Disclaimer

The information in this presentation has been reviewed and approved for public dissemination in accordance with U.S. Environmental Protection Agency (EPA). The views expressed in this presentation are those of the author(s) and do not necessarily represent the views or policies of the Agency. Any mention of trade names or commercial products does not constitute EPA endorsement or recommendation for use.

Towards a Verifiable Ammonia Emissions Inventory for Cattle Feedlots in the Great Plains

Jay Ham

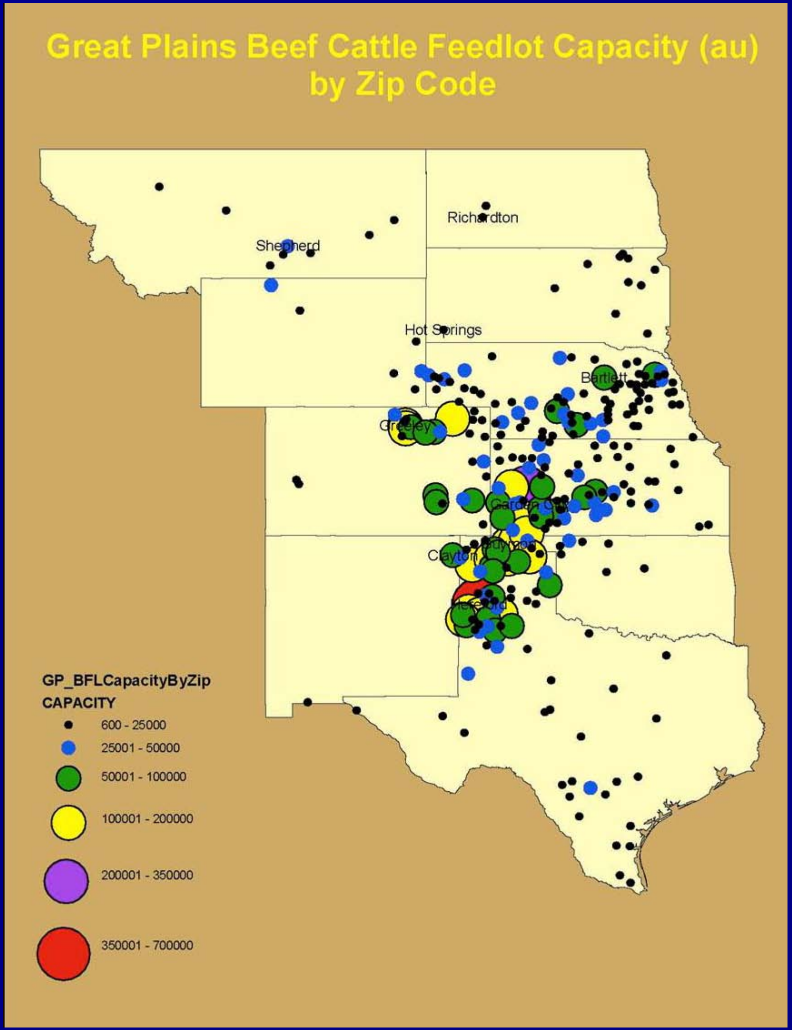
Colorado State University

Brian Lamb, Kristen Johnson, Shelley Pressley

Washington State University

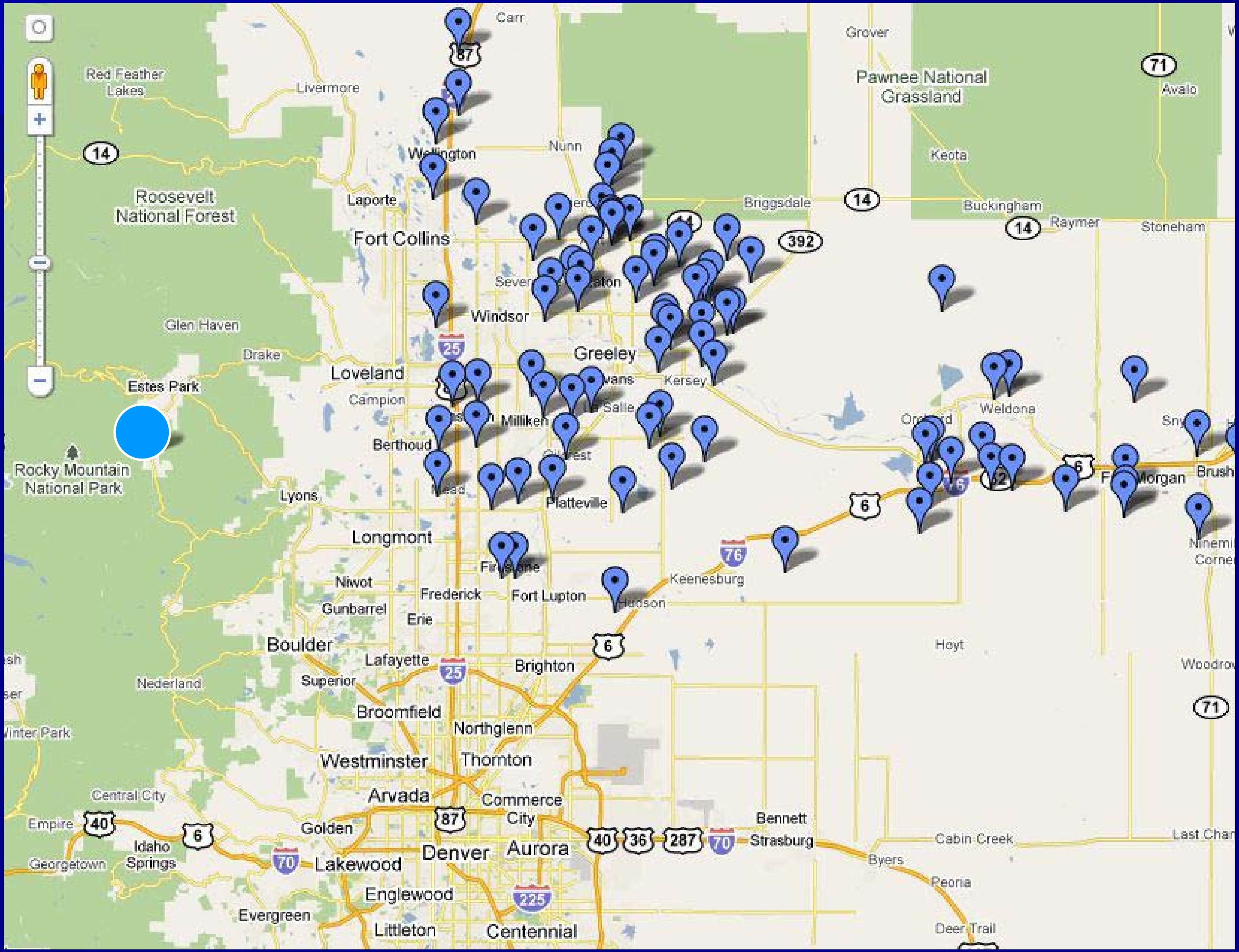
Where's the Beef ?

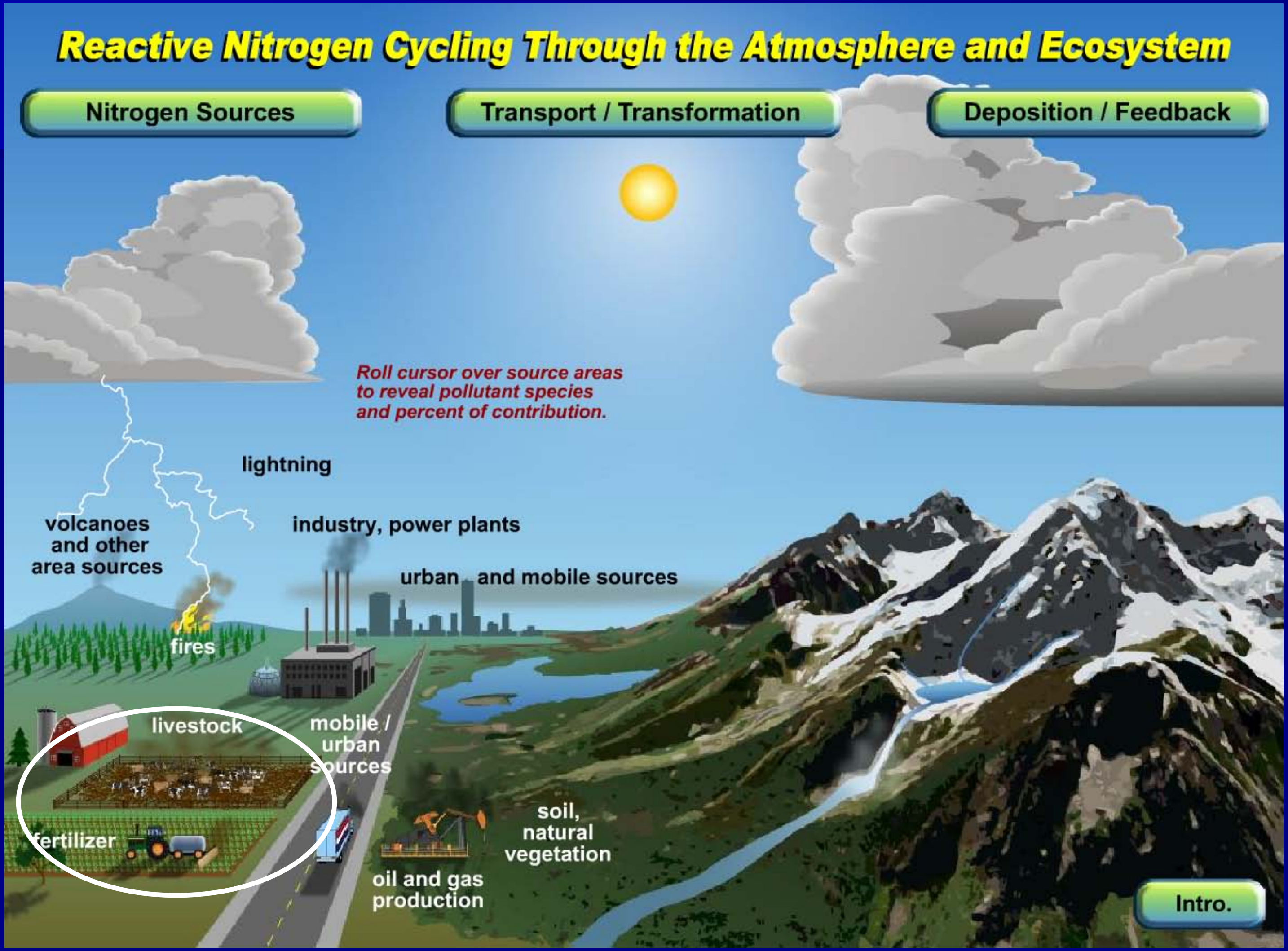
- 9 million head of cattle in beef feedlots across the High Plains
- 85% of U.S. beef feedlot inventory
- Other 15%
  - IA, CA, AZ, ID, WA



Courtesy of P.I. Coyne

NE Colorado CAFO Map





http://vista.cira.colostate.edu/improve/Education/education.htm

Got Beef ? Got Ammonia !

- Retention of fed nitrogen in feedlot cattle is typically 13%
- Most fed nitrogen is excreted in the urine as urea
- Up to 50% of fed nitrogen can be lost as NH_3

$$H_2N{-}C({=}O){-}NH_2 \;+\; 3\,H_2O \xrightarrow{\text{Urease}} 2\,NH_4^+ \;+\; OH^- \;+\; HCO_3^-$$

Back-of-the-Envelope Inventory

9 million head x

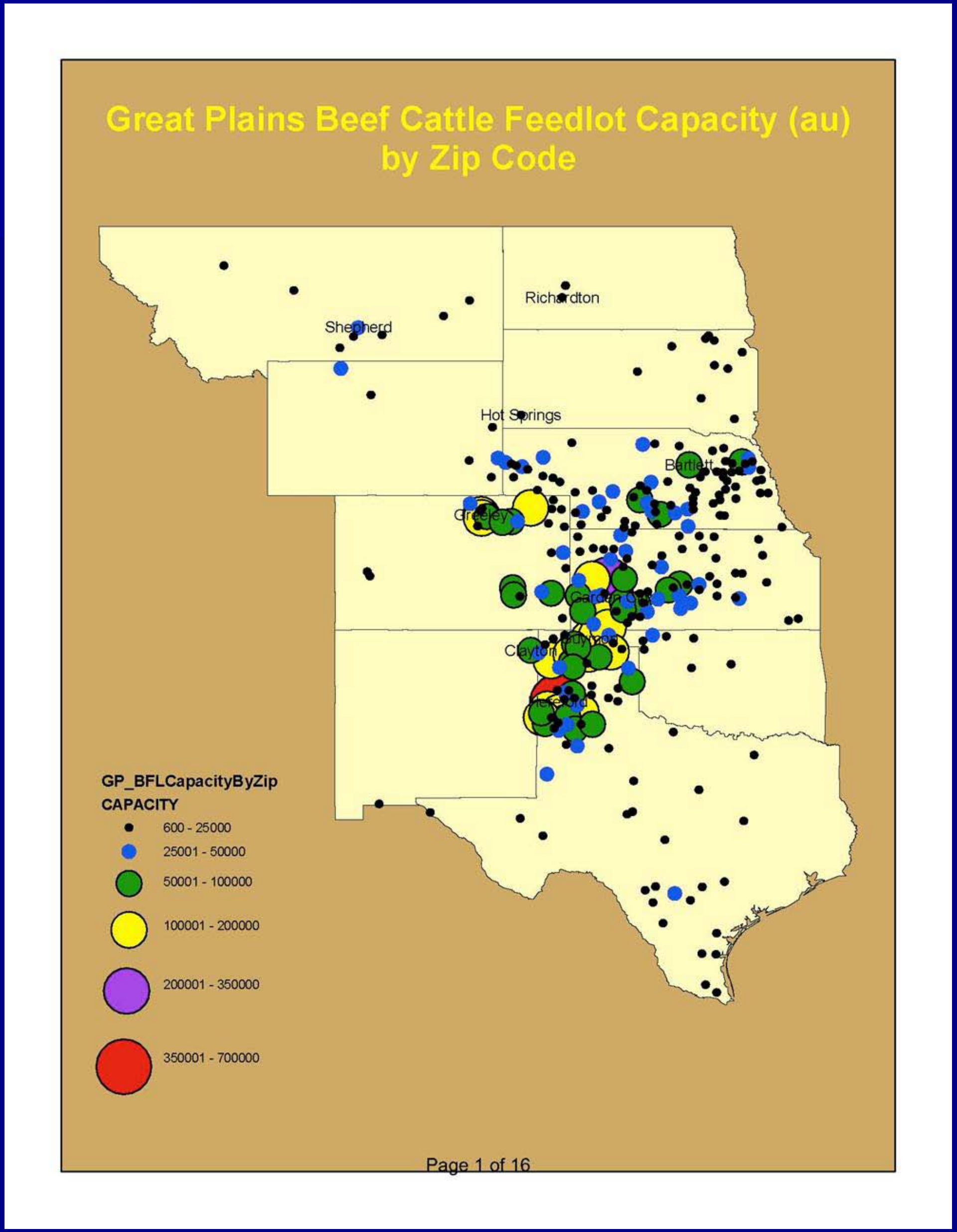
0.205 kg N excreted /d x

365 days .

673,425 metric tons N/year

$\approx$ 336,712 metric tons NH_3

Could be 10% of total U.S. inventory



Cattle Feedlot NH_3 Reporting Requirements

EPCRA, good faith air emissions estimates on NH_3 and H_2S if over 100 lbs/day

Cattle feedlots over 1000 head must report to state

Must estimate upper and lower limits

(KEEP THIS WORKSHEET FOR FEEDYARD RECORDS)

Calculation Worksheet – Ammonia and Hydrogen Sulfide
Beef Cattle Feedyards
January 2009

Could a manager could replace these simplified approaches with results from a site-specific online software tool

exceeds 100 lbs/day **or** the hydrogen sulfide exceeds 100 lbs/day. **DO NOT report ammonia or hydrogen sulfide values if the "upper bound" is LESS THAN 100 lbs/day.**

Feedyard Name: ____________________

AMMONIA (NH_3) EMISSIONS ESTIMATE

The emissions estimates provided below are inclusive of ammonia emissions from the feedyard pen surfaces and the runoff holding pond(s). Ammonia emission rates are generally lower in the winter and higher in the summer.

Ammonia (NH_3) Emissions Estimate					
	Lowest Head Count		NH_3 Emission Rate (pounds/hd/day)		**NH_3 Lower Bound** (pounds/day)
NH_3 Lower Bound =		x	**0.16**[a]	=	
			[a]winter emission rate from research data		
	Permitted Head Count		NH_3 Emission Rate (pounds/hd/day)		**NH_3 Upper Bound** (pounds/day)
NH_3 Upper Bound =		x	**0.48**[b]	=	
			[b]summer emission rate from research data		

HYDROGEN SULFIDE (H_2S) EMISSIONS ESTIMATE

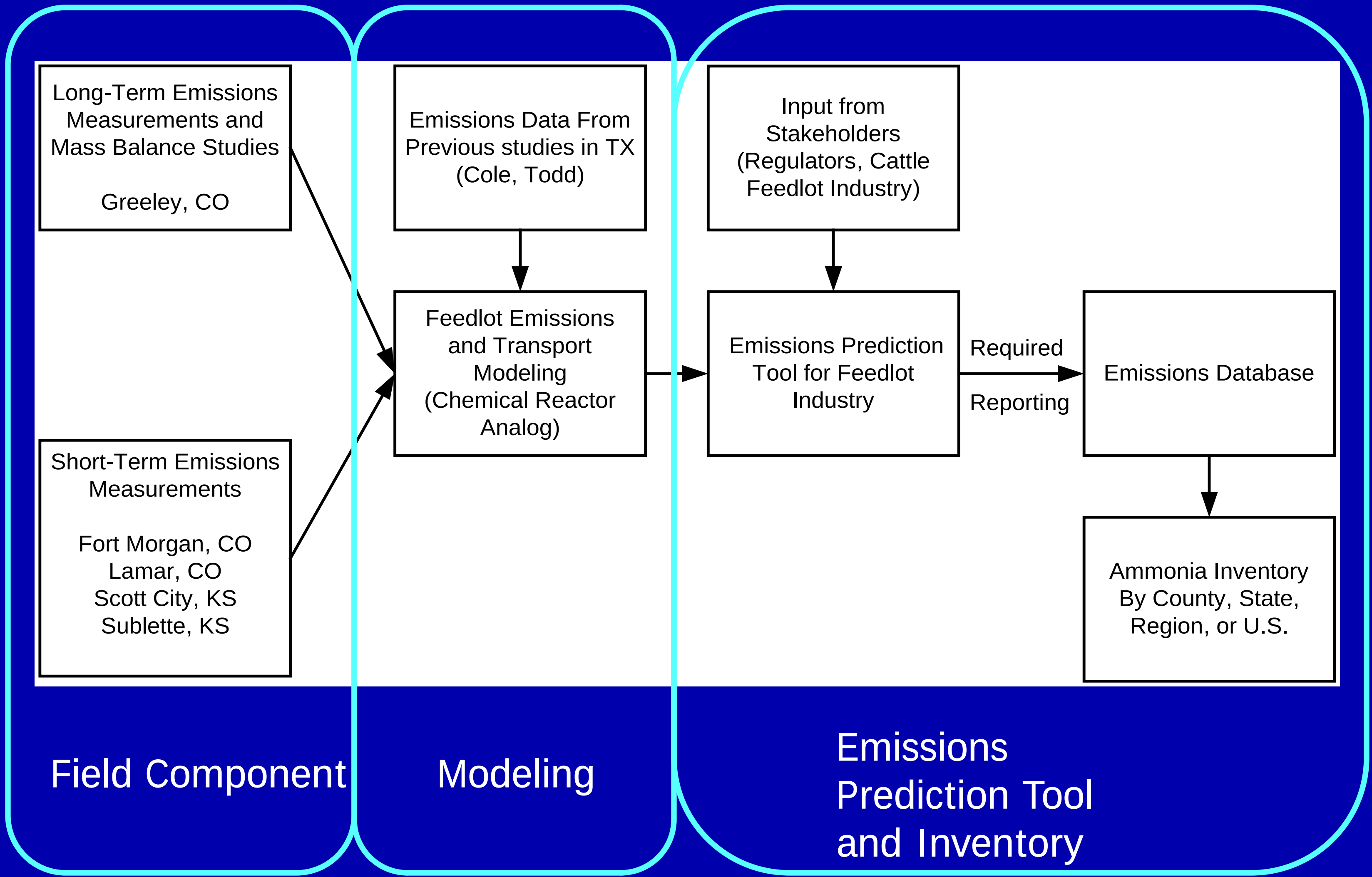
The emissions estimates provided below are inclusive of hydrogen sulfide emissions from the feedyard pen surfaces and the runoff holding pond(s). Hydrogen sulfide levels are fairly stable throughout the year, especially during dry weather conditions. Higher levels of hydrogen sulfide have been measured after rainfall/wet conditions.

Hydrogen Sulfide (H_2S) Emissions Estimate					
	Lowest Head Count		H_2S Emission Rate (pounds/hd/day)		**H_2S Lower Bound** (pounds/day)
H_2S Lower Bound =		x	**0.0047**[c]	=	
			[c]dry conditions emission rate from research data		
	Permitted Head Count		H_2S Emission Rate (pounds/hd/day)		**H_2S Upper Bound** (pounds/day)
H_2S Upper Bound =		X	**0.0085**[d]	=	
			[d]rainfall/wet conditions emission rate from research data		

EPA Project Goals

- Measurement and modeling of feedlot NH_3 losses to reduce uncertainty in emissions and the inventory.
- Develop tools that will improve the efficiency and accuracy of NH_3 reporting by feedlot managers.
- Identify points of intervention in the feedlot system where NH_3 emissions might be reduced.

Project Framework



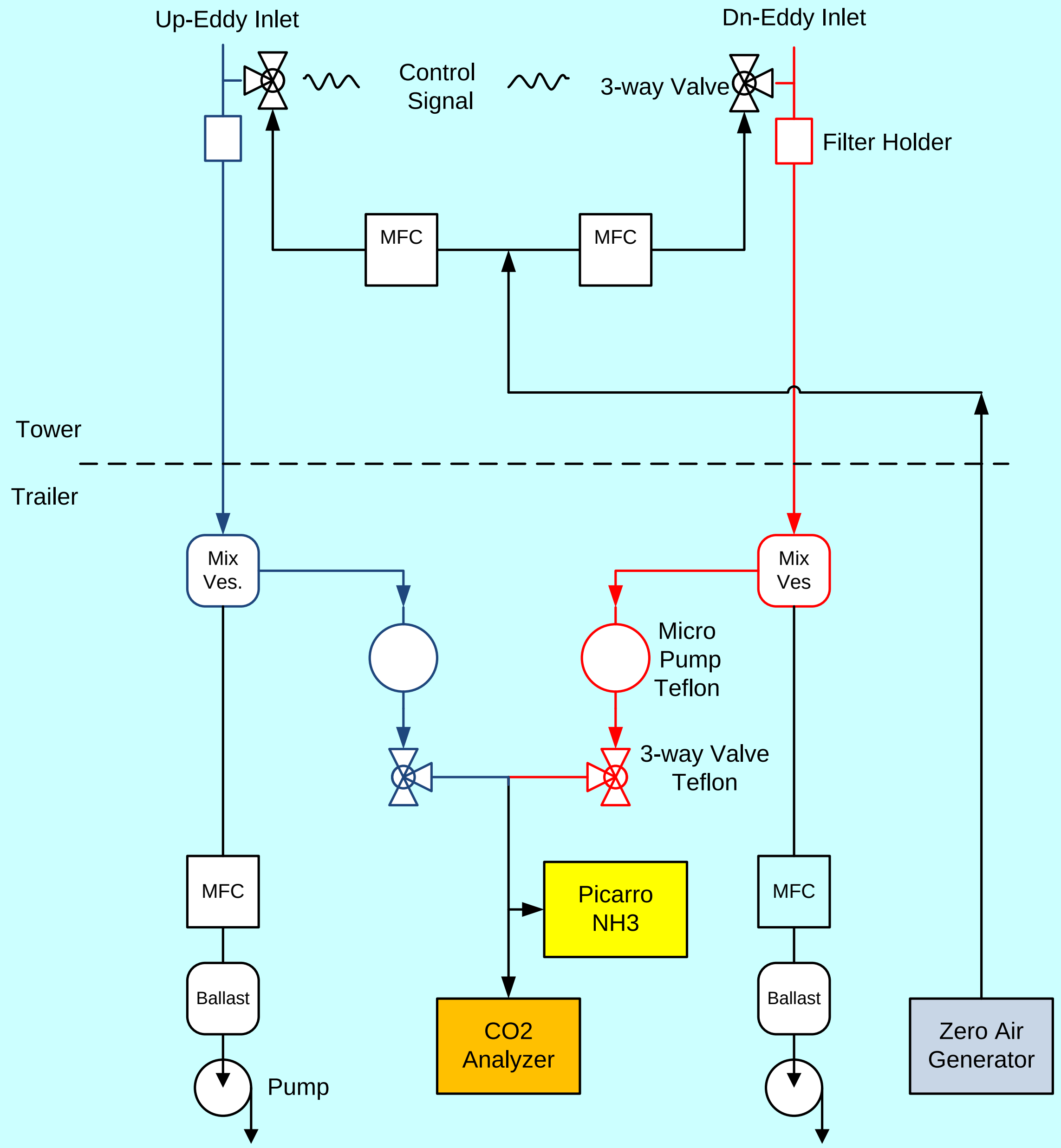
Field Component: REA System

New Research: Continuous REA Measurements of NH_3 Fluxes

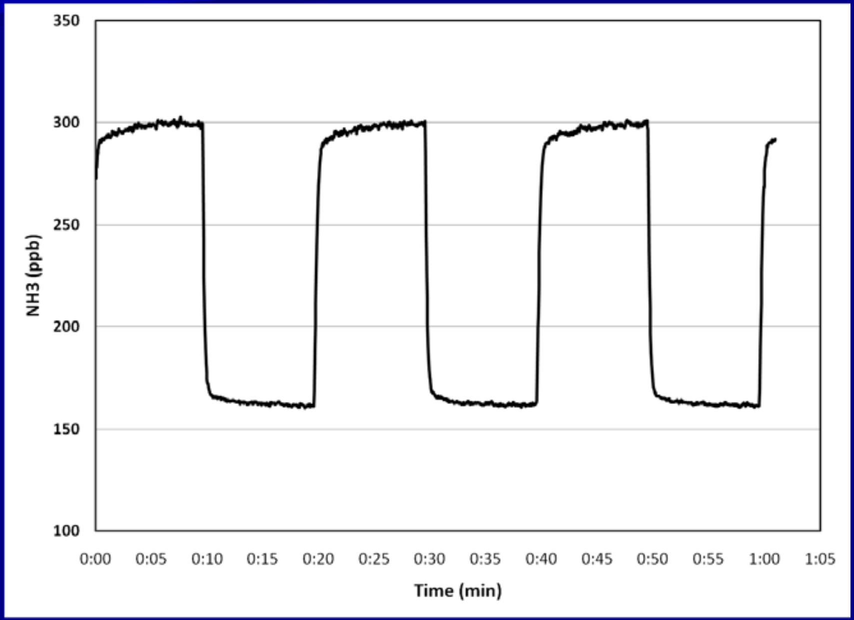
- Picarro 1103
- Ring-down Cavity Analyzer

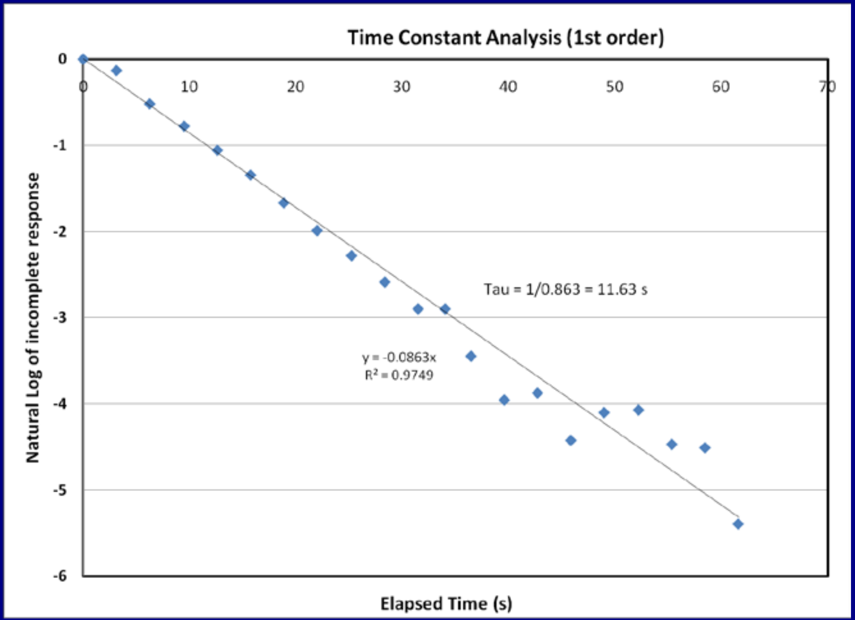
Picarro G1103

REA Air Sampling and Analysis System



Time Constant, Picarro 1103



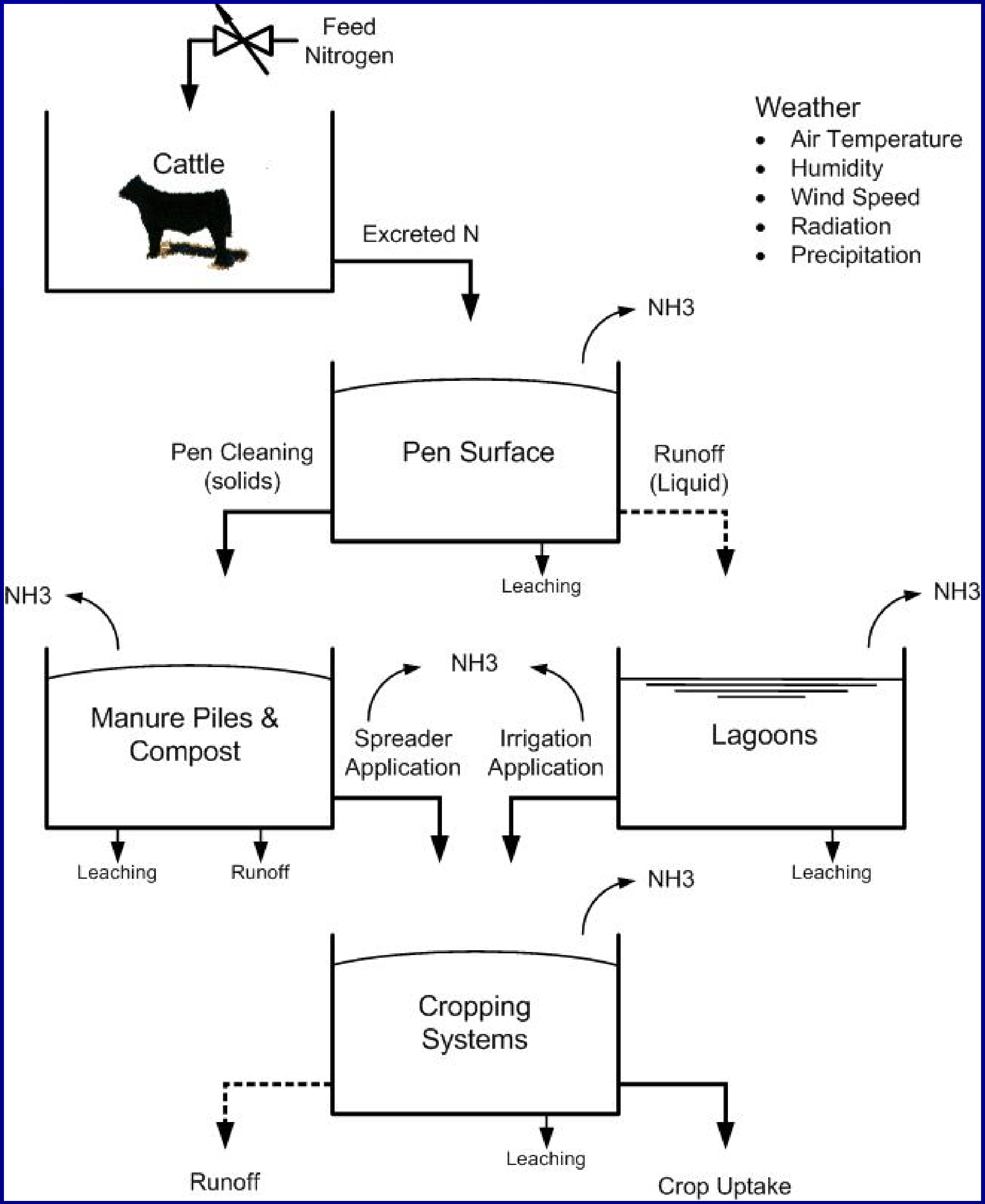


Next Steps with the REA System

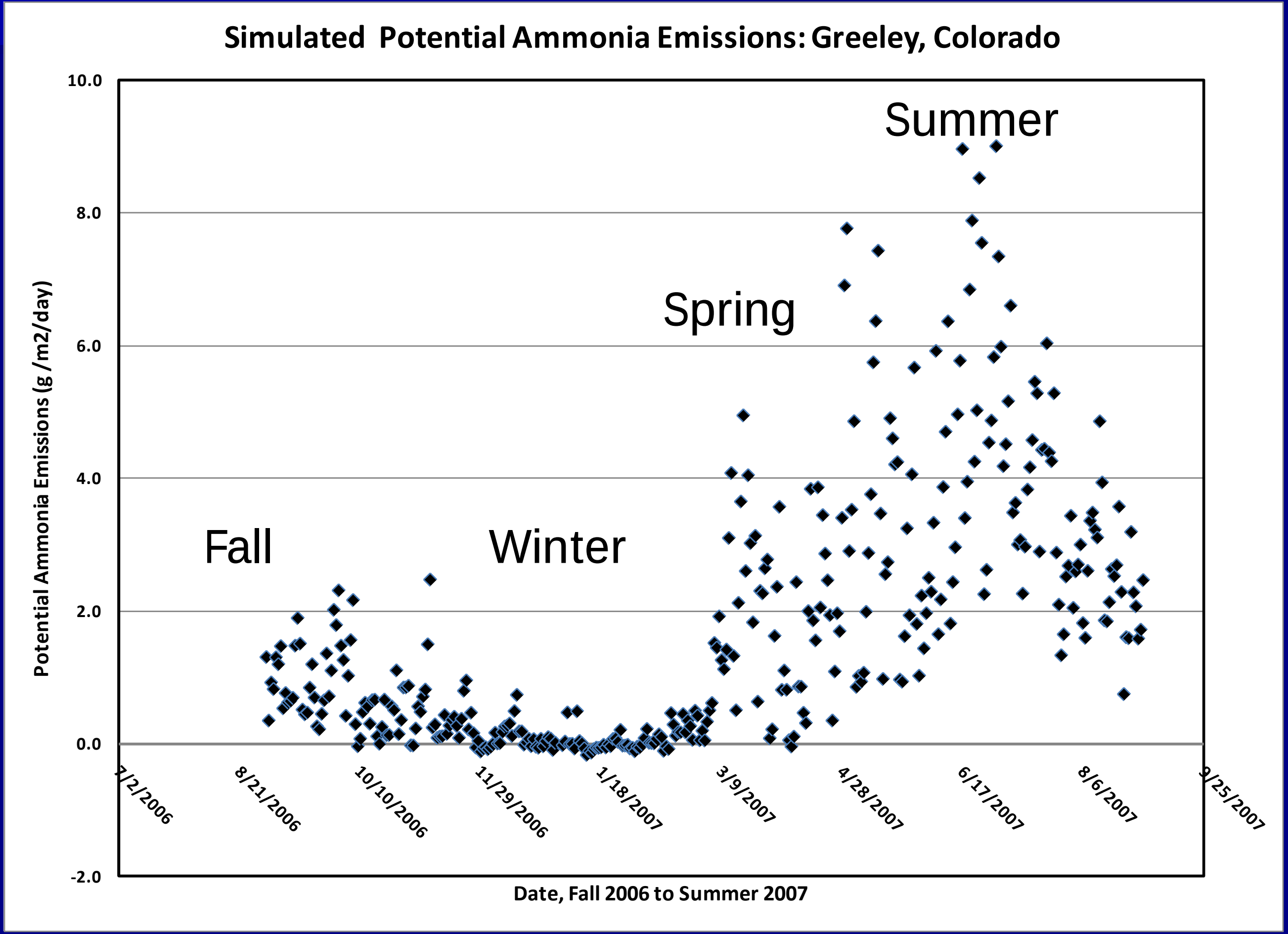
- Optimize REA system design with lab tests and simulations.
- Field deploy and compare fluxes to denuder-based REA
- Begin continuous NH_3 emission measurements in March 2011

Modeling the feedlot system as a series of tank reactors

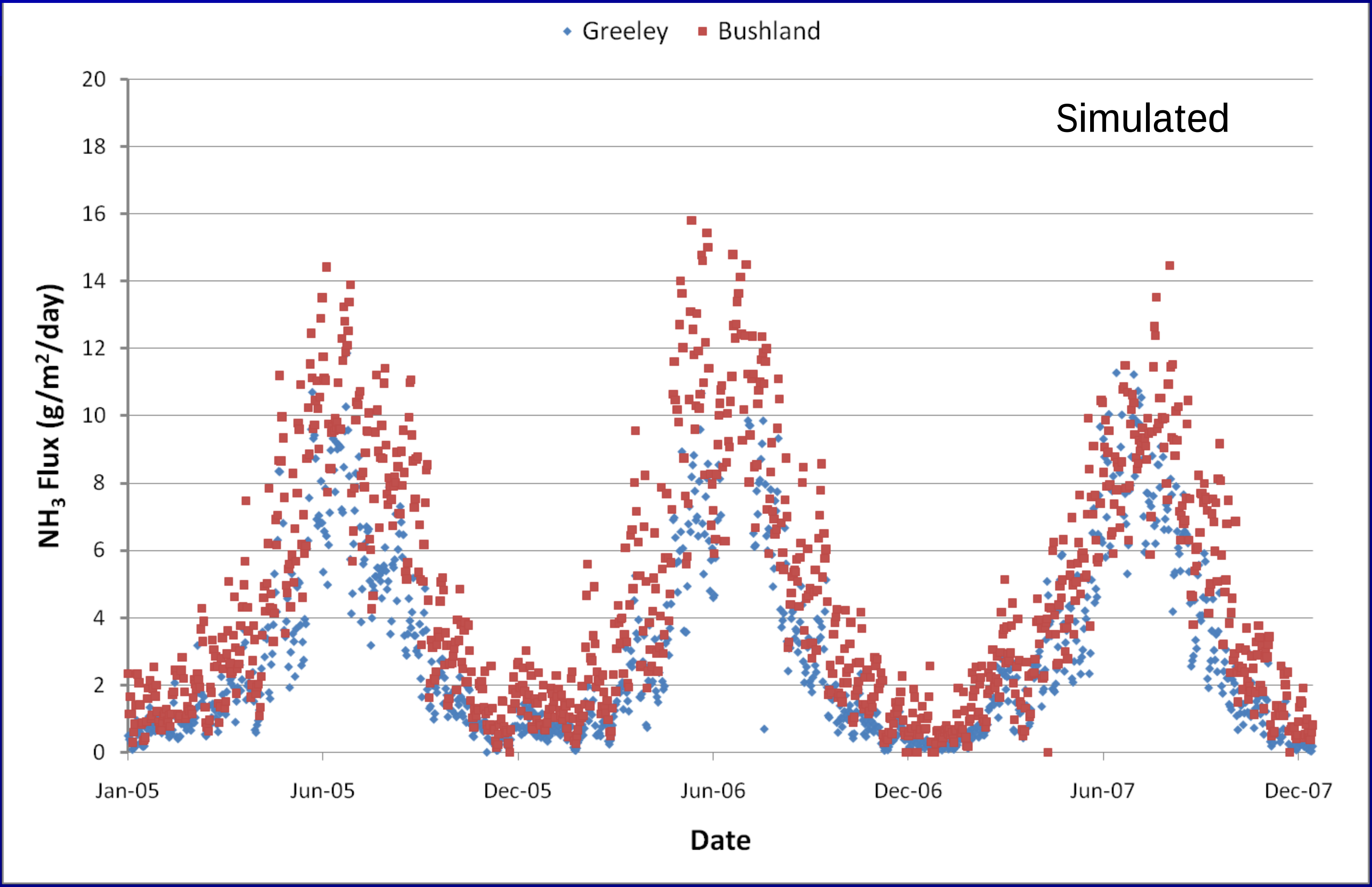
1. Maintains Mass Balance
2. Allows feedback with environment and management
3. Easily adapted for other compounds (GHGs)



Simulated NH_3 Emissions For Northern Colorado Feedlot

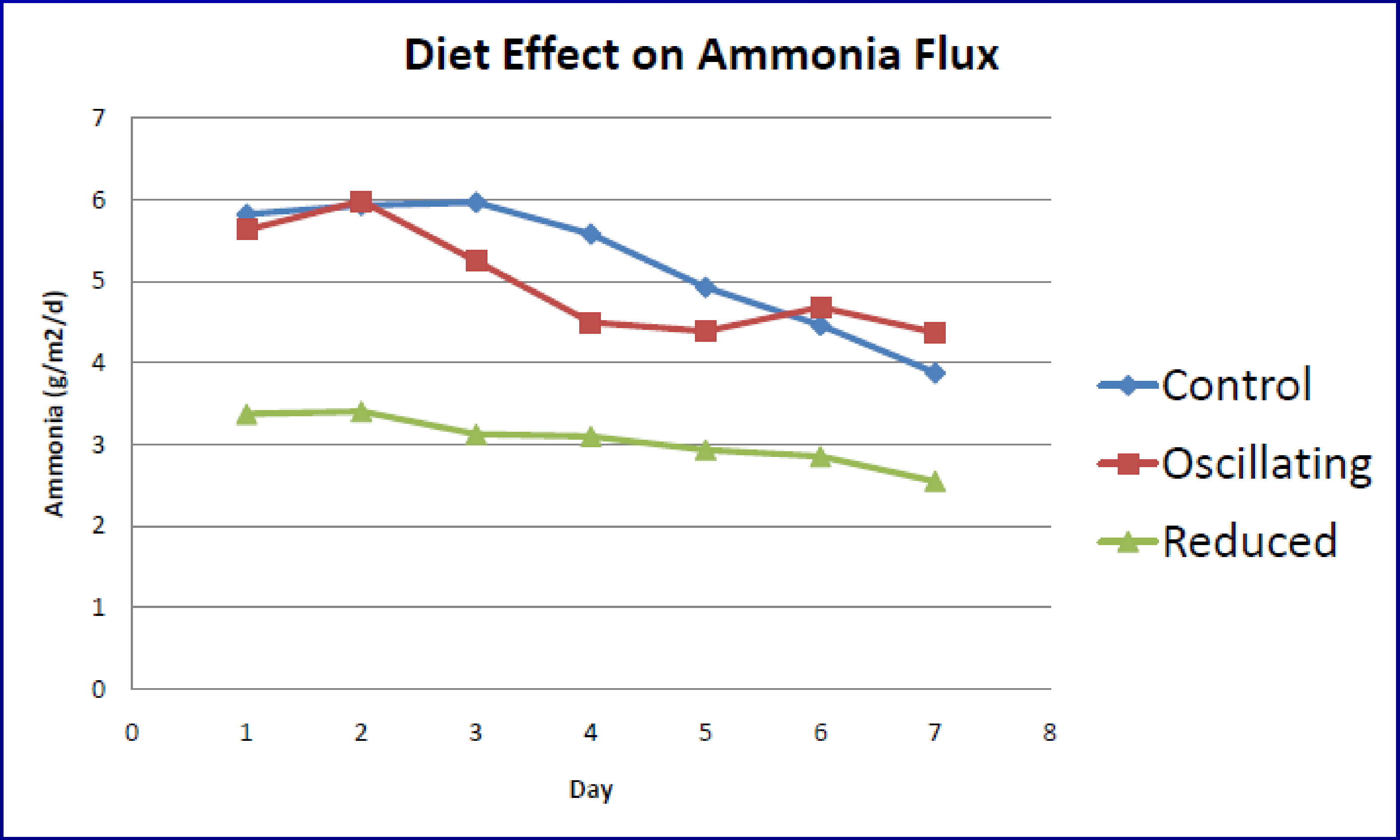


Potential NH_3 Feedlot Emissions



Emissions from Intact Soil Cores

Diet Study – Preliminary Results

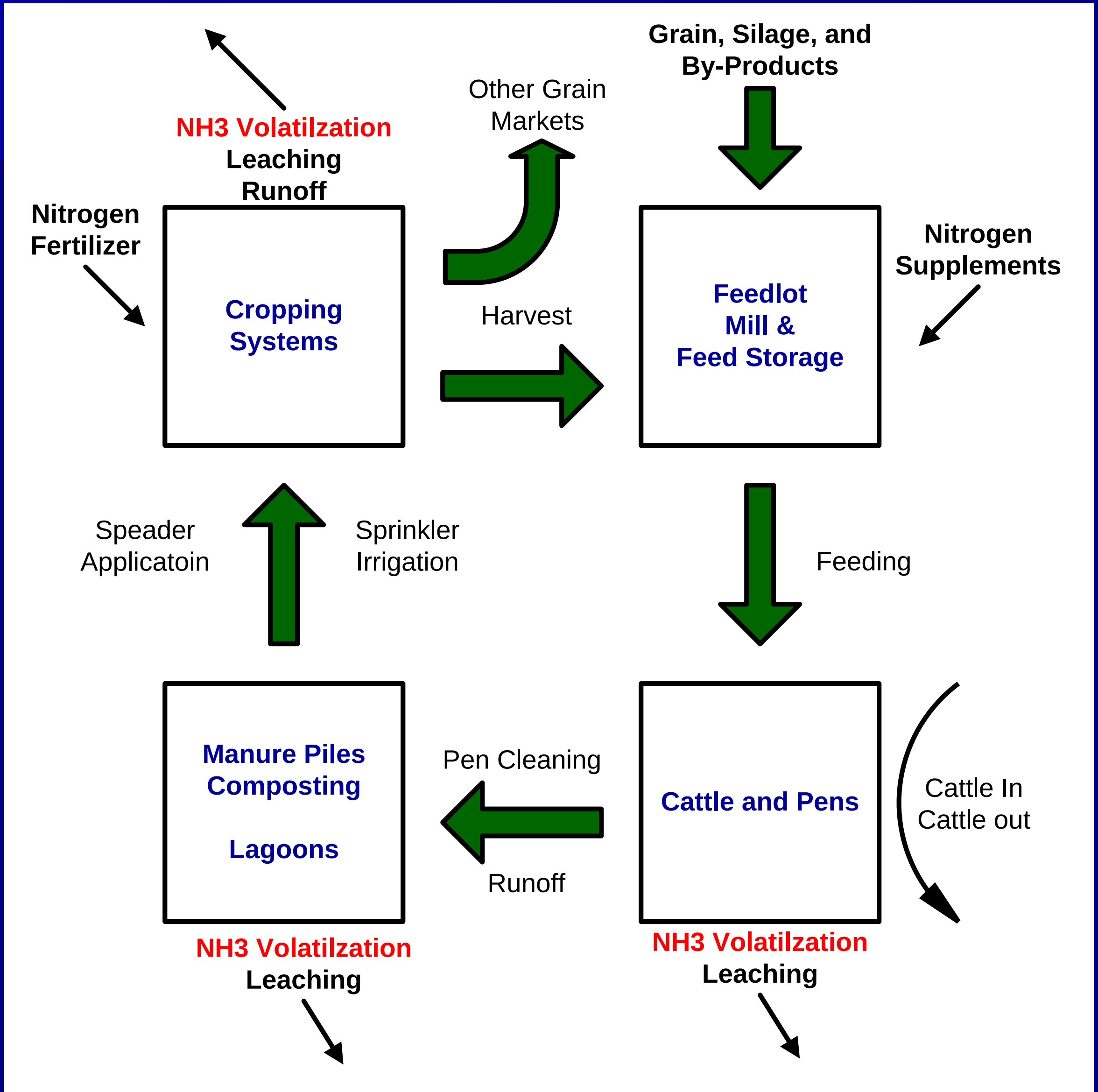


Reduced N diet: 42% reduction in total pen surface emissions compared to control diet

Next Steps: Modeling

- Lab studies to develop formula for the Henry's law and equilibrium constants in feedlot manure.
- Test submodels with soil core system
- Compare results to REA flux data from commercial feedlots

BMPs For Ammonia Require an Integrated Approach



Ham, 2008

Methane and Other GHGs