

US EPA ARCHIVE DOCUMENT

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

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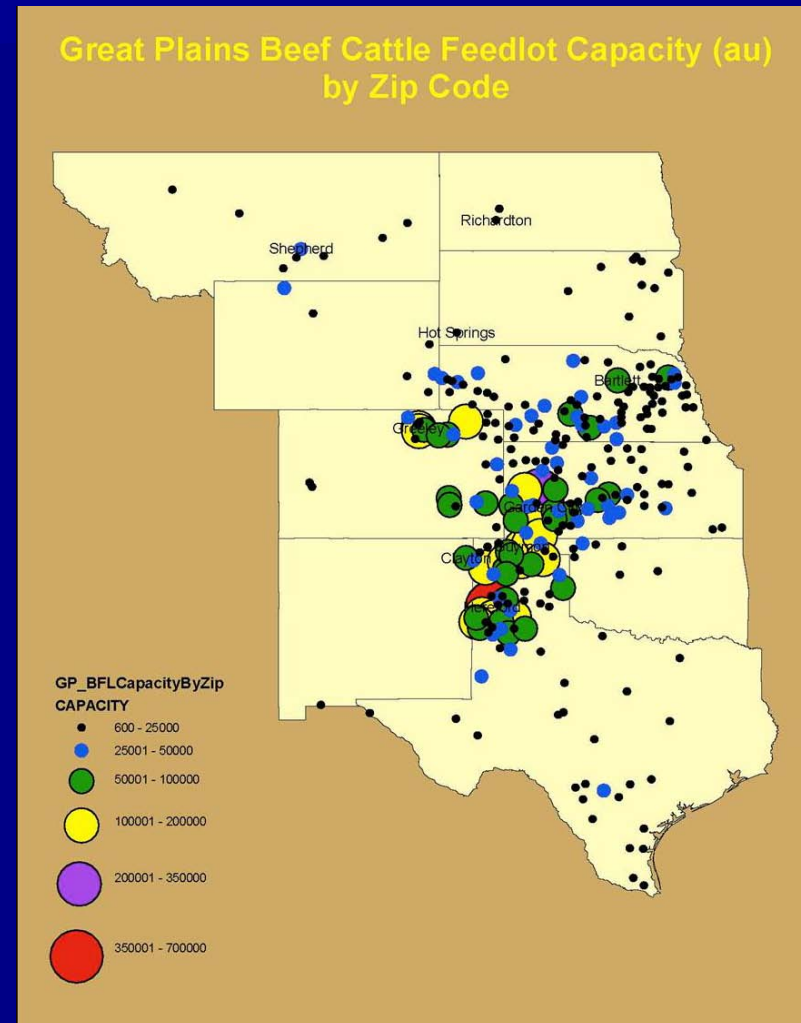
Brian Lamb, Kristen Johnson, Shelley Pressley

Washington State University



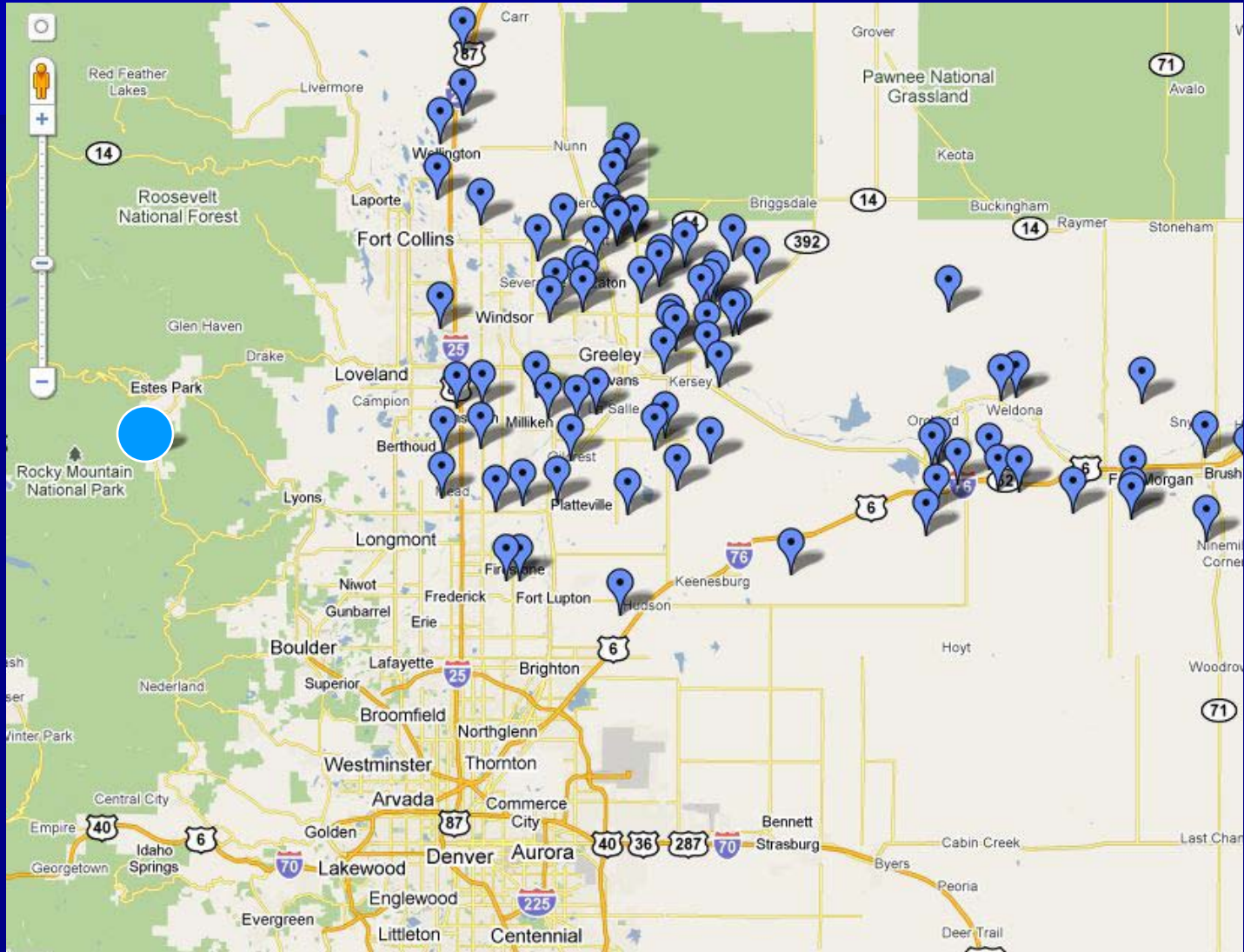
Where's the Beef ?

- 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

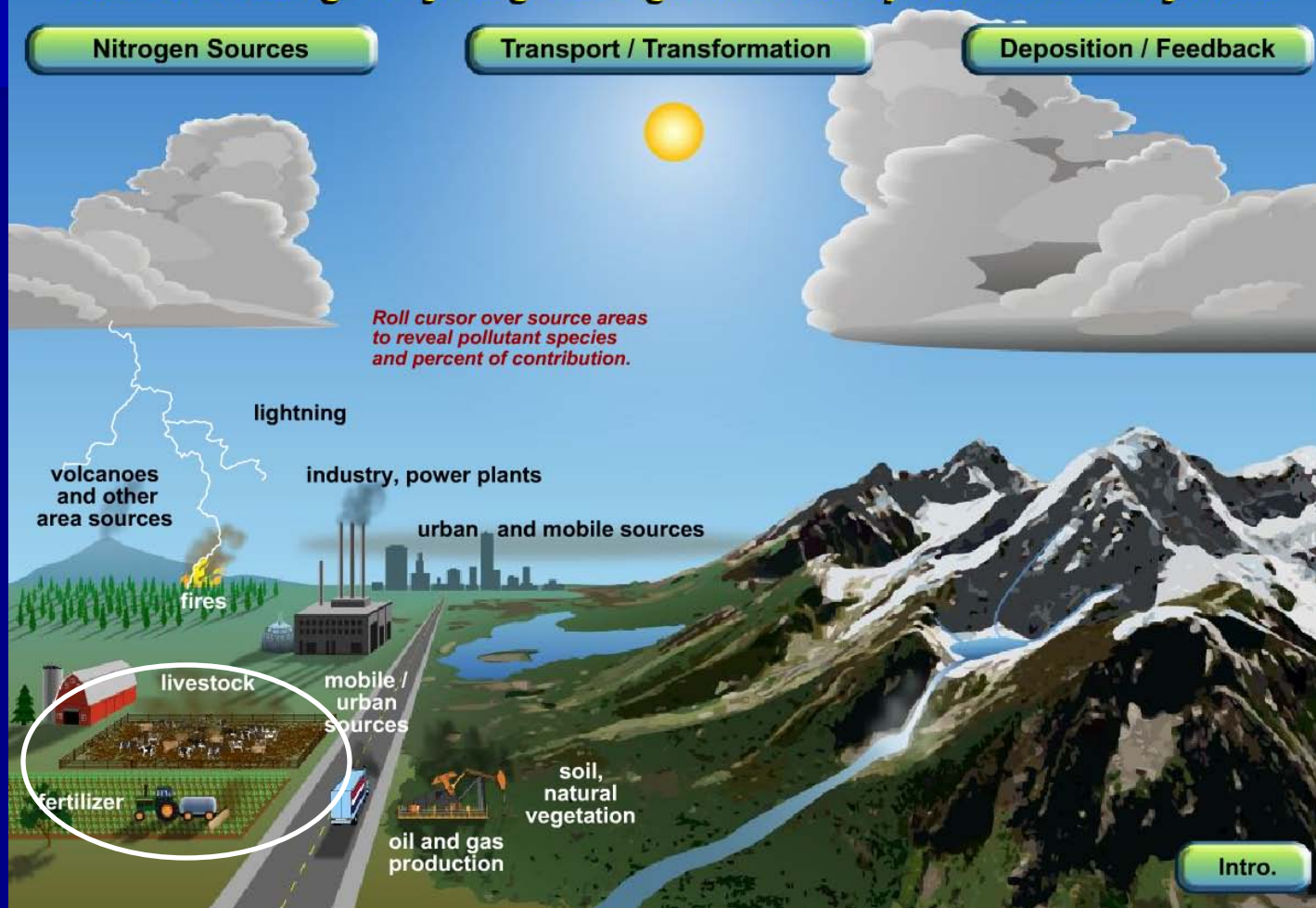


Reactive Nitrogen Cycling Through the Atmosphere and Ecosystem

Nitrogen Sources

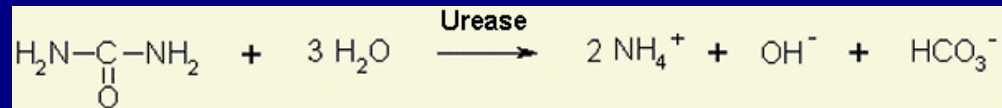
Transport / Transformation

Deposition / Feedback



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



Back-of-the-Envelope Inventory

9 million head x

0.205 kg N excreted /d x

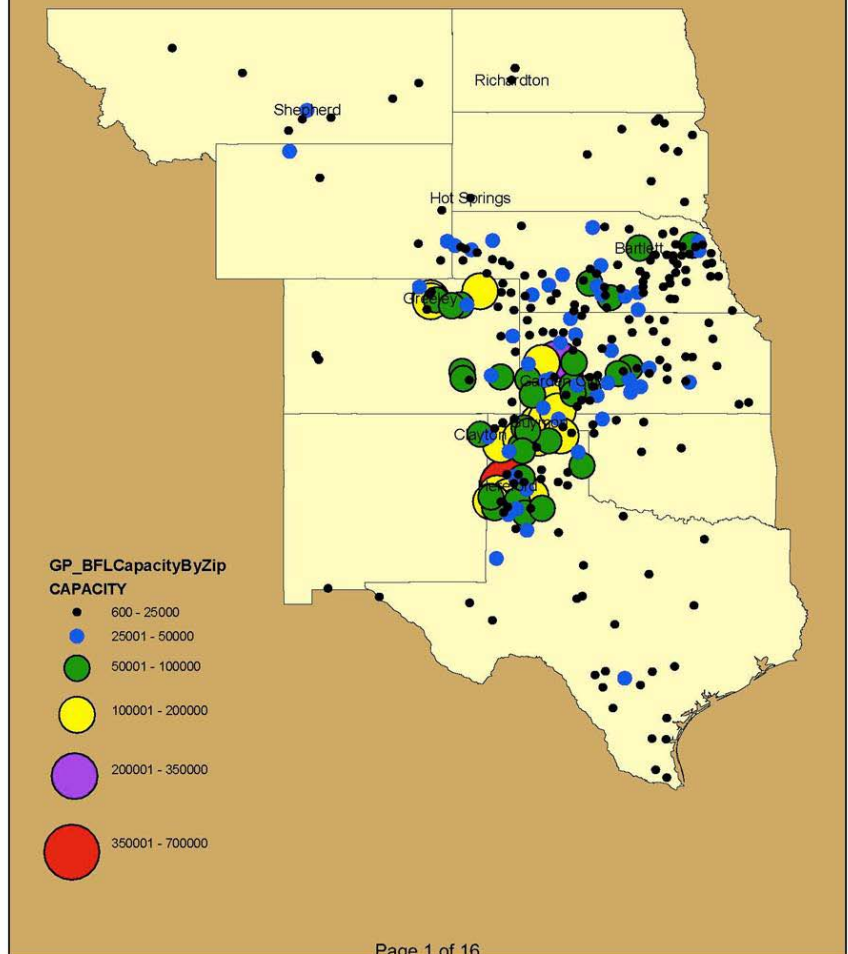
365 days

673,425 metric tons N/year

≈ 336,712 metric tons NH₃

Could be 10% of
total U.S. inventory

Great Plains Beef Cattle Feedlot Capacity (au)
by Zip Code



Cattle Feedlot NH₃ Reporting Requirements

EPCRA, good faith air emissions estimates on NH₃ and H₂S 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 (NH₃) 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 (H₂S) 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.

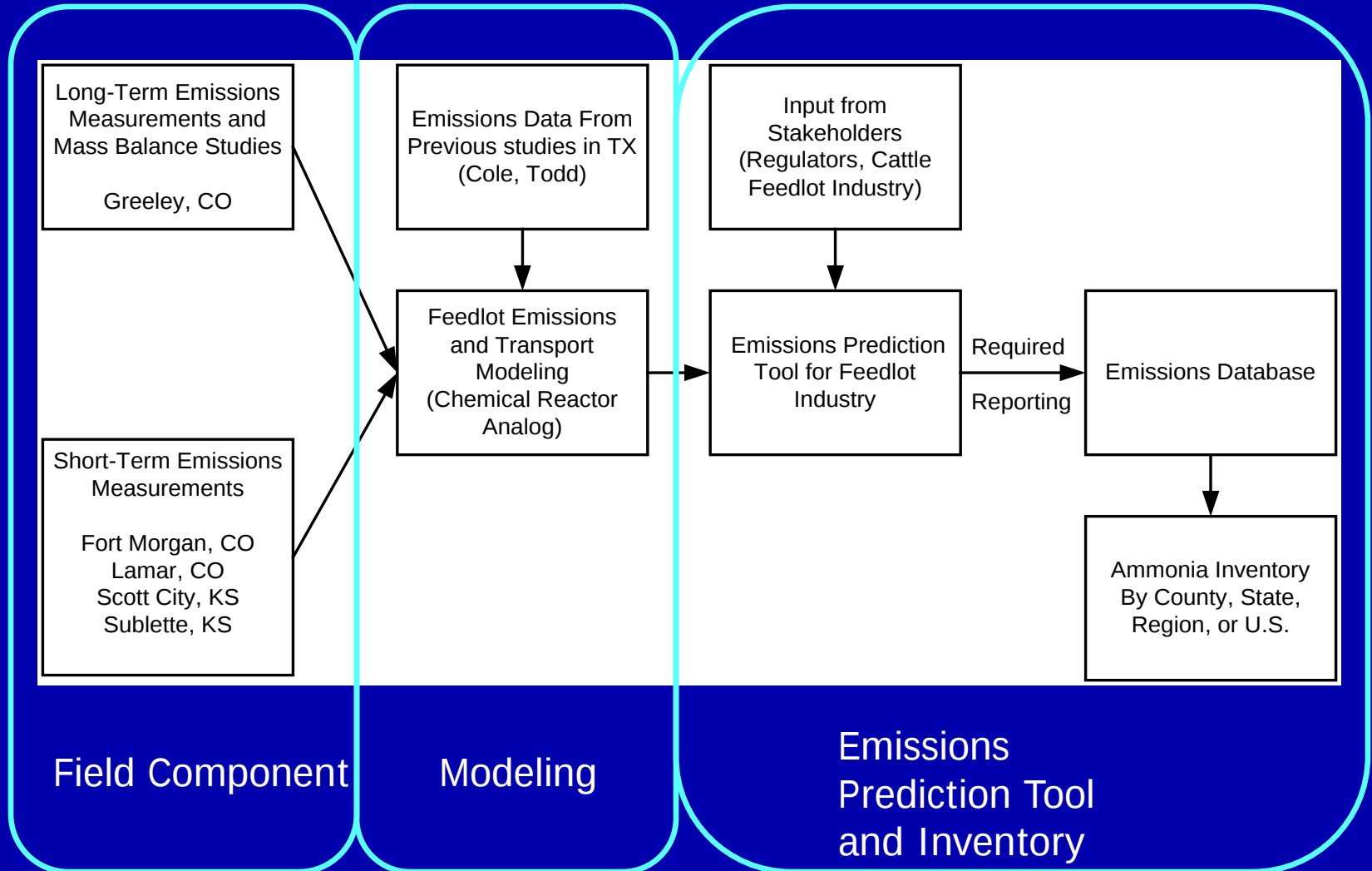
Hydrogen Sulfide (H ₂ S) Emissions Estimate				
	Lowest Head Count		H ₂ S Emission Rate (pounds/hd/day)	H ₂ S Lower Bound (pounds/day)
H ₂ S Lower Bound =		x	0.0047 ^c	=
^c dry conditions emission rate from research data				
	Permitted Head Count		H ₂ S Emission Rate (pounds/hd/day)	H ₂ S Upper Bound (pounds/day)
H ₂ S 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



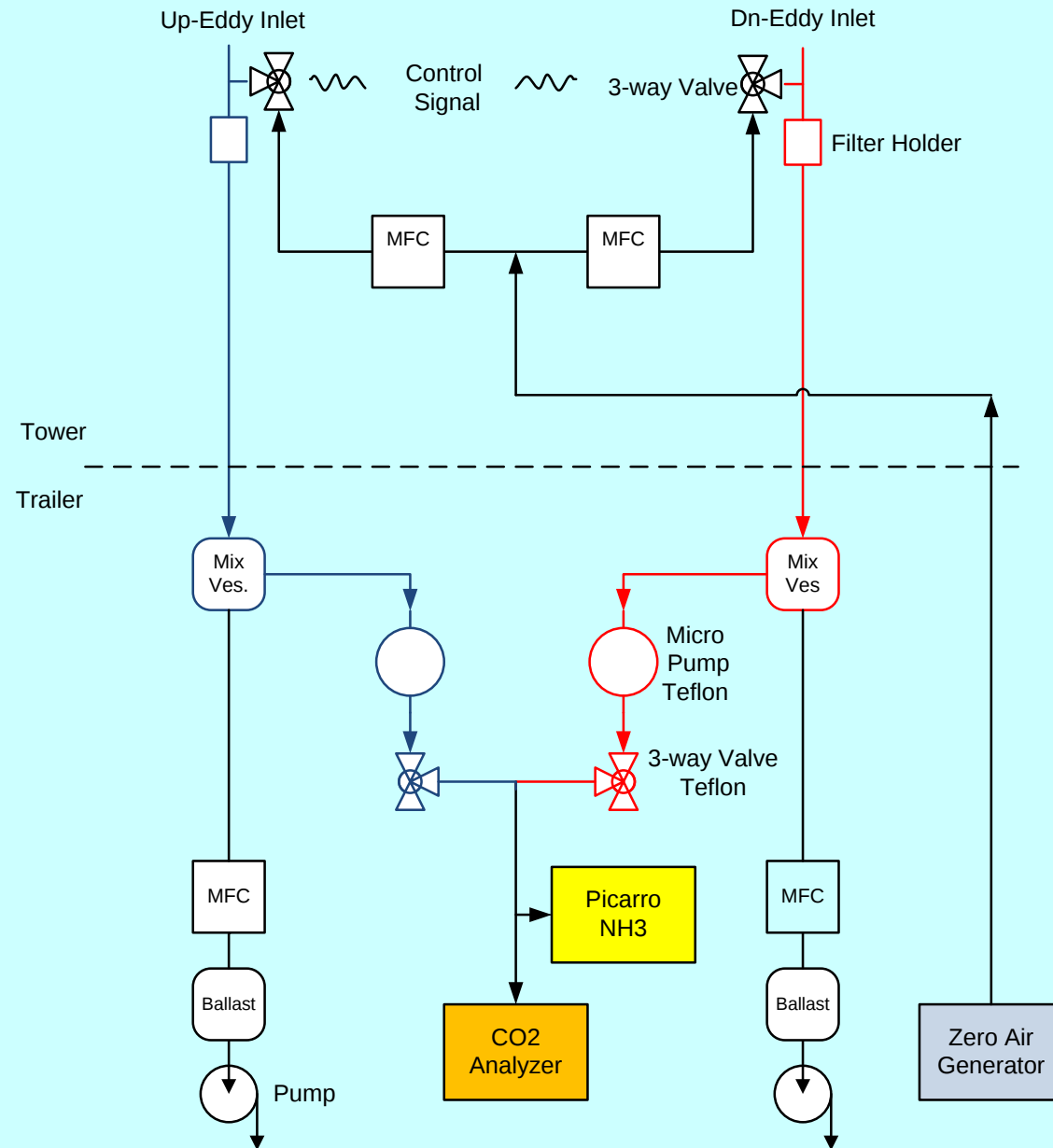
New Research: Continuous REA Measurements of NH_3 Fluxes

- Picarro 1103
- Ring-down Cavity Analyzer

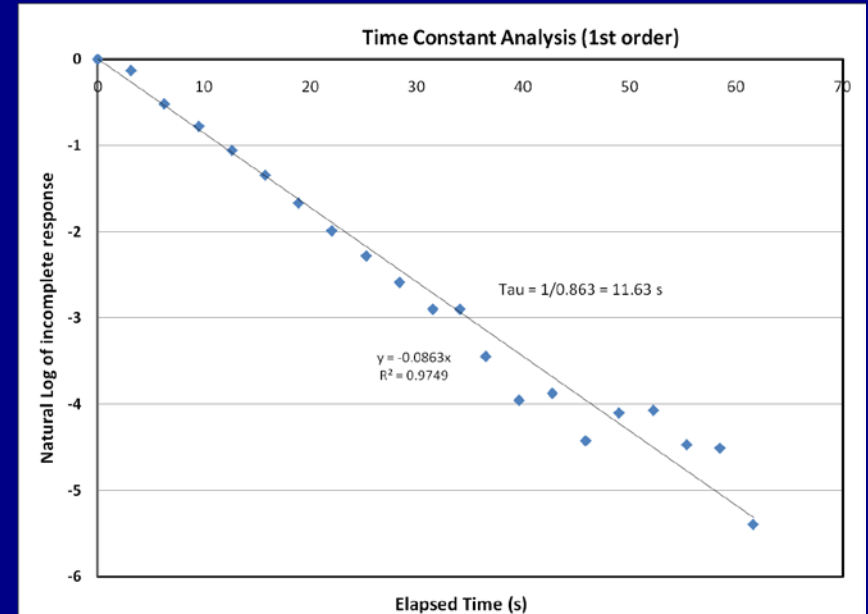
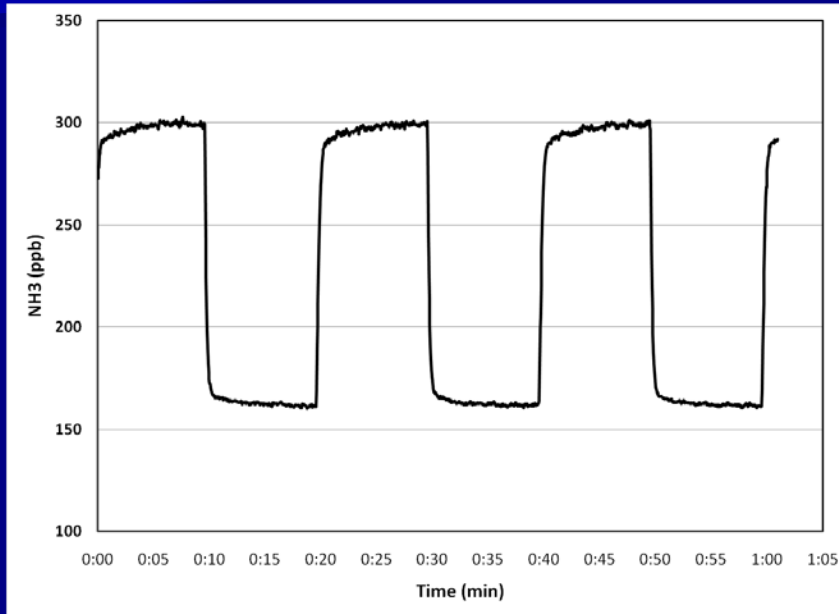


Picarro G1103

REA Air Sampling and Analysis System



Time Constant, Picarro 1103



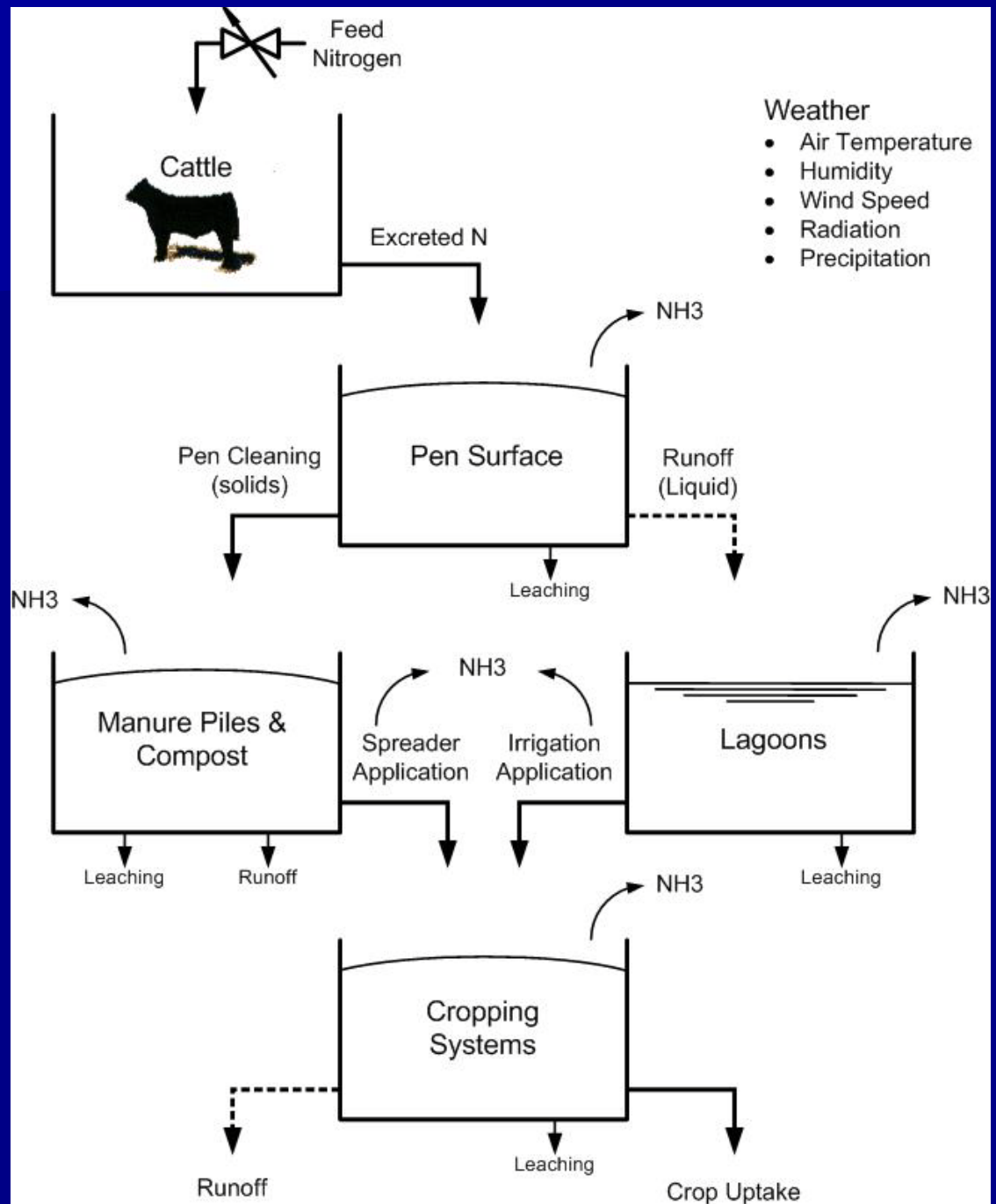
Next Steps with the REA System

- 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

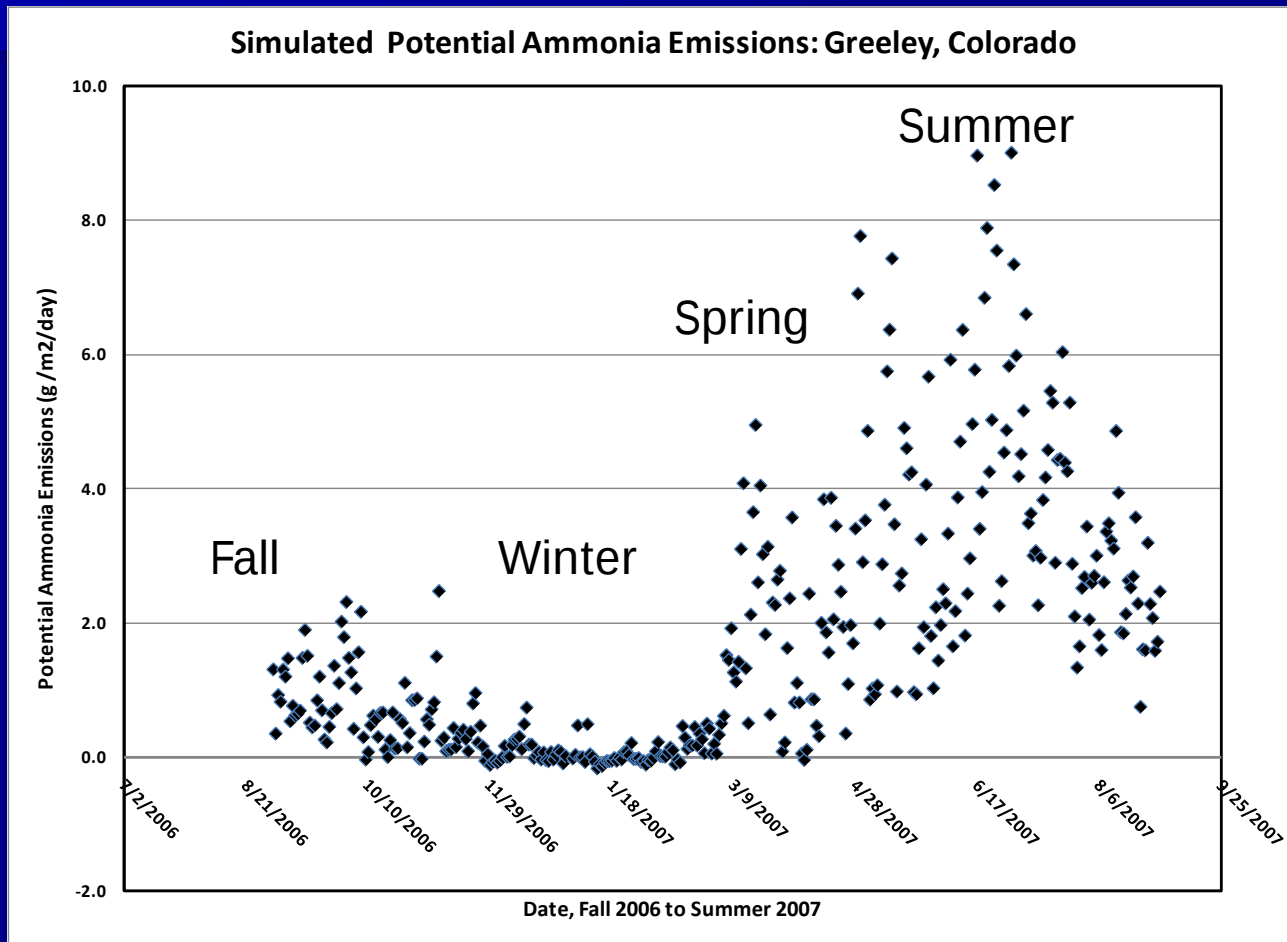


Modeling the feedlot system as a series of tank reactors

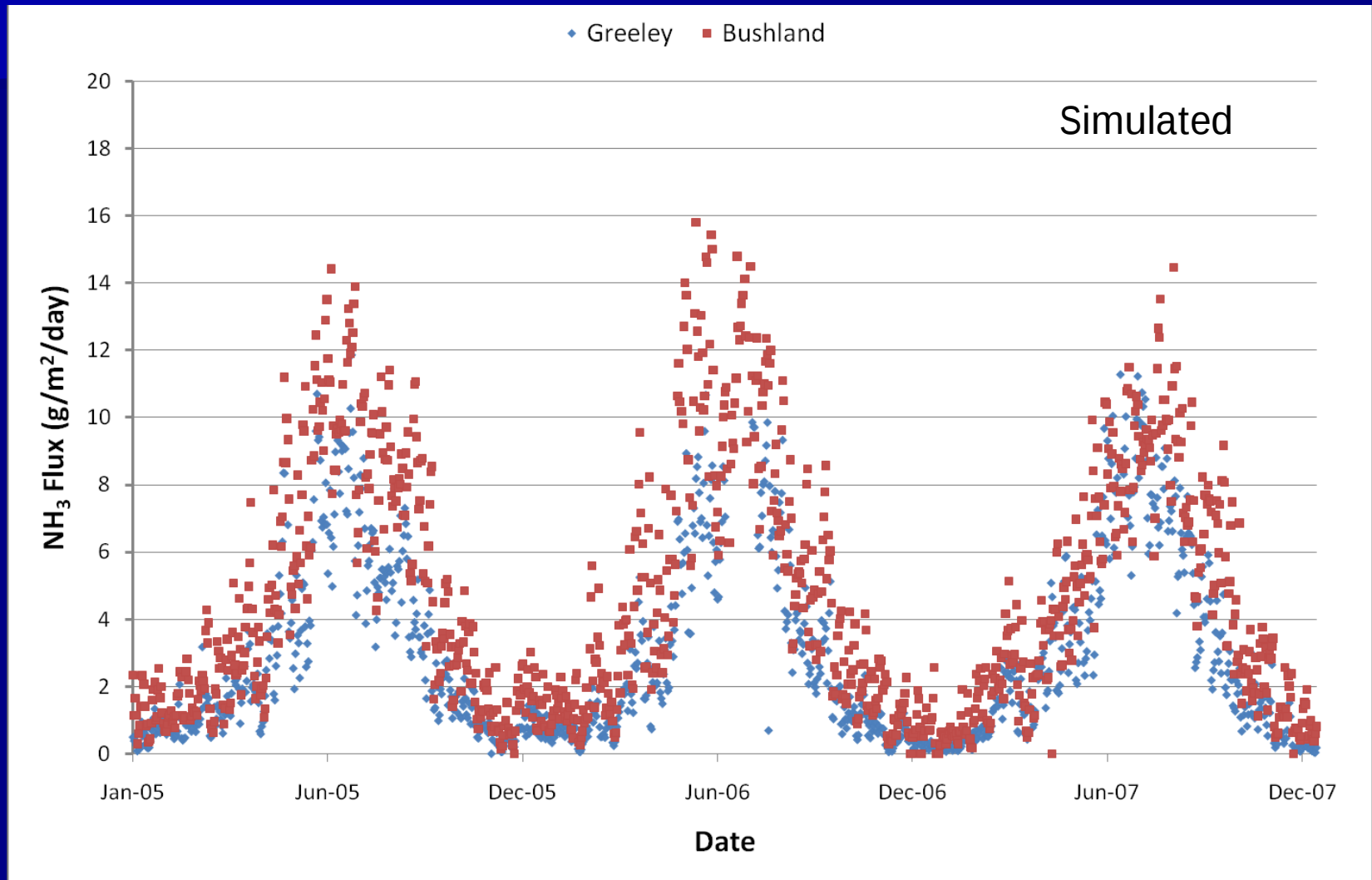
1. Maintains Mass Balance
2. Allows feedback with environment and management
3. Easily adapted for other compounds (GHGs)



Simulated NH_3 Emissions For Northern Colorado Feedlot



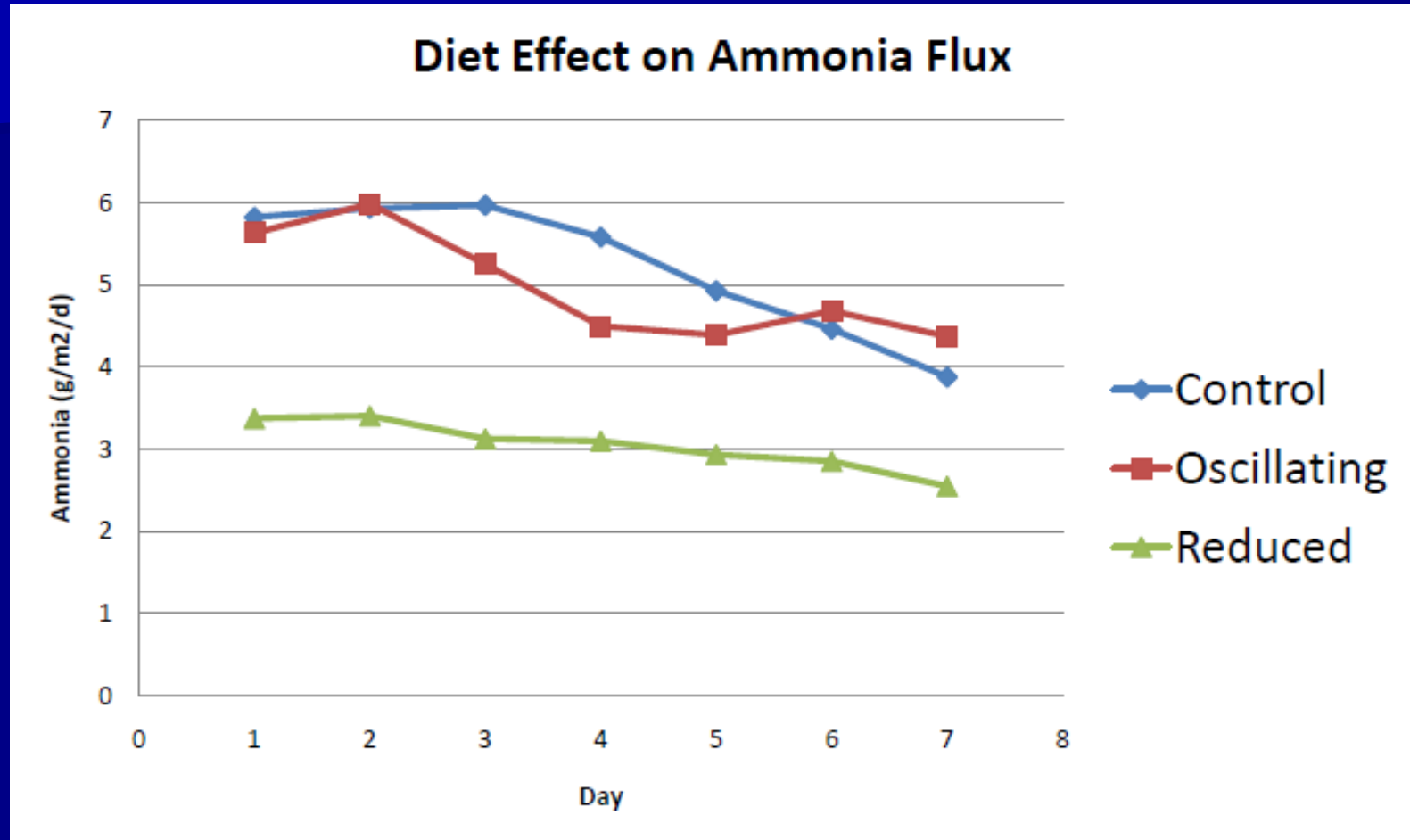
Potential NH₃ Feedlot Emissions



Emissions from Intact Soil Cores



Diet Study – Preliminary Results



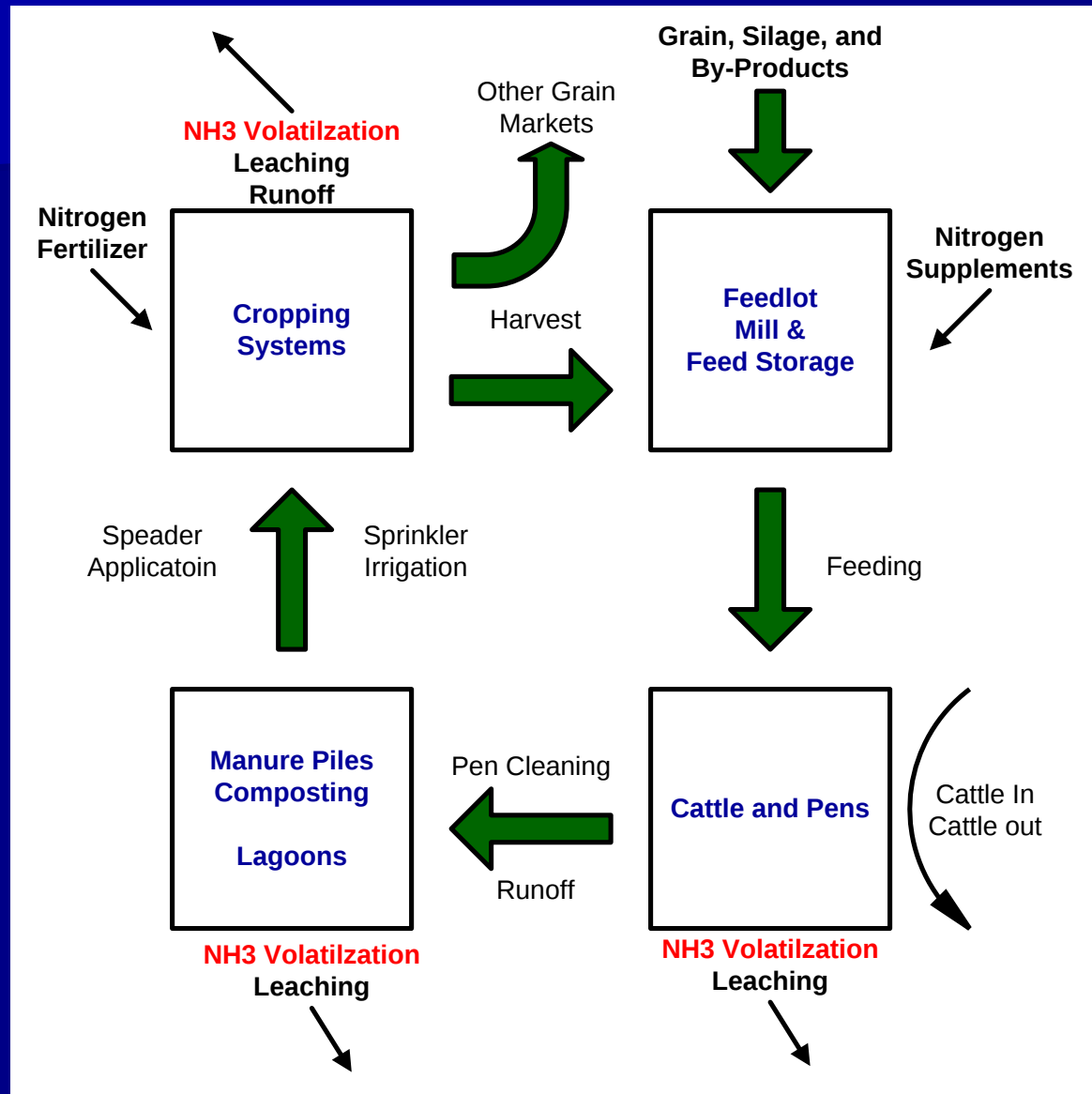
Reduced N diet: 42% reduction in total pen surface emissions compared to control diet

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



Methane and Other GHGs

