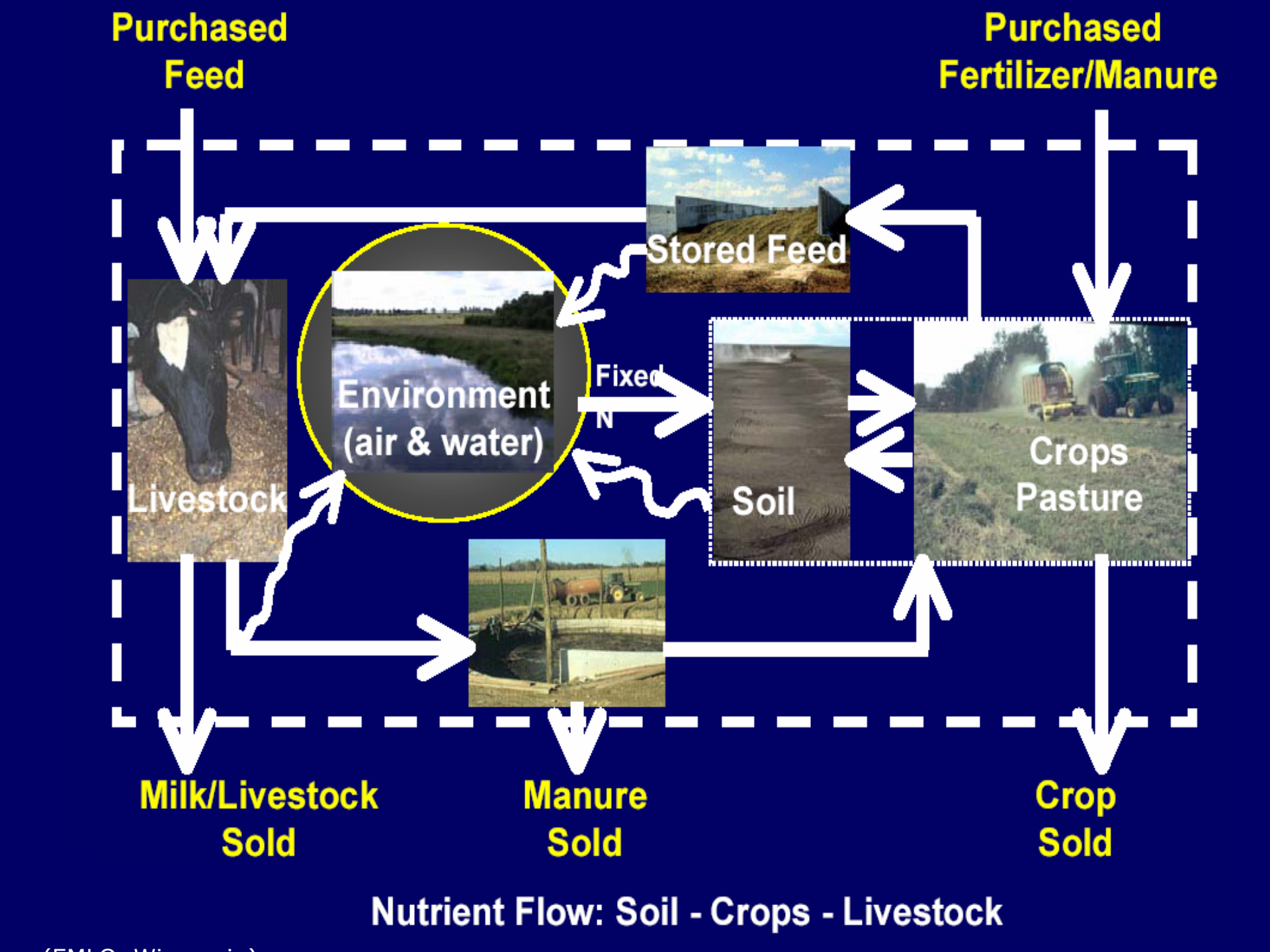
Air Quality CE Specialist
Animal Science, UC Davis

GHG Mitigation Strategies

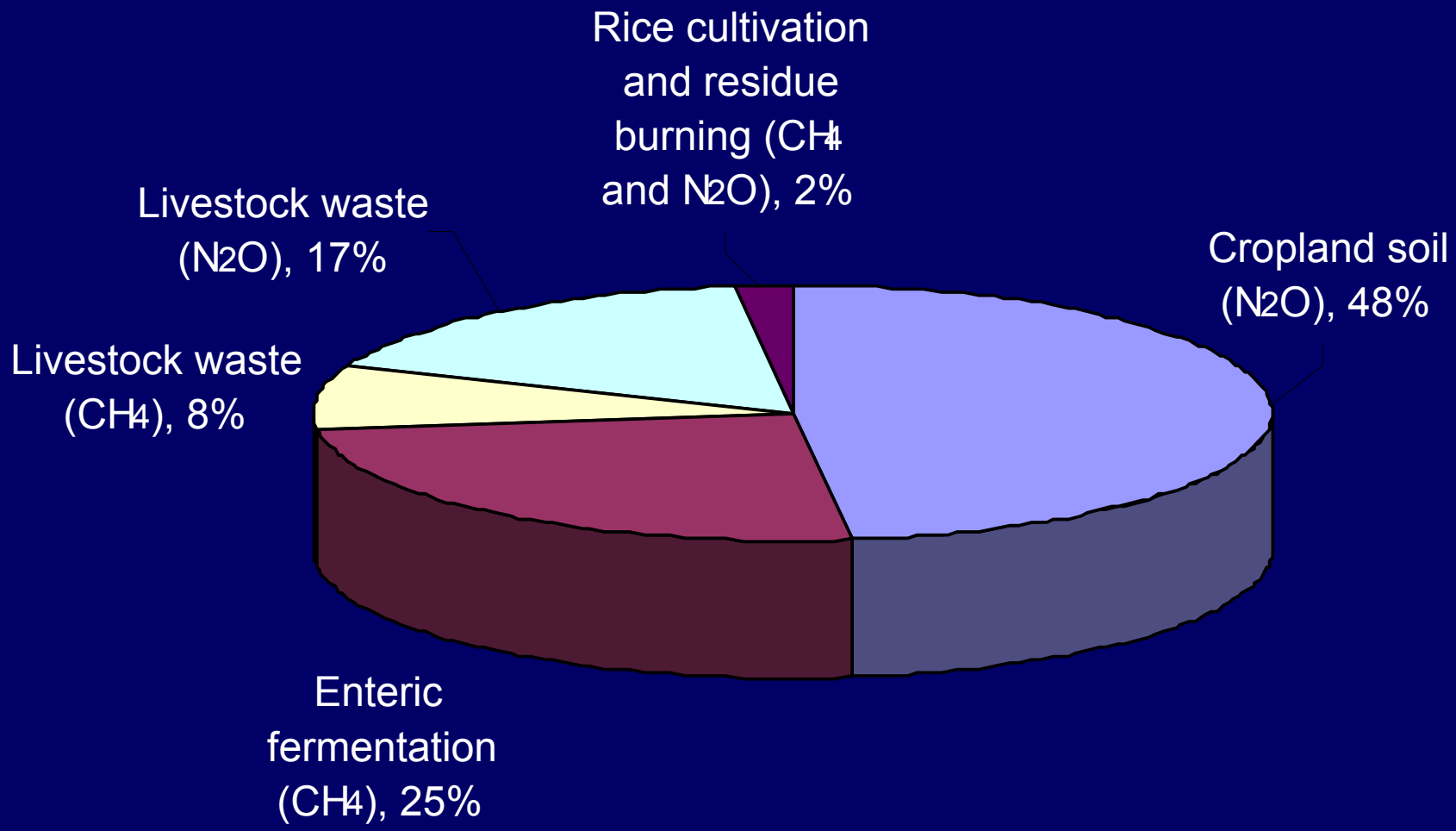
Strategy	Basic Nature	CO2	CH4	N2O
Crop Mix Alteration	Emis, Seq	X		X
Crop Fertilization Alteration	Emis Seq	X		X
Crop Input Alteration	Emission	X		X
Crop Tillage Alteration	Emission	X		X
Grassland Conversion	Sequestration	X		
Irrigated/Dry land Mix	Emission	X		X
Biofuel Production	Offset	X	X	X
Afforestation	Sequestration	X		
Existing timberland	Sequestration	X		
Deforestation	Emission	X		
Enteric fermentation	Emission		X	
Livestock Herd Size	Emission		X	X
Livestock System Change	Emission		X	X
Manure Management	Emission		X	X
Rice Acreage	Emission	X	X	X



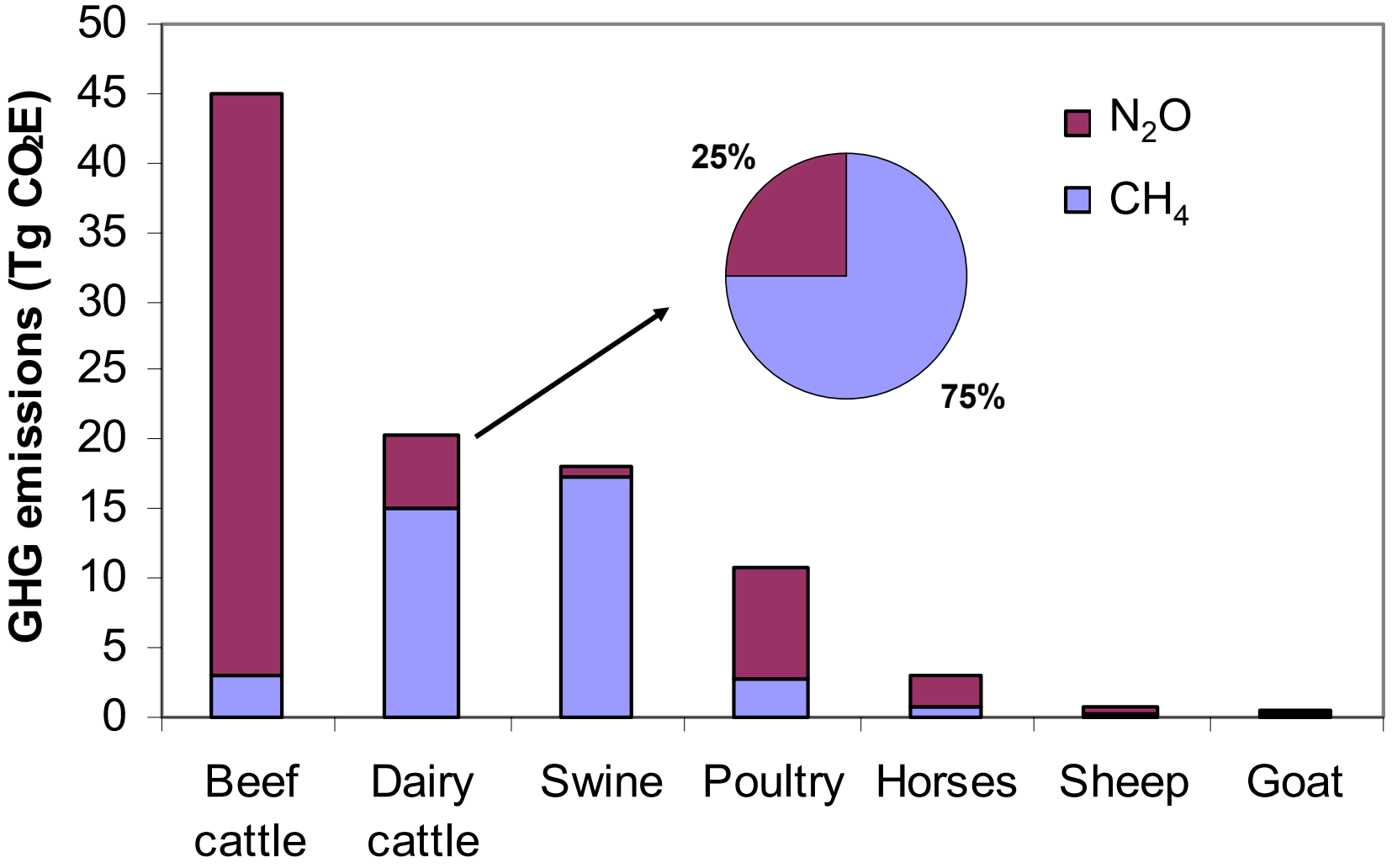
Aerobic and Anoxic Processes


Purchased Feed
Purchased Fertilizer/Manure
Stored Feed
Environment (air & water)
Fixed N
Livestock
Soil
Crops Pasture
Milk/Livestock Sold
Manure Sold
Crop Sold
Nutrient Flow: Soil - Crops - Livestock

Agricultural Sources of GHG Emissions in 2001 in U.S.



U.S. GHG Emissions from Livestock Waste by Livestock Type, 2001



Nitrous Oxide Emission, US: EPA (Millions of Metric Tons CO_2 eq/yr)

Source	1990	2000	%
Agricultural Soils	**267**	**298**	**70**
Manure	**16**	**18**	**4**
Transport	51	58	14
Industrial	55	54	13
Total	389	428	100

Agriculture and in particular Agricultural soils are major source of N_2O

About 2% of N input into (aerobic) agricultural system would be emitted as N_2O-N per year.

Nitrous Oxide Emission

- 100 years global warming potential
  - CO_2: 1;
  - CH_4: 21;
  - N_2O: 310,
- Occur during denitrification primarily, but somewhat during nitrification as well,

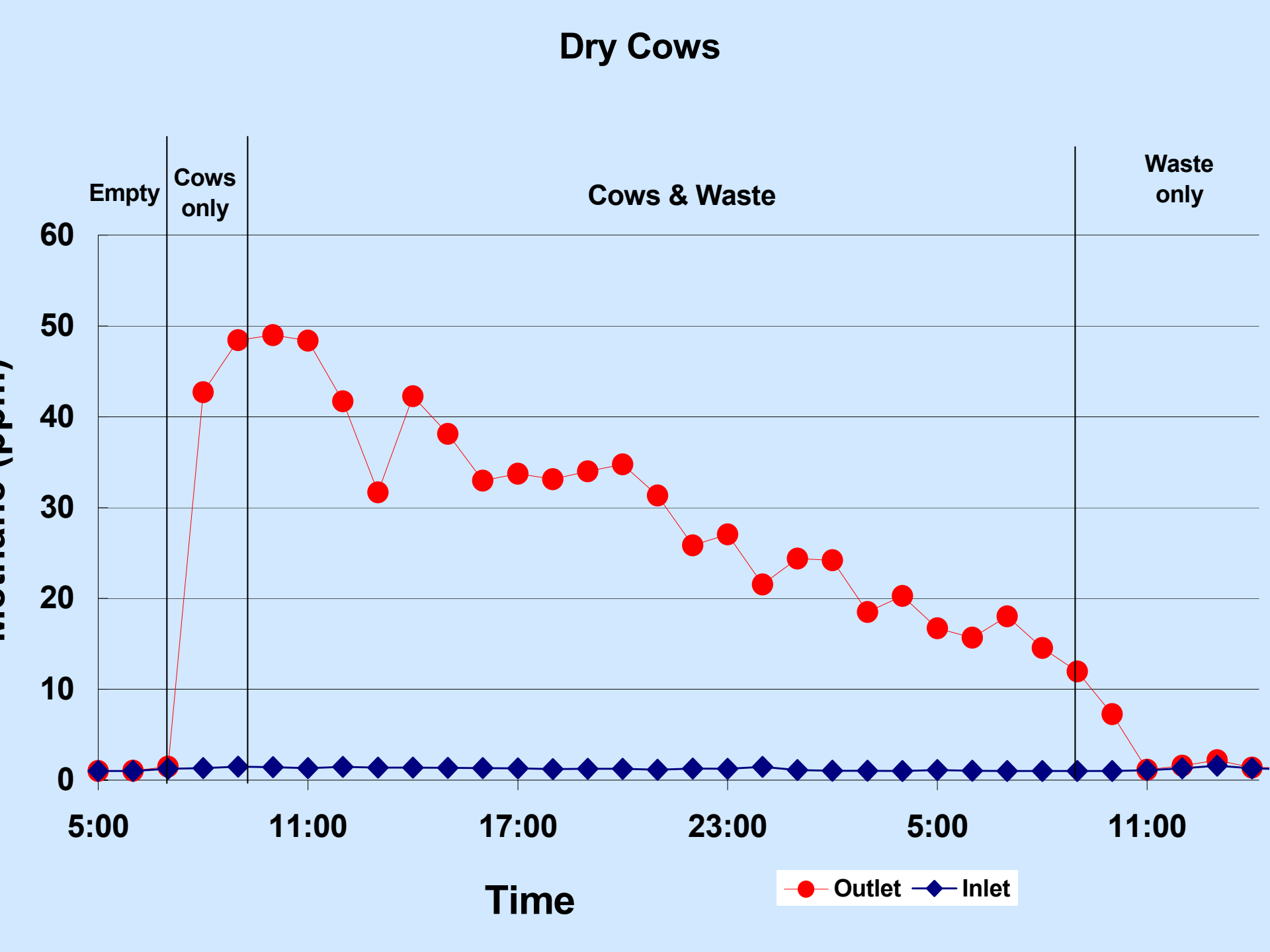
- The N_2O emission is higher when
  - NO_2^- and NO_3^- concentration is high
  - Lower pH
  - High O_2
  - Lower C availability
  - Lower temperature
  - Lower N_2O reductase activity


LGR
DLT-100

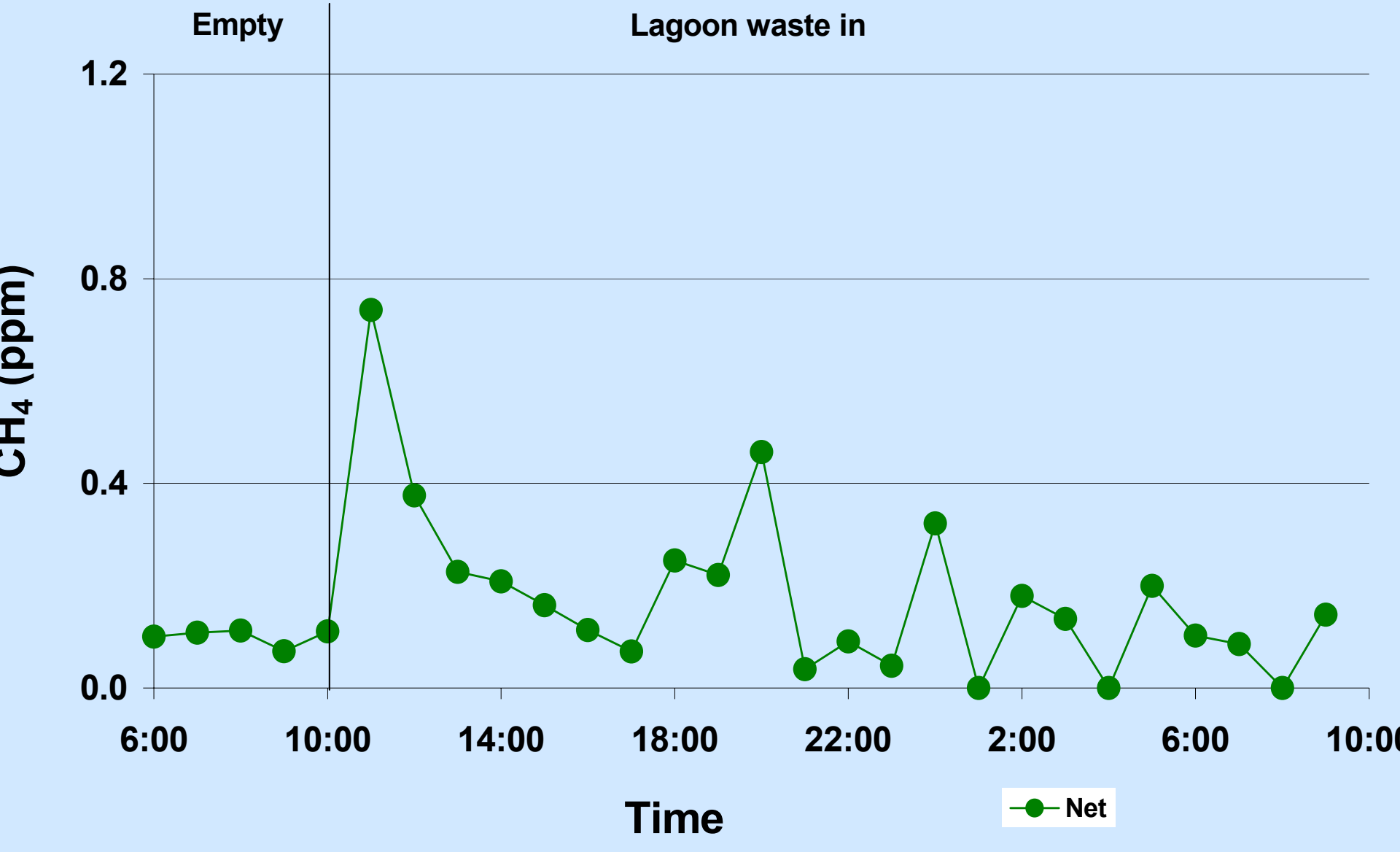

INNOVA 1412 Photoacoustic Field Gas-Monitor
RESET
LOCK
MEASURE

Avg Emissions per Cow (lb/cow/yr)

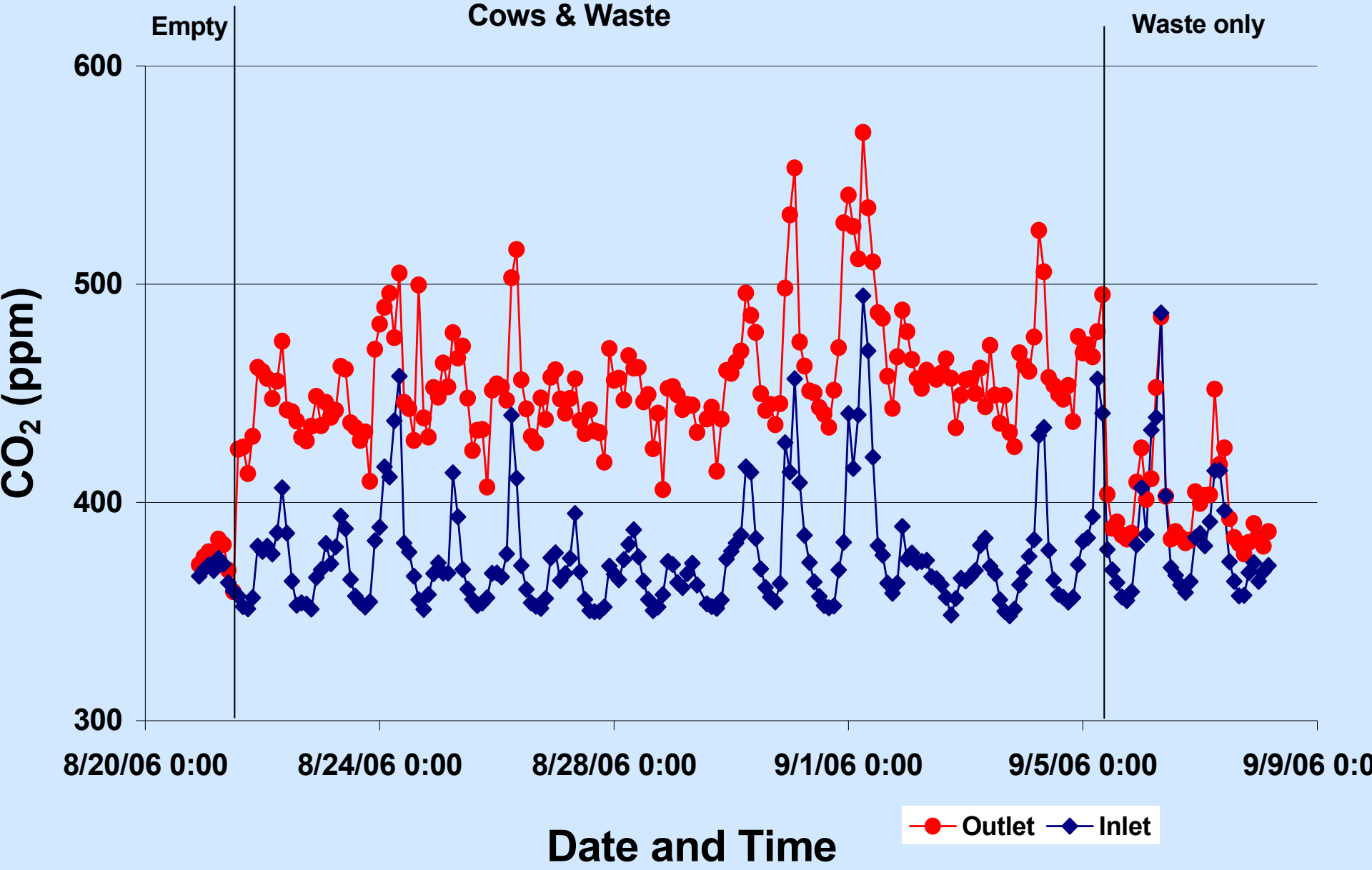
	CO_2	CH_4	N_2O
Dry cows	13,637	268	6.9
Lact cows	18,325	412	8.7

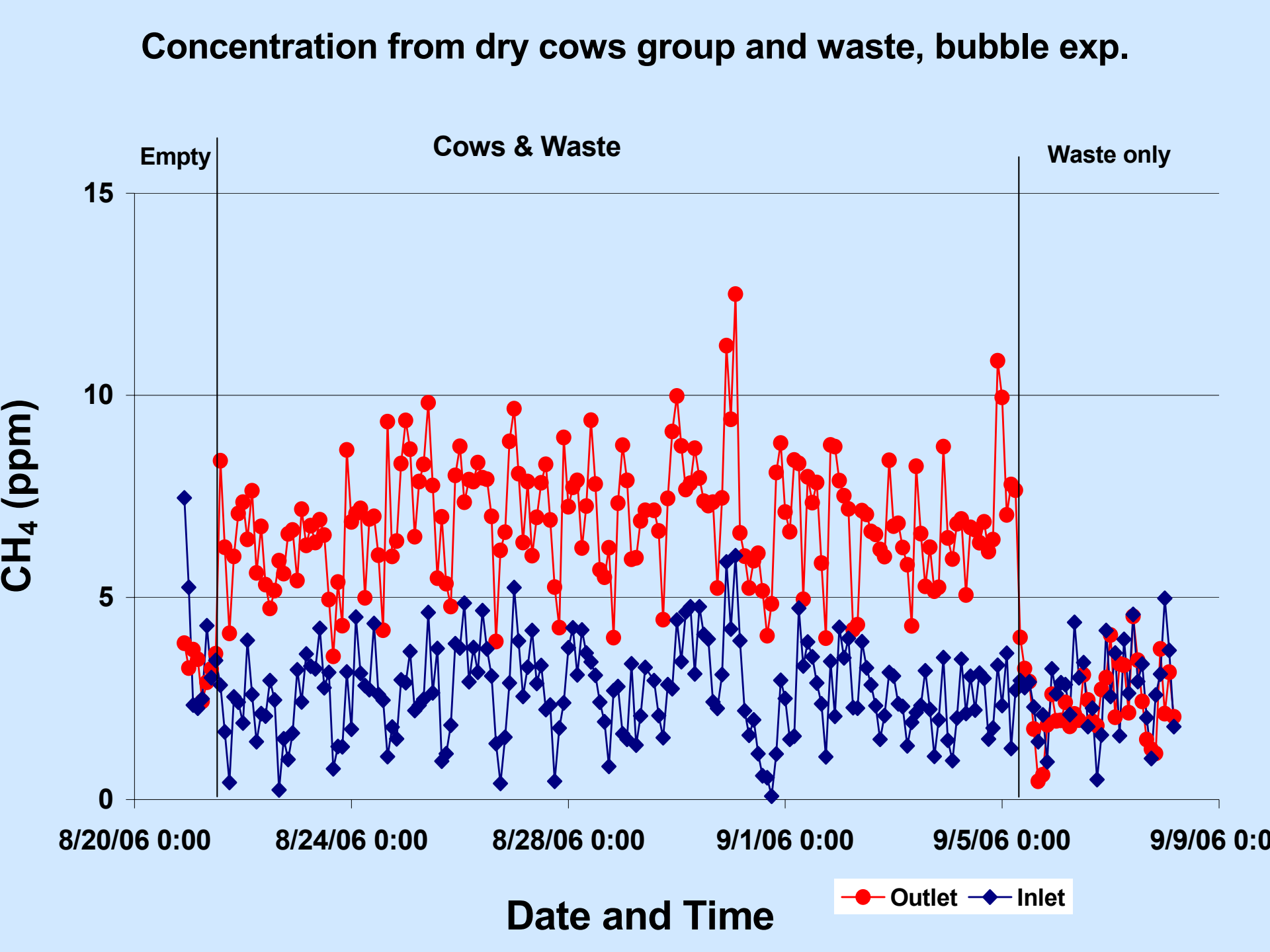

Dry Cows
Empty
Cows only
Cows & Waste
Waste only
60
50
40
30
20
10
0
5:00
11:00
17:00
23:00
5:00
11:00
Time
Outlet
Inlet

Lagoon waste

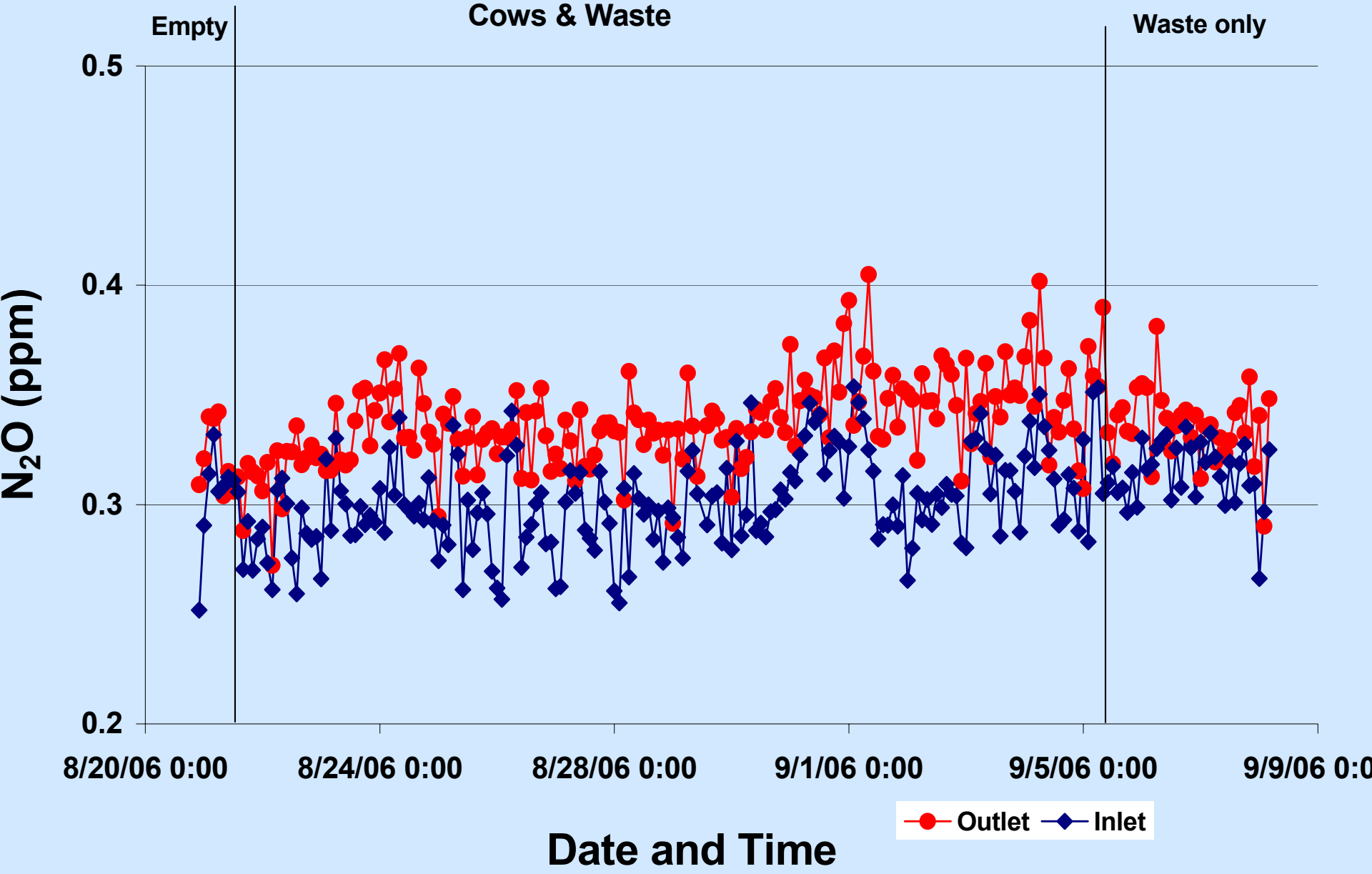


Concentration from dry cows group and waste, bubble exp.




Concentration from dry cows group and waste, bubble exp.
Empty
Cows & Waste
Waste only
15
10
5
0
CH4 (ppm)
8/20/06 0:00
8/24/06 0:00
8/28/06 0:00
9/1/06 0:00
9/5/06 0:00
9/9/06 0:0
Date and Time
Outlet
Inlet

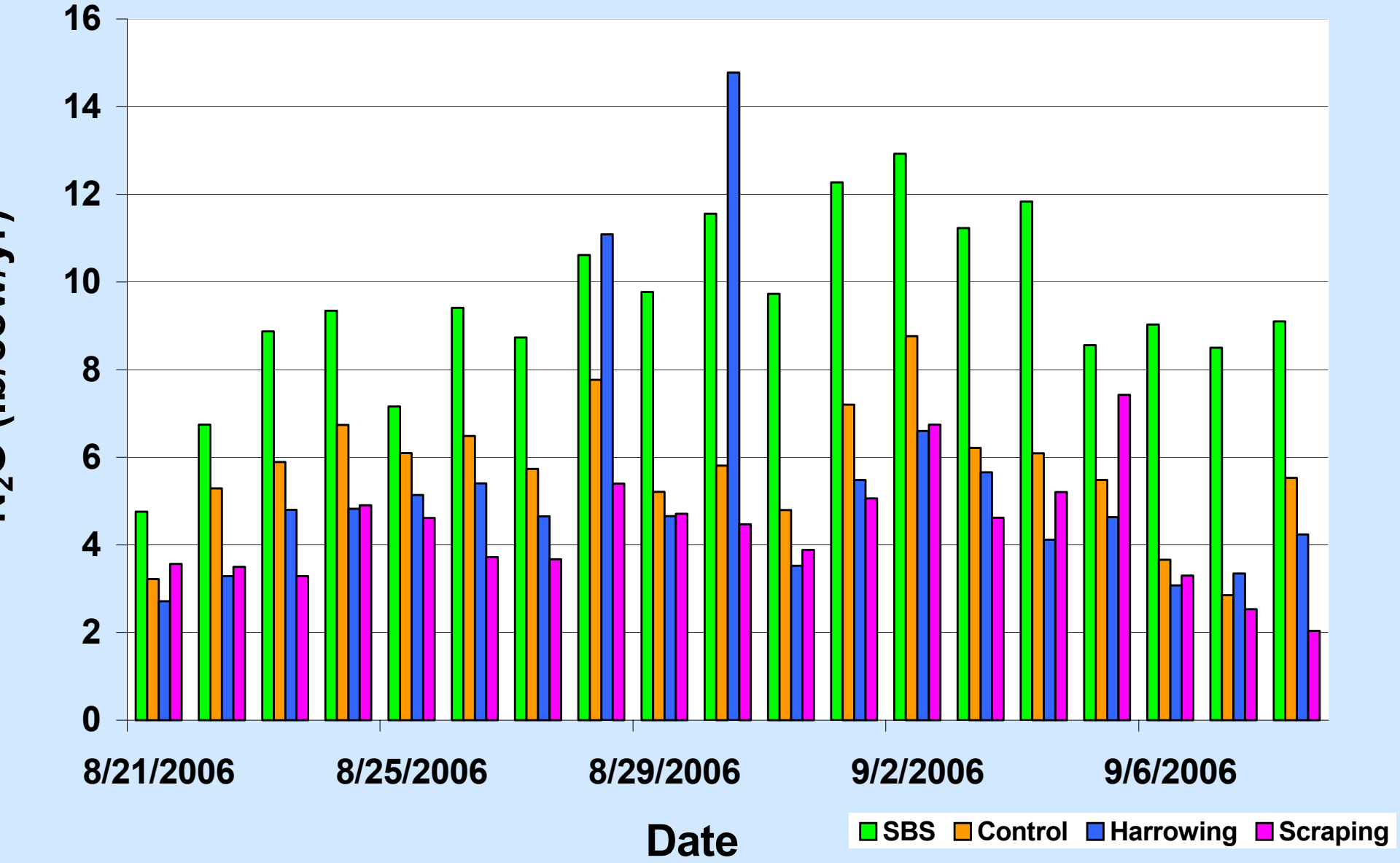
Concentration from dry cows group and waste, bubble exp.



The Effect of different Dairy Manure Management on N_2O Emissions

- Acidifier application
- Scraping
- Harrowing
- Control (no treatment)

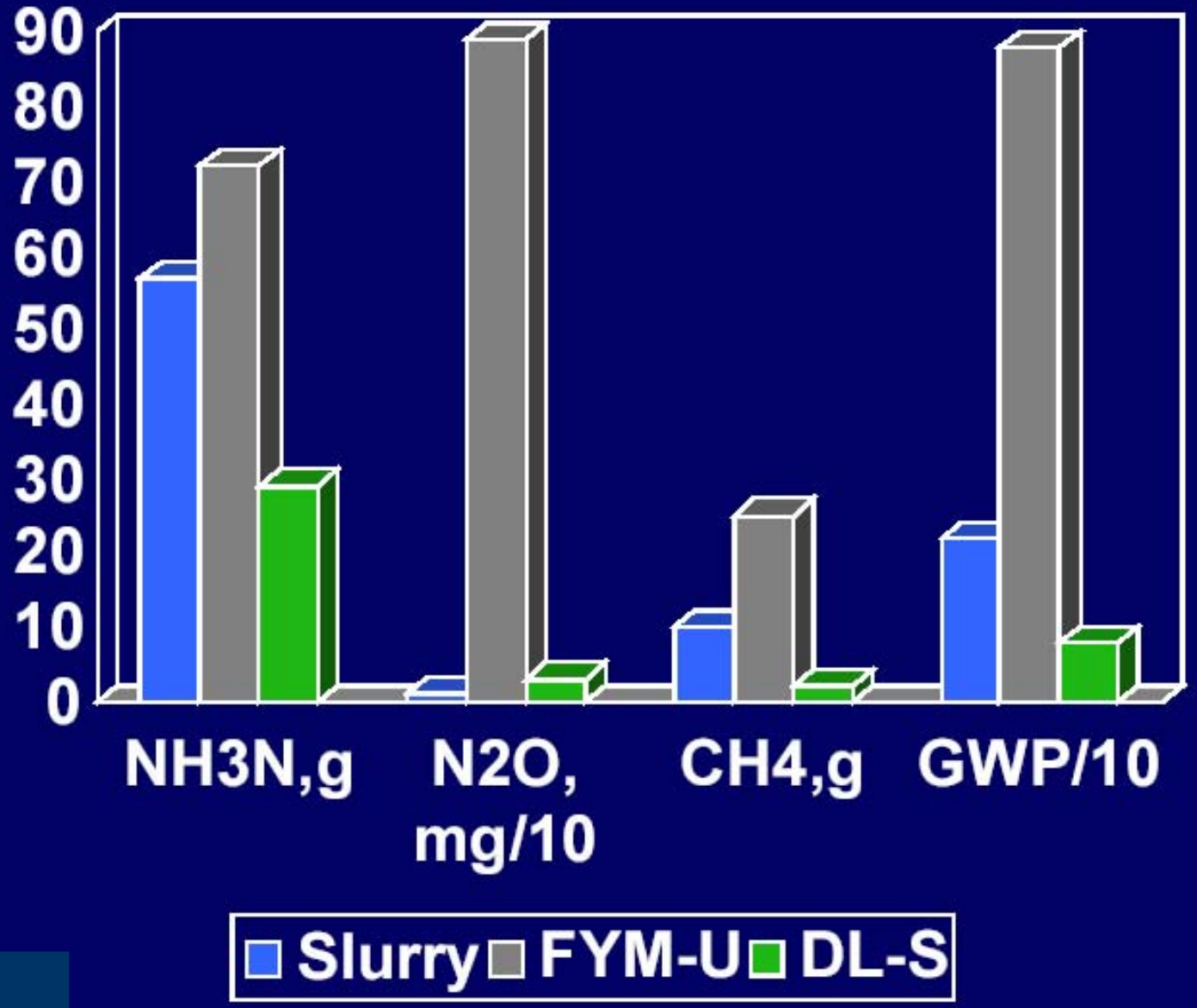
Emissions from dry cows and waste



Impact of Dairy Housing System on GHG Emissions

- Kulling et al. 2001, J. An. Sci. 137-235
- Three "housing" management systems,
  - Liquid manure in slurry,
  - Farmyard manure (feces+1.75kg straw) & urine (FYM-U),
  - Deep liter + 12 kg of straw (DL-S),

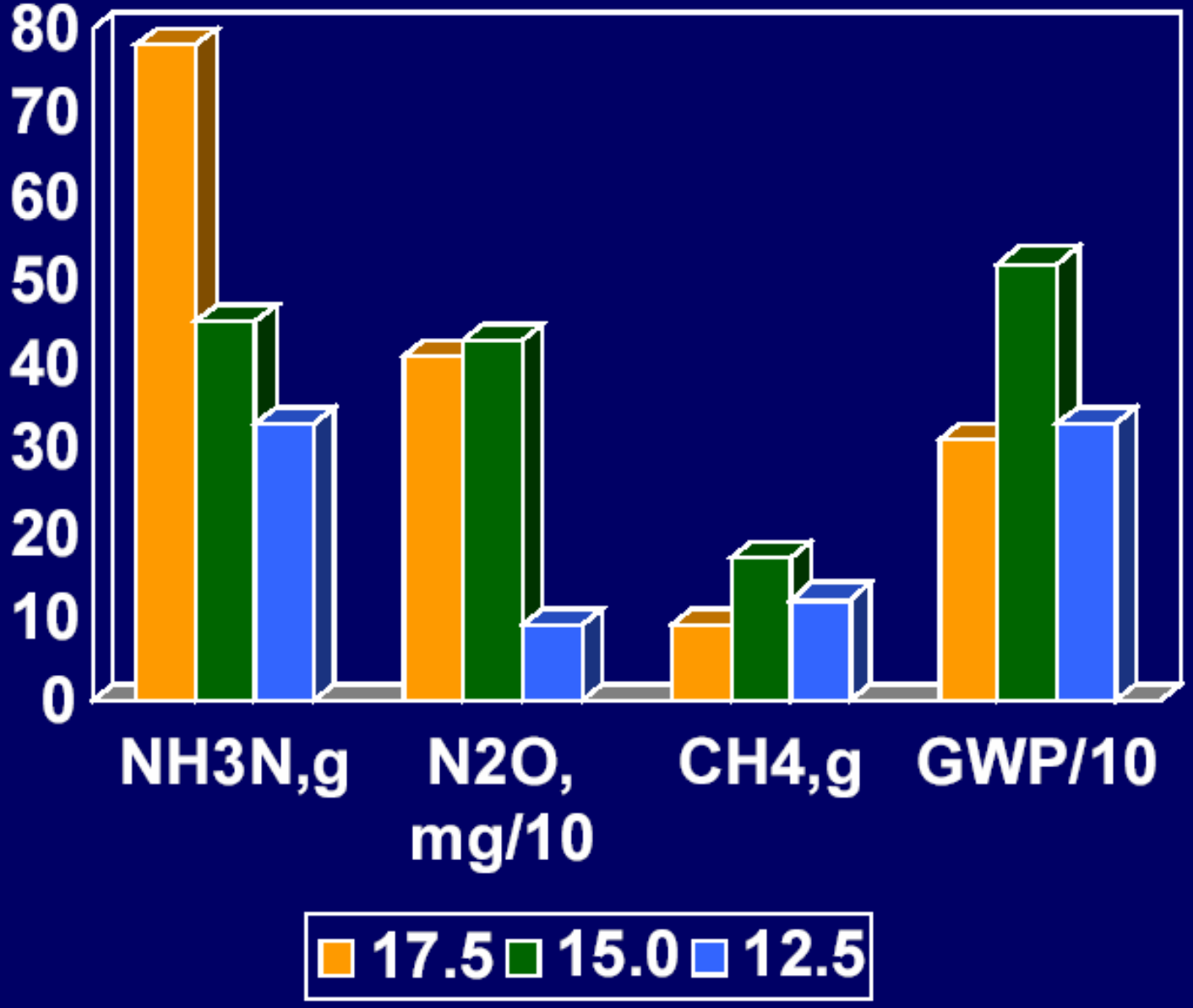
npact of Housing on GHG Emission from Manure



Diet Treatment to Reduce N_2O Emissions

- Kulling et al. 2001, J. An. Sci. 137-235,
- Lactating cows (39kg/day),
- Three levels of CP in the diet,
  - 12.5, 15.0, and 17.5% of the diet DM

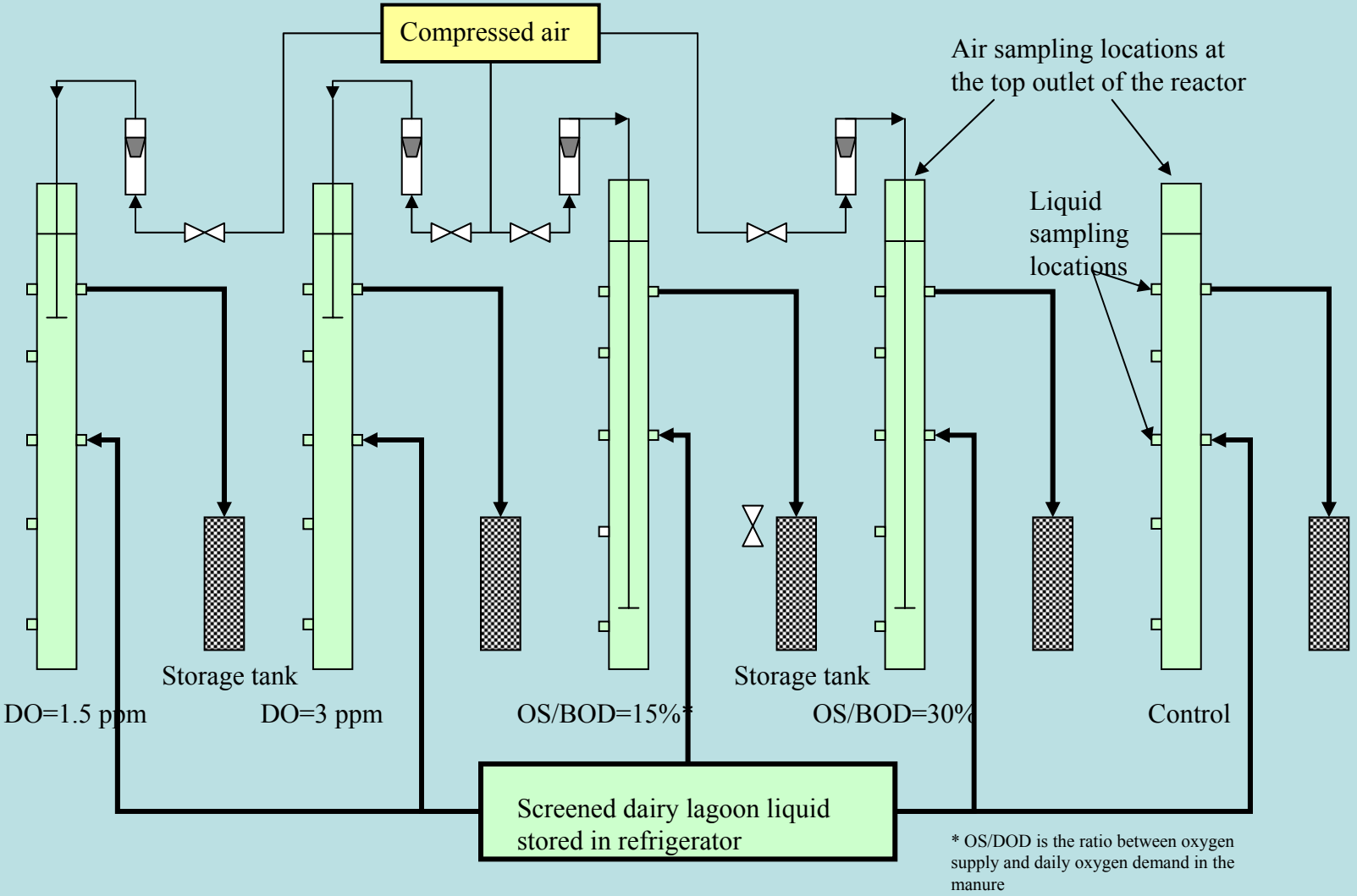
Impact of Diet CP on GHG Emission from Manure



The Effect of Aeration on N_2O Emissions from Lagoon Storage

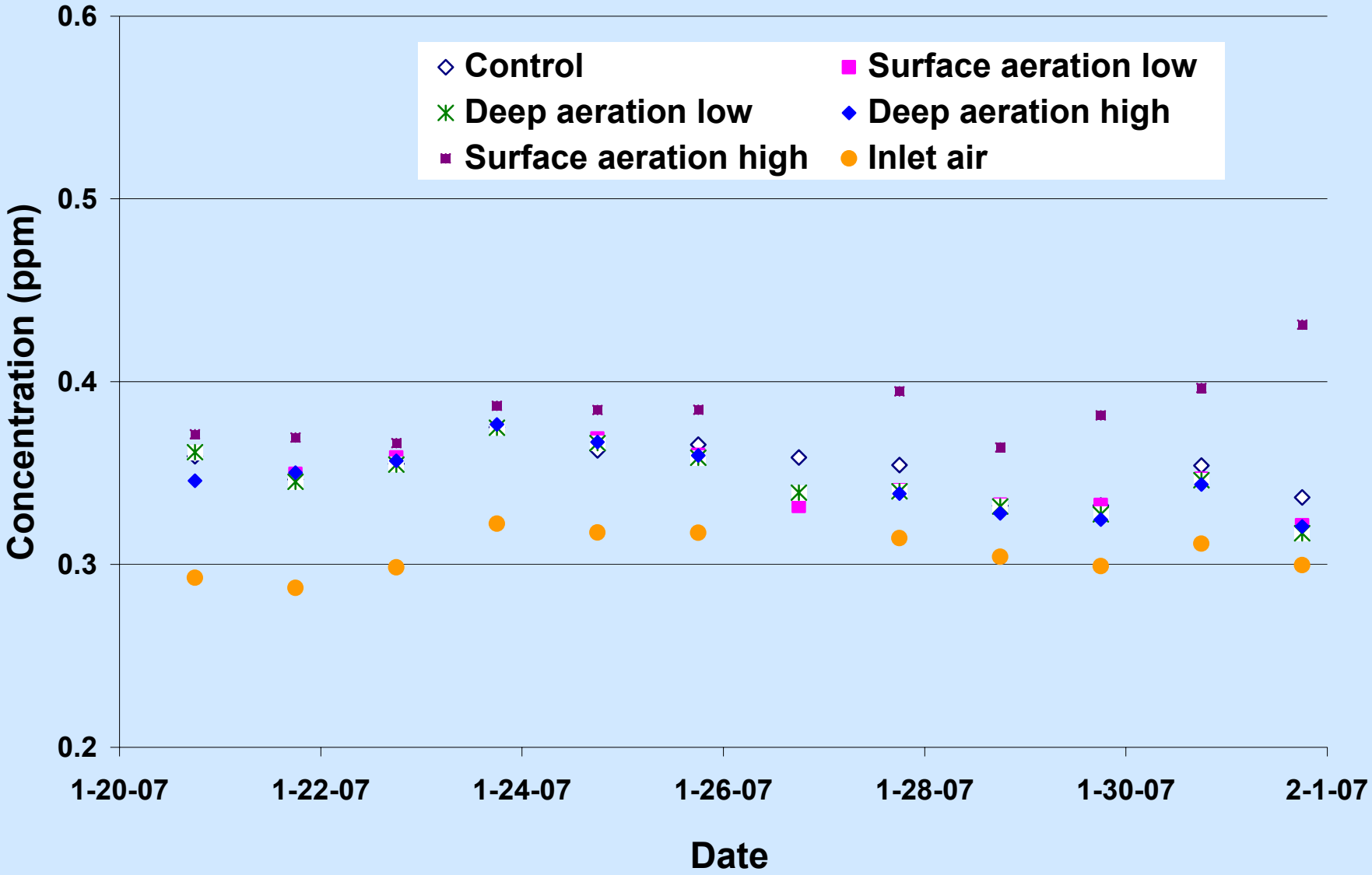
- Deep aeration
  - 15% of BOD loading
  - 30% of BOD loading
- Surface aeration
  - 0.5 ppm O_2 in the top layer
  - 1.5 ppm O_2 in the top layer

Laboratory Aeration Study



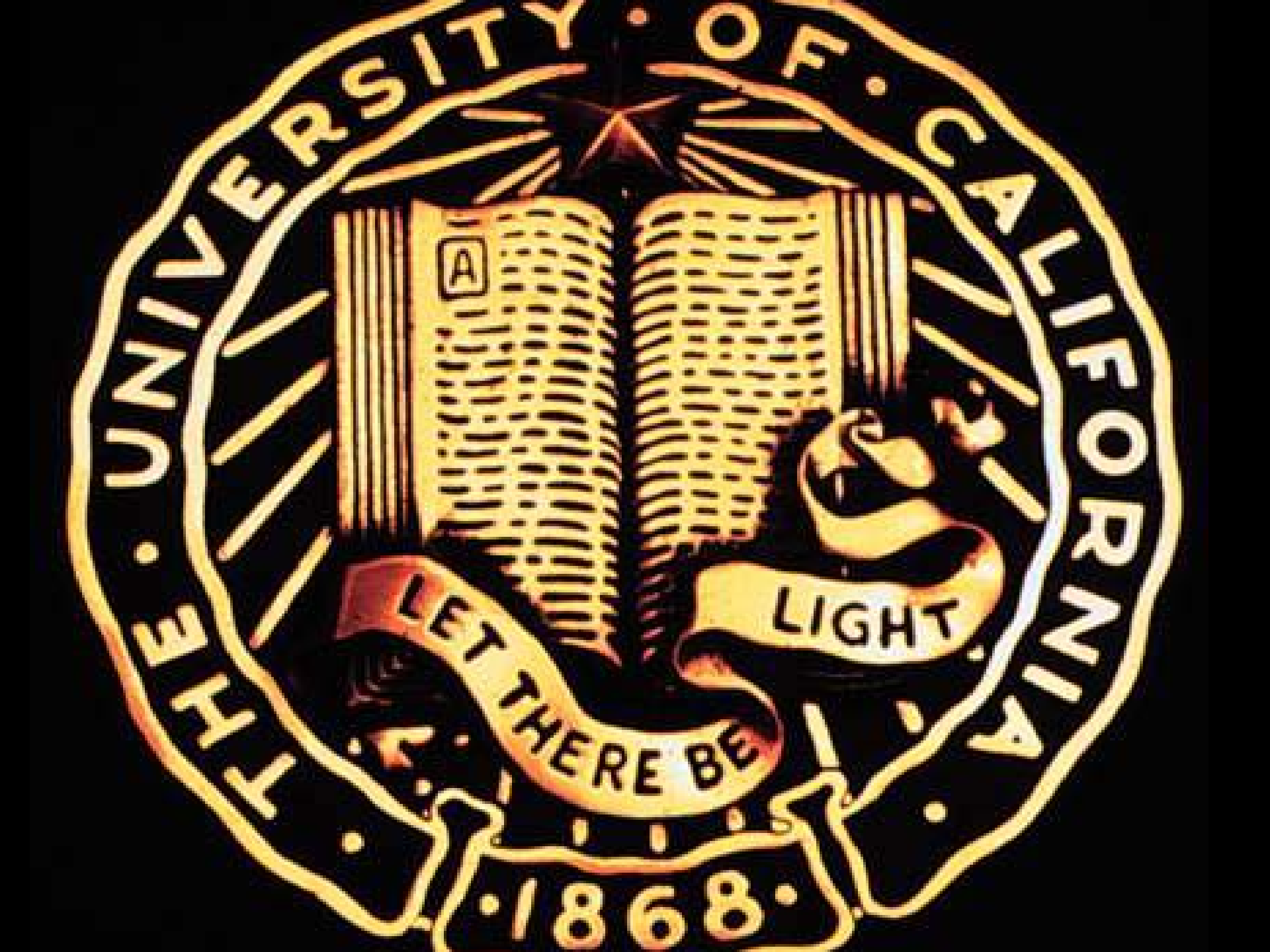
Laboratory Aeration System

The Effect of Aeration on N_2O Emissions from Lagoon Storage



Conclusion

- N_2O is important to consider because of its effects on global warming potential
- CH_4 and N_2O abatement strategies may conflict with each other
- Reduction in the feed/product ratio of N is central to minimize N_2O emission
- Application of N nutrients at agronomic rates is critical to reduce N_2O and other N related emission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