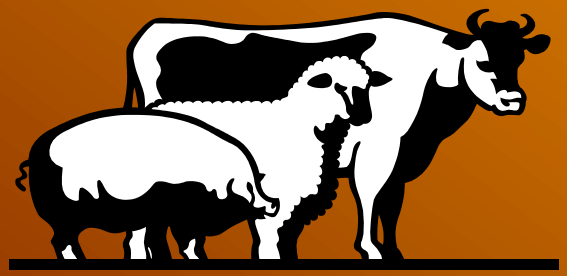
Gaseous Emissions from Manure-impacted Environments

Dan Miller

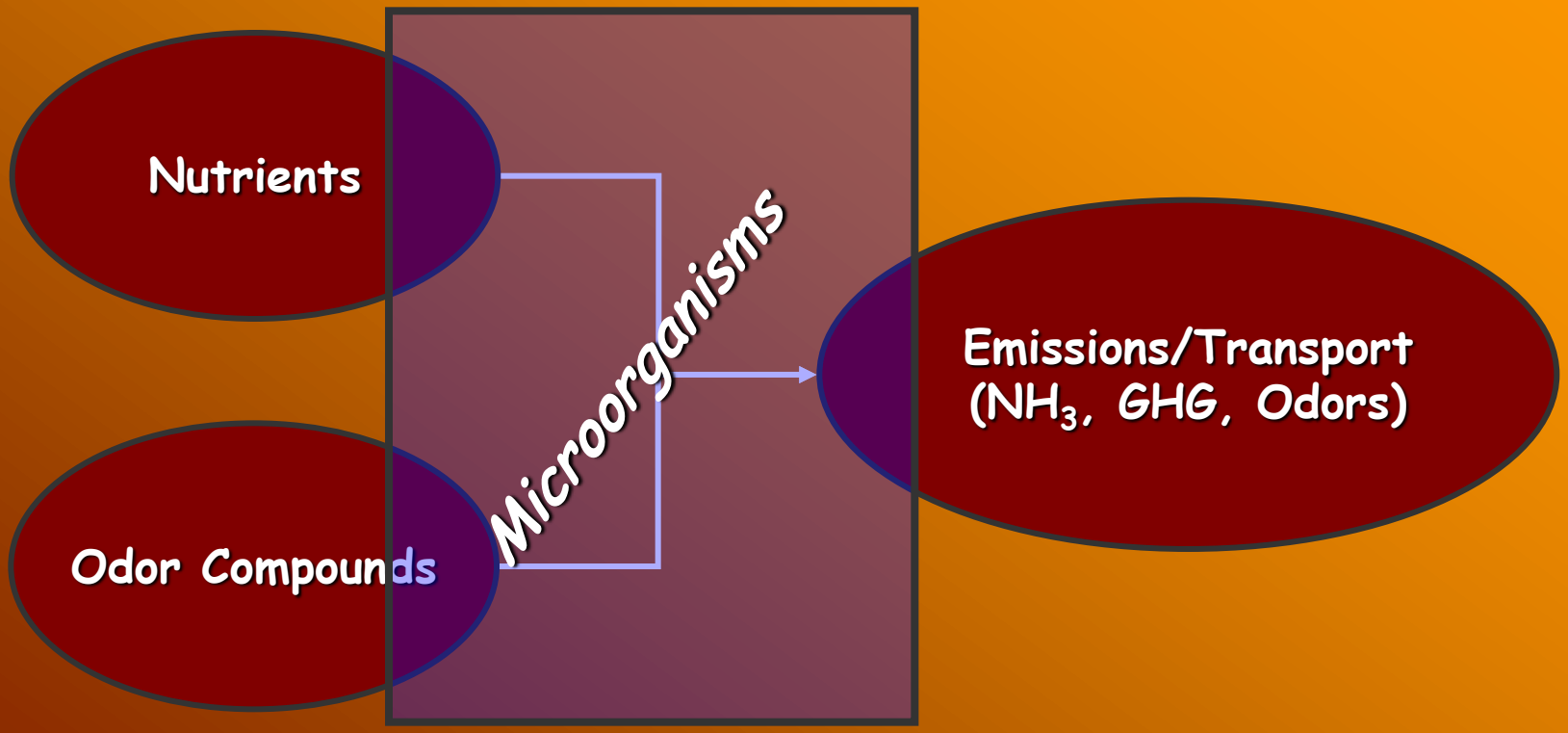


ARS Personnel

- Odors & Gas Emissions (Dan)
- Nutrients (John)
- Pathogens & antibiotic resistance (Lisa)
- Technicians (2)
- Students (3 to 6)

→ Environmentally Sound Manure Management

Research Interests



Manure-impacted Environments

Research Questions

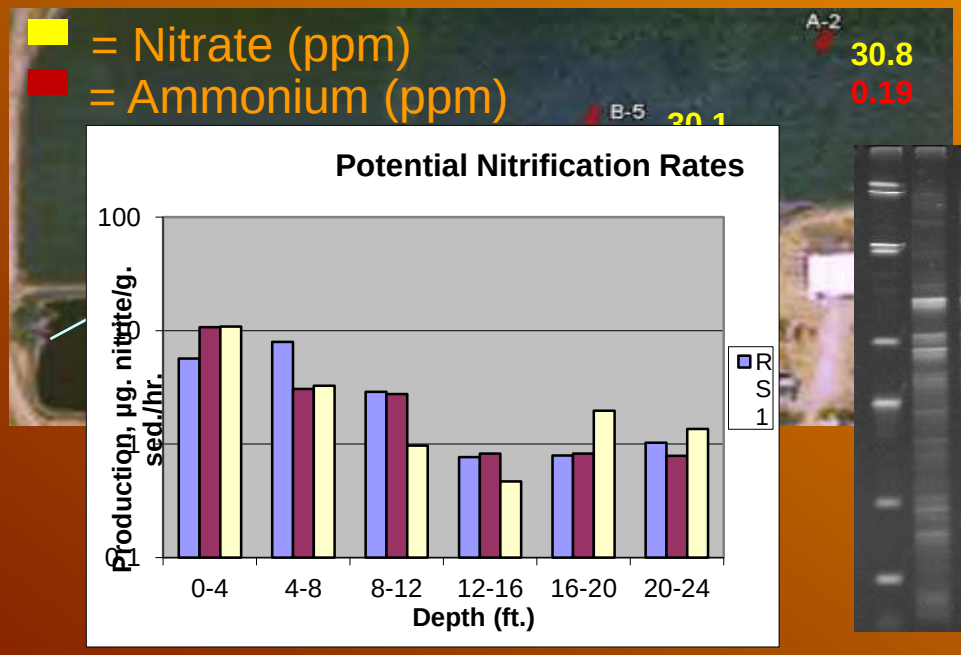
- Nutrient Fate
  - ✓ Nitrogen (NH_3, N_2O, NO_2, NO_3)
  - ✓ Sulfur (H_2S)
- Odor Production & Relative Emission
  - ✓ Manure composition (starch or protein?)
  - ✓ Lab/field chambers
  - ✓ GC/MS analysis
- Microbial Processes
  - ✓ Nitrification/Denitrification
  - ✓ S & Fe oxidation/reduction
  - ✓ Methanogenesis
  - ✓ Fermentation

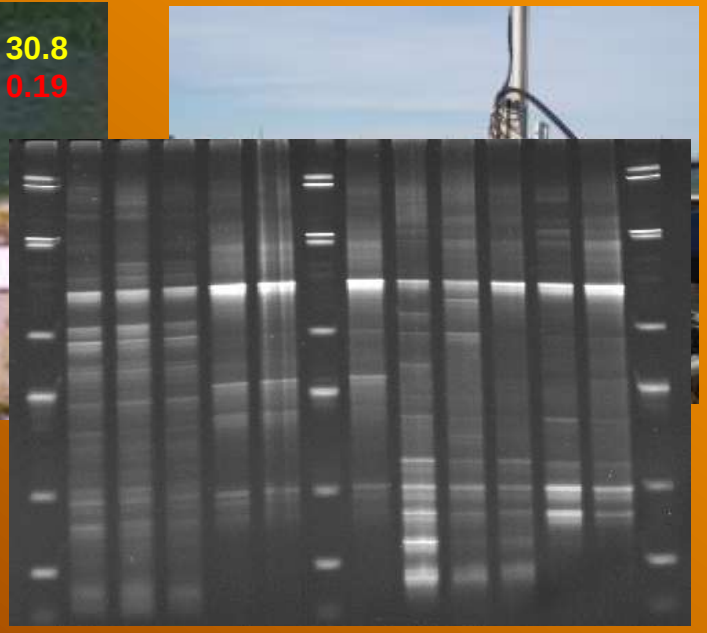
Ongoing Projects—Dairy N

- Where is the nitrogen?
  - ✓ Soil (no)
  - ✓ Crop uptake (no)
  - ✓ Ammonia losses (no)
  - ✓ Denitrification or AnAmmOx…

Ongoing Projects—Holding Ponds

- How are microorganisms helping to clean up high nitrogen groundwater?





Ongoing Projects—Lagoon Covers

- Are microorganisms in lagoon biocovers an important part of emission control?

Potential Nitrification Rate (micromoles NO_2 m^{-2} d^{-1})

Sample	Site A	Site B	Site C
New Biocover	-1.3	0.0	0.0
Mature Biocover	**143.3***	-28.4	**1657.0***
Wastewater	0.9	0.0	**551.1***
Buffer	0.4	0.0	0.0

Potential Denitrification Rate (millimoles NO_X m^{-2} d^{-1})

Sample	Site A	Site B	Site C
New Biocover	-0.1	-0.9	-0.9
Mature Biocover	**2.0***	**2.5***	**3.7***
Wastewater	0.0	**2.9***	-1.0
Buffer	-0.7	-0.4	-0.2

Number of Positive Amplifications from Three Samples

		Bacteria				Archaea	
Site	Location	General 16S	BamoA 16S	CTO 16S	amoA gene	General 16S	amoA gene
A	Biocover	3	3	3	2	3	0
	Wastewater	3	0	0	0	3	0
B	Biocover	3	1	2	0	3	0
	Wastewater	3	0	0	1	3	0
C	Biocover	3	3	3	3	3	0
	Wastewater	3	3	3	3	3	0

- **Since the nitrification potential in the biocover is only 0.1 to 2 micromole m^{-2} d^{-1}, the biofilm community has a limited effect (2% or less) on NH_3 emission.**
- **PCR results indicate that *Betaproteobacteria* nitrifiers are present in the microbial community.**

Ongoing Projects—Distillers Byproducts & Emissions

- Do distillers byproducts (high in S) result in higher reduced sulfur emissions in feedlots?

Manure Composition

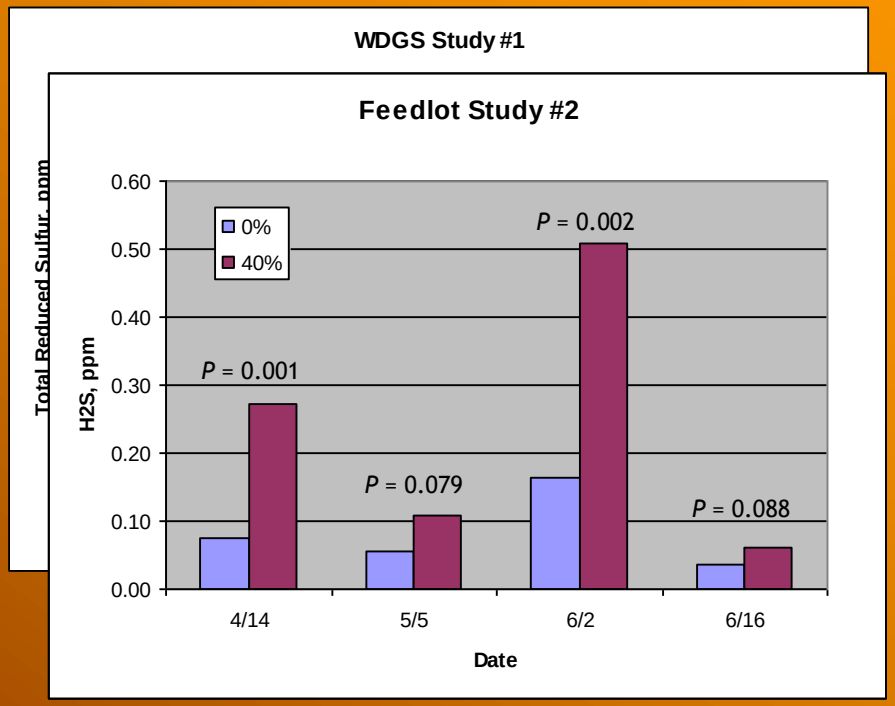
	WDGS in diet (% DM basis)				
Constituent	0%	20%	40%	60%	SEM
Total S (mg/g DM)	5.1[a]	8.7[b]	11.7[c]	14.2[d]	0.3
H_2S-S (μg/g DM)	1.57[a]	3.07[a]	8.85[b]	16.41[c]	0.88

Feeding >20% WDGS increases H_2S content in the manure.

Ongoing Projects—Distillers Byproducts & Emissions

- How do the relative fluxes of reduced S compare?

Fresh Manure Flux



What about other odor compounds (VOC)?

Ongoing Projects—Manure Emissions & Storage Structures

- Do odor compound emissions differ based upon swine manure structure? Do they change over a year? What about when it is applied to crops?

Relative Emission

Amt (ng on fiber)	Lagoon	Pit	Tank
Total Alcohols	3.26[a]	4.49[a]	2.81[a]
Total VFA	0.76[a]	2.36[ab]	3.32[b]
Total Aromatics	2.77[a]	41.06[b]	21.42[c]
Total VOC	8.70[a]	121.41[b]	80.51[b]

- <u>Seasonal Effect</u>: Total alcohols (P), total VFA (L), total aromatics (LPT), total VOC (P).
- Highest rel. emissions in winter & spring.

Ongoing Projects—VTS

- How do nutrients, pathogens, pharmaceuticals, and antibiotic resistant microbes behave in VTS treatment cells?

VTS design—Chris Henry, UNL

VTS Research Questions

- Persistence at the surface, movement into soil, gas fluxes?
- What happens after a large rainfall event?
  - ✓ Would contaminants wash off an uncontained VTS?

- Approach
  - ✓ Seasonal sampling of pen runoff as it is applied to the cells
  - ✓ Yearly soil sampling (post pen application & depth profile)
  - ✓ Application of clean ground water (mimic rainfall on the VTA)

- Key collaborations
  - ✓ ARS (Lisa Durso)
  - ✓ UNL BSE (Chris Henry)
  - ✓ UNL Water Center (Dan Snow)
  - ✓ DEQ (Elbert Traylor)

What Collaborations Do I Need?

- Microbiologists specializing in pathogens
- Pharmaceuticals detection/quantification
- Access to field sites, novel research locations
- New data/statistical analysis methods
- Other emission researchers (beyond pots & pans)
- All the other stuff I haven't thought of!

Questions?