

# Proceedings of the 5<sup>th</sup> Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference

**5th Annual  
NITROGEN:  
MINNESOTA'S GRAND  
CHALLENGE & COMPELLING  
OPPORTUNITY CONFERENCE**



**Tuesday,  
February 5, 2019**

**Verizon Wireless Center,  
Mankato, MN**



**5TH ANNUAL  
NITROGEN: MINNESOTA'S GRAND CHALLENGE  
& COMPELLING OPPORTUNITY CONFERENCE**

**Sessions 9:05 a.m.-3:40 p.m.**

■ GENERAL SESSION

8:15 a.m.	<i>Registration</i>	
9:00 a.m.	<i>Welcome</i> Tom Rothman	University of Minnesota
9:05 a.m.	<i>Lessons Learned in 2018, Opportunities for 2019</i> Brad Carlson Dave Nicolai Brandon Fast	University of Minnesota Extension University of Minnesota Extension Minnesota Corn Research & Promotion Council
9:55 a.m.	<i>An Industry Perspective on Nitrogen: Beginning with 4R Nutrient Stewardship</i> Dr. Tai Maaz	International Plant Nutrition Institute
10:50 a.m.	<i>Break</i>	
11:05 a.m.	<i>NUE and Potential Environmental Outcomes Associated with N Application Timing</i> Dr. Carrie Laboski	University of Wisconsin-Madison
12:00	<i>Lunch</i>	

■ BREAKOUT SESSION #1

1:00 p.m.	<i>Managing Corn for High Yield and Environmental Stewardship While Controlling Costs</i> Dr. Jeff Coulter	University of Minnesota
1:55 p.m.	<i>N loss from Midwest cropping systems: What can we do about it?</i> Dr. Dan Jaynes	USDA ARS, Ames, IA
2:50 p.m.	<i>Urea Fertilizer Do's and Don'ts</i> Dr. Fabián Fernández	University of Minnesota

■ BREAKOUT SESSION #2

1:00 p.m.	<i>Improving Nitrogen Mineralization Predictions</i> Dr. Jason Clark	South Dakota State University
1:55p.m.	<i>Soil Health and Implications for Nitrogen Management</i> Dr. Anna Cates	University of Minnesota
2:50 p.m.	<i>Nitrogen Management with Manure</i> Dr. Melissa Wilson	University of Minnesota
3:40 p.m.	<i>Adjourn</i>	

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# Nitrogen Management with Manure

**MELISSA WILSON, Ph.D.**

Assistant Professor and Extension Soil Scientist  
Department of Soil, Water, and Climate  
University of Minnesota

Photo credit: MPCA



# AGENDA

- What impacts nitrogen availability?
  - Housing/Storage
  - Species
  - Application equipment
  - Timing/Seasonal application



# NITROGEN LOSSES FROM MANURE

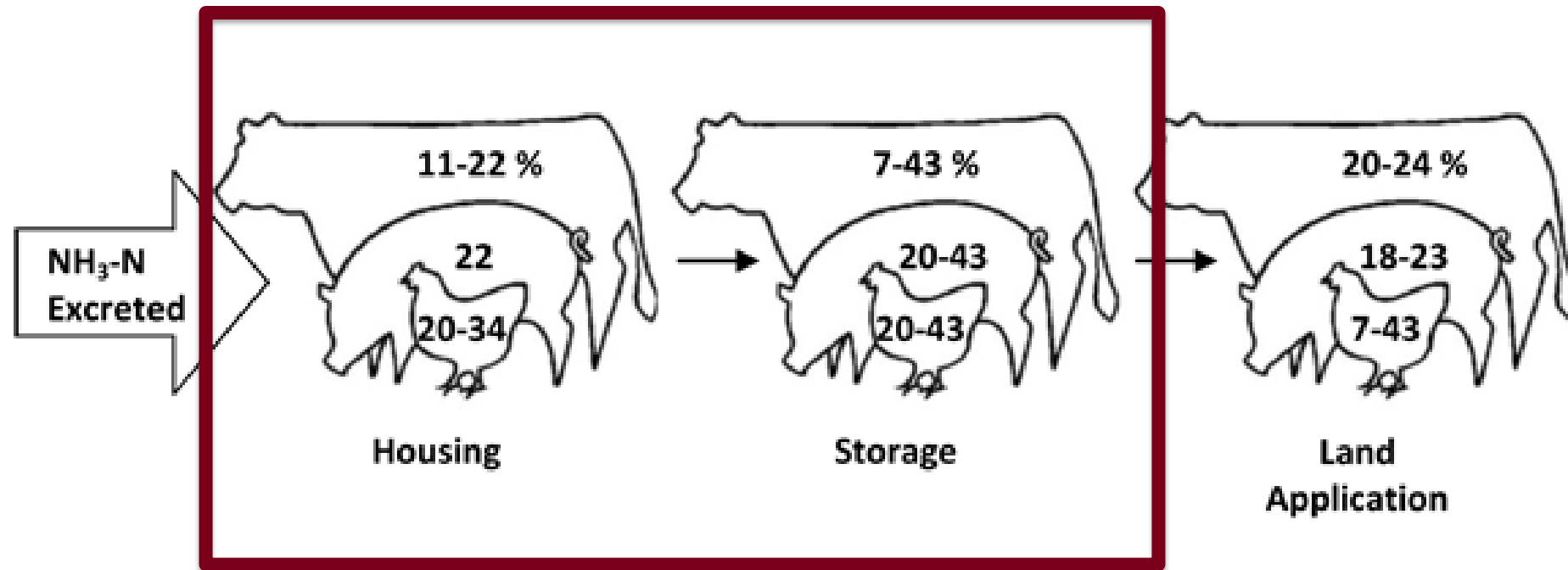


Figure 1. Percent  $\text{NH}_3$  emissions from total manure- $\text{NH}_3$  in each component of livestock operation (EPA National Emissions Estimates, 2005)

# MANURE STORAGE AND HANDLING

- How is the manure collected and stored?
  - Liquids: Deep pits? Flushed system? Anaerobic lagoons or storage ponds?
  - Solids: Indoors or outdoors? Is it mixed often? How is it stacked?

**Table A2. Nitrogen losses by storage/handling method**

Storage, handling method	Manure type	% N loss
Daily scrape, haul	Solid (tons)	25
Manure pack	Solid (tons)	30
Open lot	Solid (tons)	50
Litter	Solid (tons)	35
Above ground tank	Liquid (gals)	20
Below ground covered pit	Liquid (gals)	20
Below ground open pit	Liquid (gals)	25
Under-floor dry	Solid (tons)	25
Under-floor liquid	Liquid (gals)	20
Earthen storage	Liquid (gals)	30
Lagoon	Liquid (gals)	75



# NITROGEN LOSSES FROM MANURE

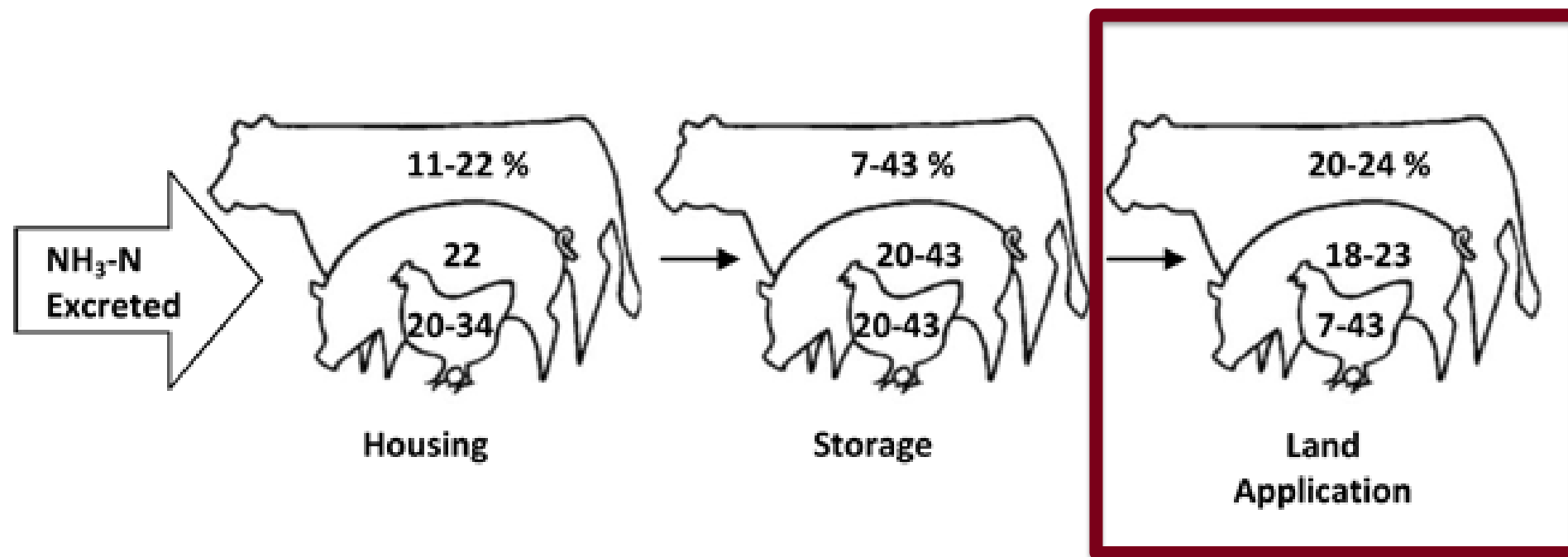
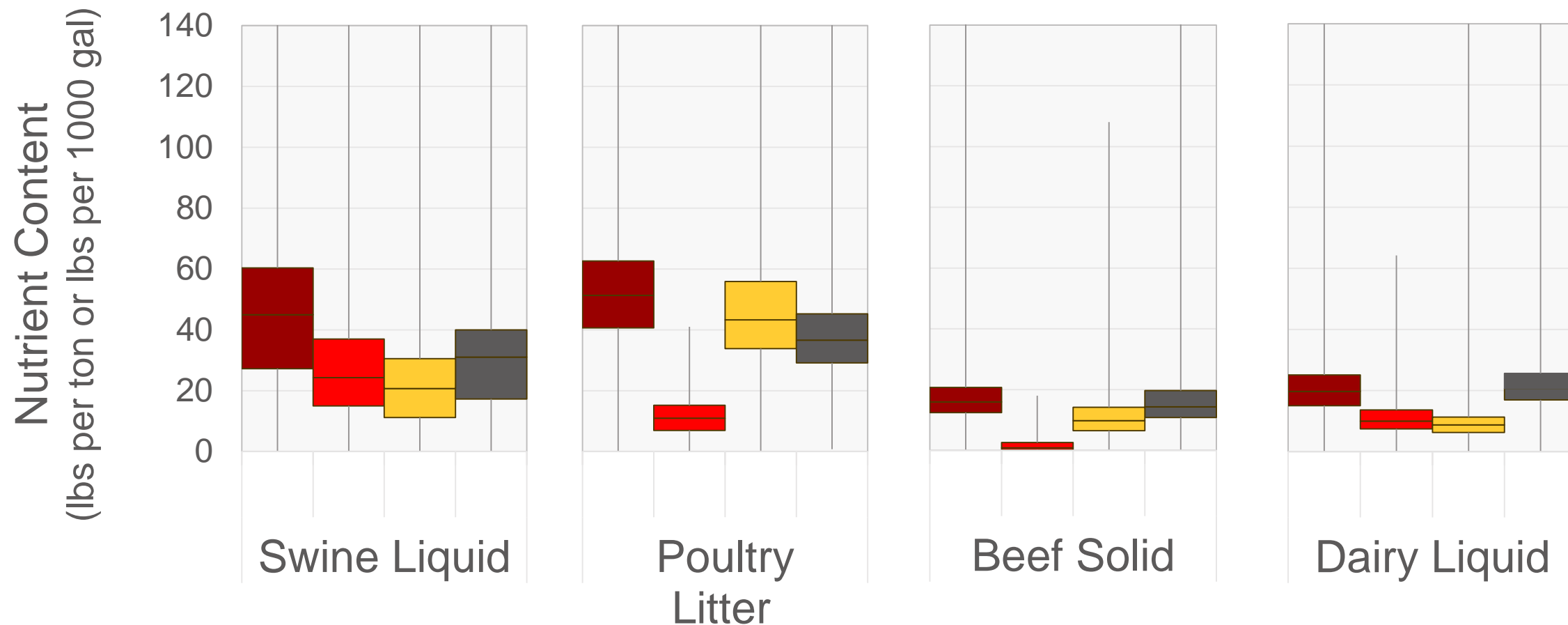


Figure 1. Percent  $\text{NH}_3$  emissions from total manure- $\text{NH}_3$  in each component of livestock operation (EPA National Emissions Estimates, 2005)



# NUTRIENT CONTENT VARIES BY ANIMAL TYPE

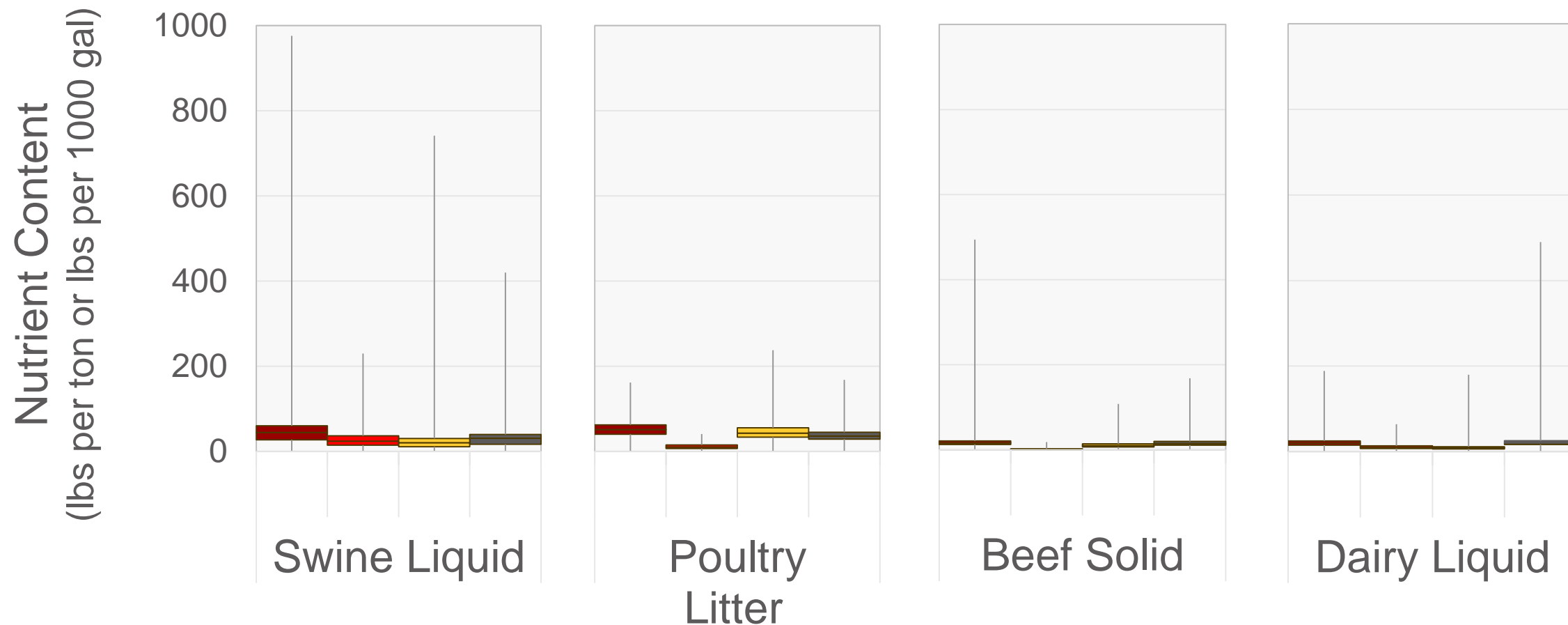
■ N (total) ■ Ammonium-N ■ Phosphate ■ Potash





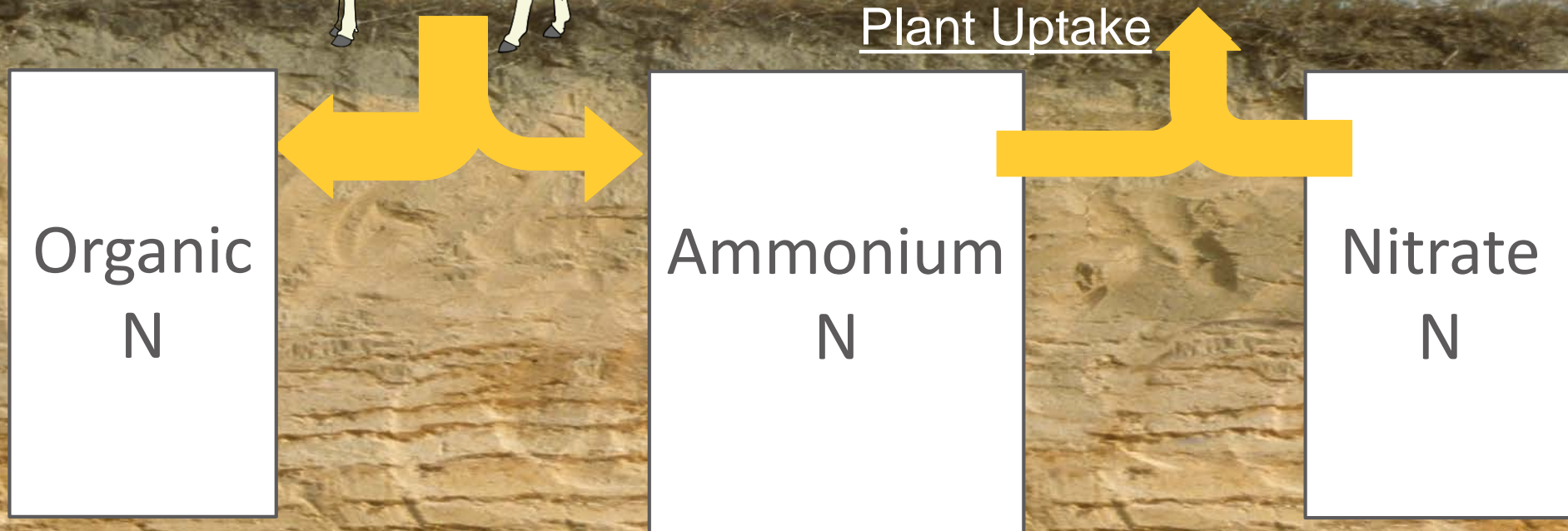
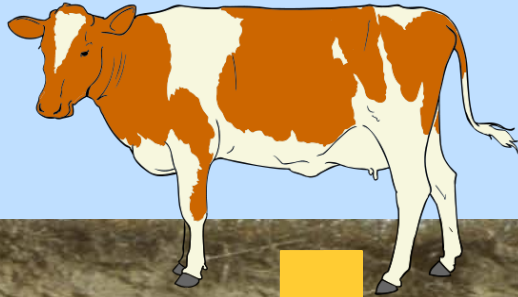
# NUTRIENT CONTENT VARIES BY ANIMAL TYPE

■ N (total) ■ Ammonium-N ■ Phosphate ■ Potash





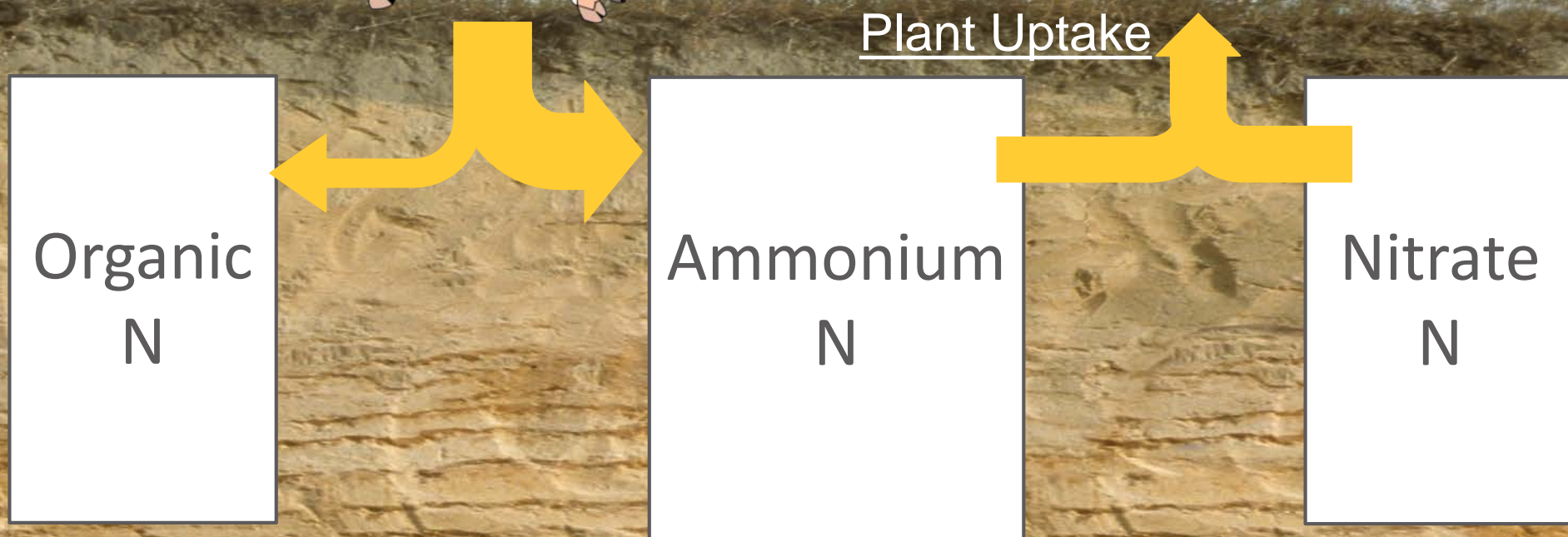
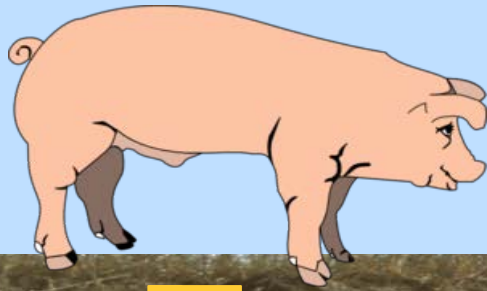
# NITROGEN CYCLING



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# NITROGEN CYCLING

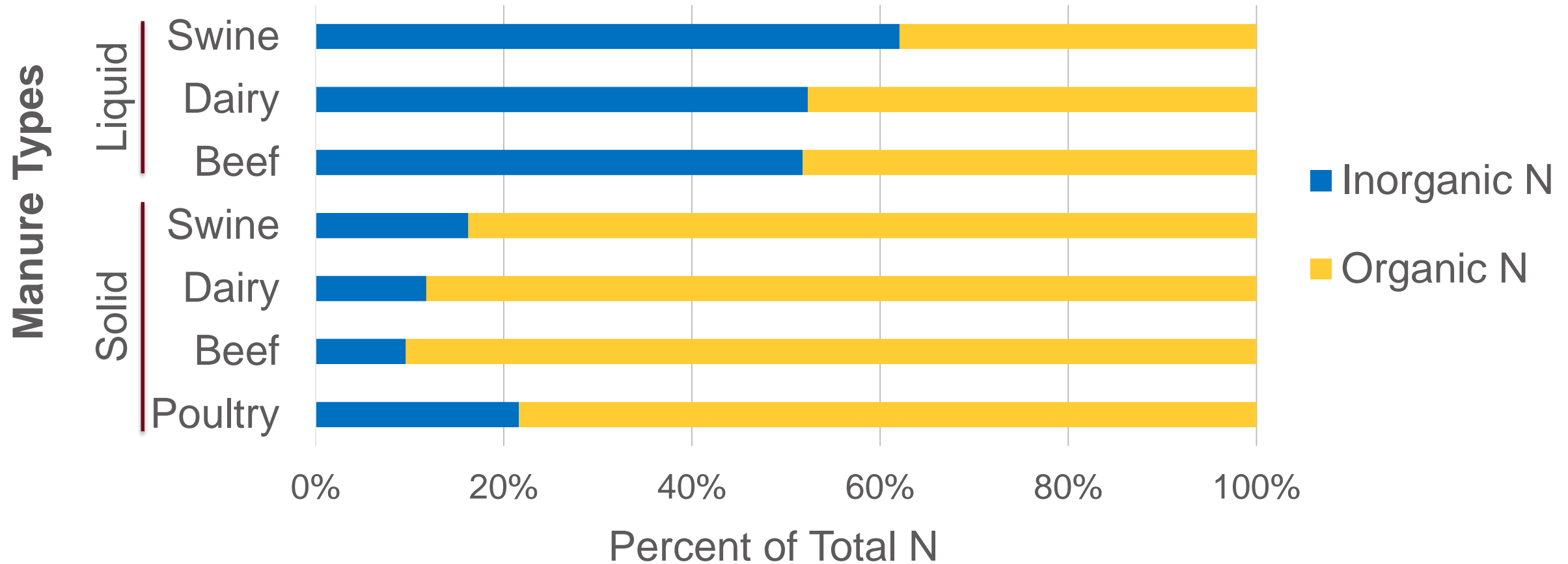


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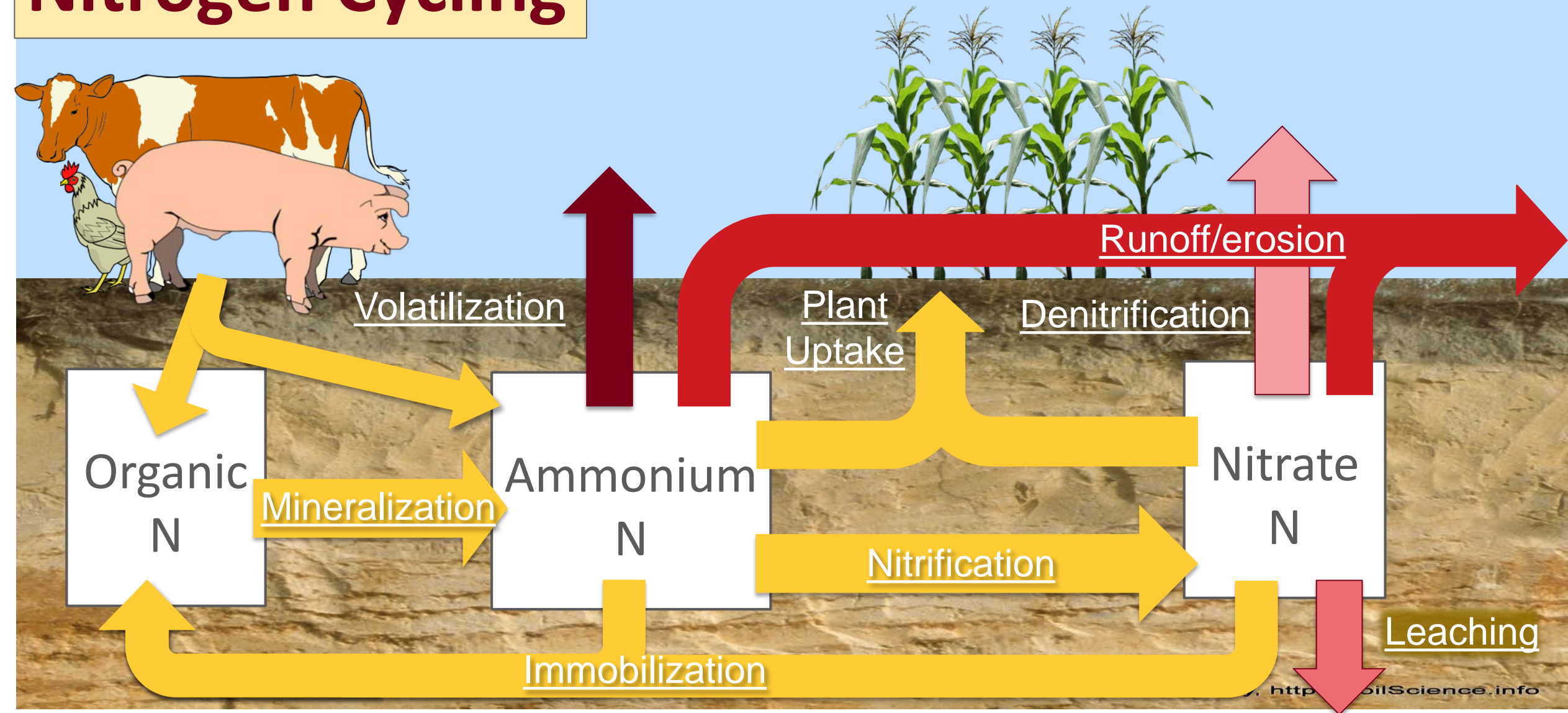
UNIVERSITY OF MINNESOTA EXTENSION

# MANURE N DISTRIBUTION





# Nitrogen Cycling





# IMPACTS ON NUTRIENT AVAILABILITY

- Animal species
- Application method

Year Available	Percent of total nitrogen available per year				
	<u>Broadcast + Timing of Incorporation</u>			<u>Injection</u>	
	> 96 hours	12-96 hours	< 12 hours	Sweep	Knife
<b>Beef</b>					
1	25	45	60	60	50
2	25	25	25	25	25
Lost	40	20	5	5	10
<b>Dairy</b>					
1	20	40	55	55	50
2	25	25	25	25	25
Lost	40	20	10	5	10
<b>Swine</b>					
1	35	55	75	80	70
2	15	15	15	15	15
Lost	50	30	10	5	15
<b>Poultry</b>					
1	45	55	70	n/a	n/a
2	25	25	25	n/a	n/a
Lost	30	20	5	n/a	n/a



# APPLICATION METHOD

\*Depends on type and form\*

\*Most influential factor for  
controlling N losses\*

## Three basic methods for application:

1. Surface (no incorporation)
2. Incorporation or injection
3. Irrigation



# APPLICATION METHOD

## 1: Surface application

- Substantial  $\text{NH}_3$  volatilization (most in first 24 hours)
- P and K losses through runoff and erosion
- Odors can be an issue

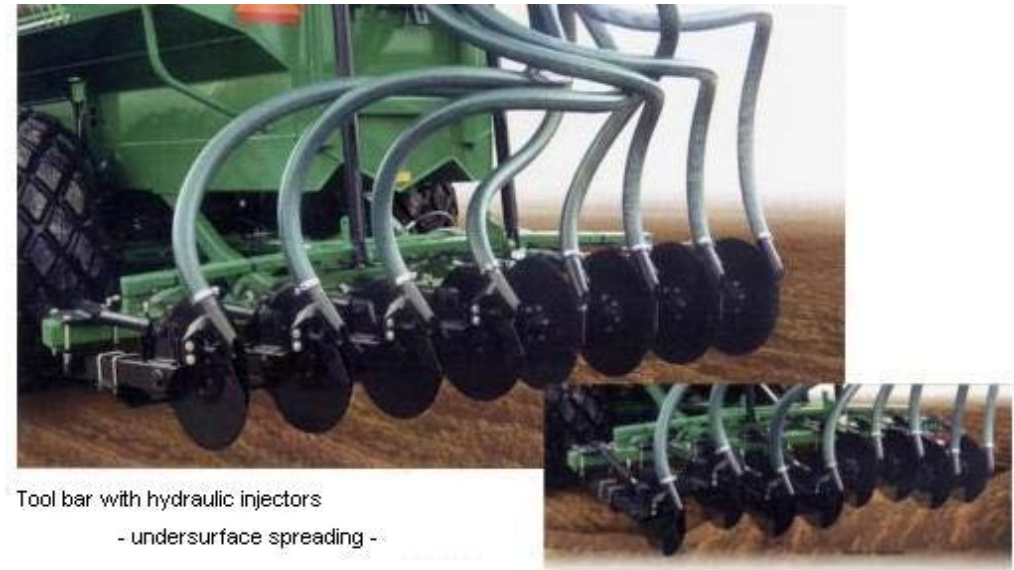


Image: <http://njaes.rutgers.edu/animal-waste-management/spreading-manure.asp>

# APPLICATION METHOD

## 2: Incorporation and injection

- Substantially reduces total N loss
  - 5-10% lost if incorporated within 12 hours
  - 20-30% if within 4 days
  - 30-50% if left on surface
- Also reduces odors and P & K loss



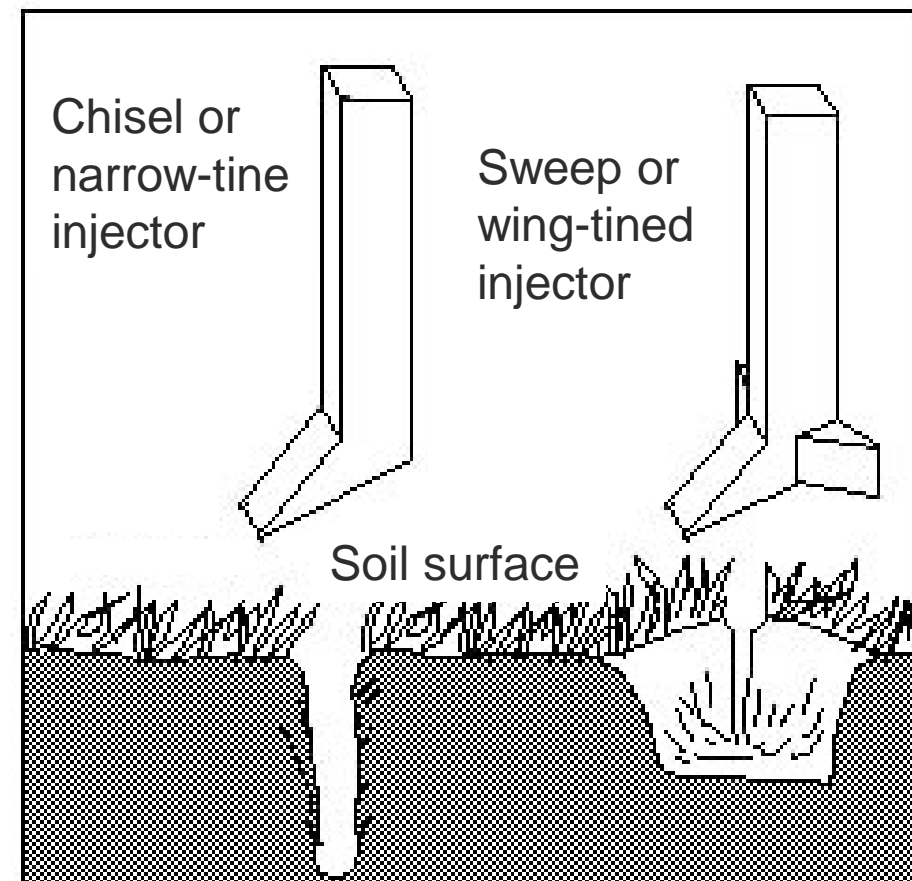
Tool bar with hydraulic injectors  
- undersurface spreading -





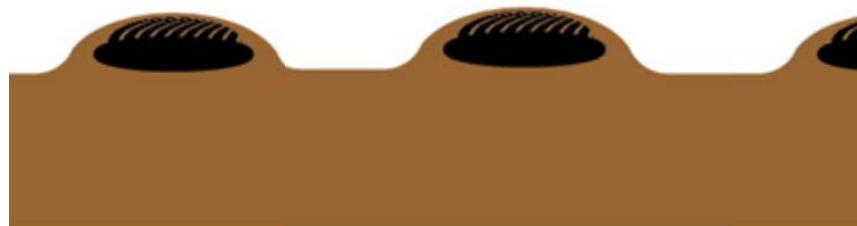
# INJECTION

- Uniform application
  - Pockets of high ammonium & salts can reduce seed germination, injure seedlings
  - Spacing is important, can see striping
- Sweep vs. knife injection
  - Disperses liquid, reduces denitrification loss
  - Shallower, so slows down leaching in sandy soils



# WHAT ABOUT THESE?

## Double disk applicators



## Aerway (soil aerators)



# DOUBLE DISK APPLICATORS

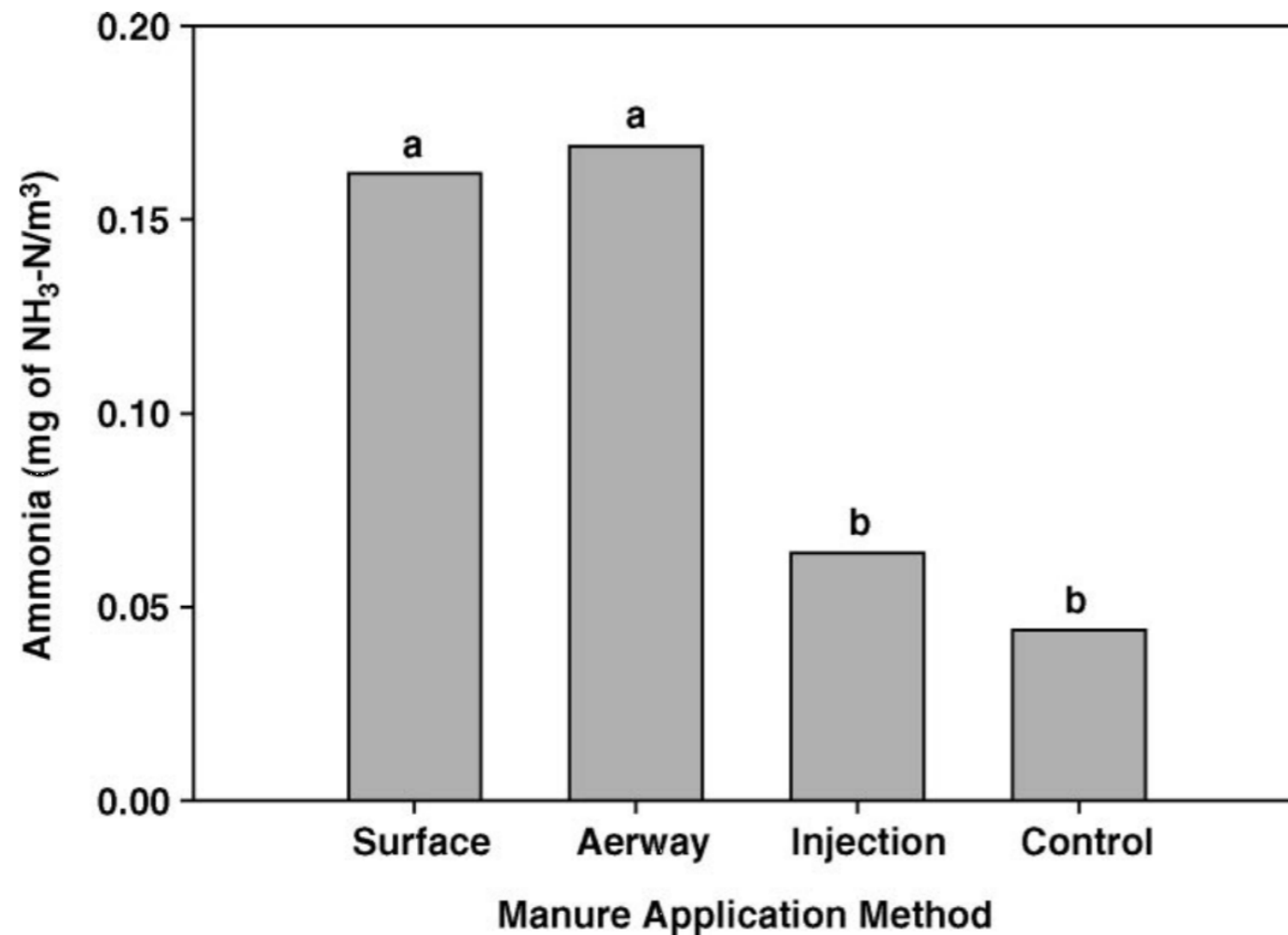
- Essentially, it bands manure and immediately incorporates it
  - Shallow incorporation



Year Available	% of total N available per year		
	<u>Broadcast + Timing of Incorporation</u>		
	> 96 hours	12-96 hours	< 12 hours
<b>Beef</b>			
1	25	45	60
2	25	25	25
Lost	40	20	5
<b>Dairy</b>			
1	20	40	55
2	25	25	25
Lost	40	20	10
<b>Swine</b>			
1	35	55	75
2	15	15	15
Lost	50	30	10
<b>Poultry</b>			
1	45	55	70
2	25	25	25
Lost	30	20	5

# AERWAY (SOIL AERATORS)

- Study found dairy manure applied at 20,000 gal per acre to cropland:





# AERWAY (SOIL AERATORS)

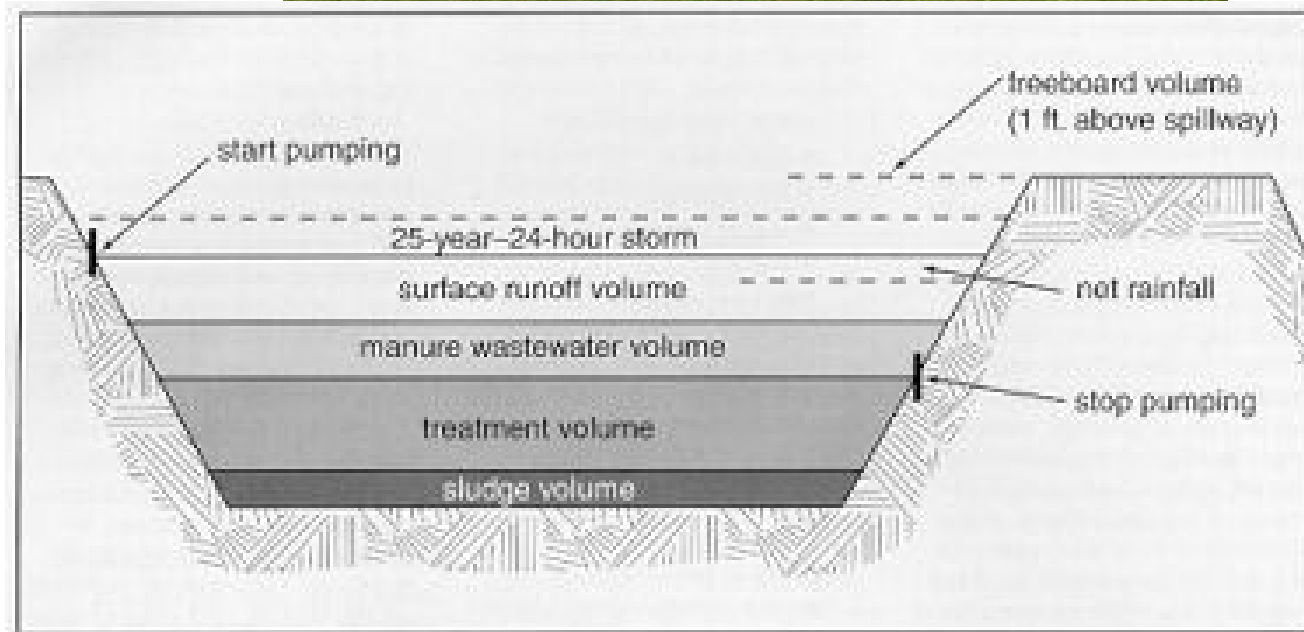
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1	20	40	55
2	25	25	25
Lost	40	20	10
<b>Swine</b>			
1	35	55	75
2	15	15	15
Lost	50	30	10
<b>Poultry</b>			
1	45	55	70
2	25	25	25
Lost	30	20	5



# APPLICATION METHOD

## 3: Irrigation

- Lagoon effluent alkaline -  
>  $\text{NH}_3$  concentration high
- Large volatilization losses
- Need to monitor salt levels in effluent to avoid burning plants



# APPLICATION METHOD

Application method	Manure type	NH <sub>4</sub> -N loss*
		(% of total)
Surface	Solid	15-30
Surface	Liquid	10-25
Incorporate <sup>†</sup>	Solid	1-5
Incorporate <sup>†</sup>	Liquid	1-5
Injection	Liquid	0-3
Irrigation	Liquid	30-40

\*N loss 3 days after application; <sup>†</sup>Incorporated within a few hours.

Source: Animal Manure as a Plant Nutrient Resource, Purdue CES, 2001.



# WHAT ELSE IMPACTS NUTRIENT AVAILABILITY?

- Application timing



Spring



Summer



Fall



Winter





# APPLICATION TIMING: SPRING

## Advantage

- Short window between application and uptake
  - Best time on sandy soils



## Disadvantages

- Logistics
- Greater risk of salt and  $\text{NH}_3$  toxicity for germinating seeds and young seedlings
- Less time for mineralization for manures with high C:N ratio
  - Immobilization => early season N deficiency

# FIELD EXPERIMENTS

- 2 locations with two sites each
- 6 types of manure
  - Applied all at N-based rate of 140 pounds of plant available N per acre
- Fertilizers (to develop response curve)
- Total treatments: 16

## Location 1: Waseca, MN

	Site 1	Site 2
2018	Corn	
2019	Corn	Corn
2020	Corn	Corn
2021	Corn	Corn
2022		Corn
2023		

## Location 2: Lamberton, MN

	Site 1	Site 2
2018	Corn	
2019	Corn	Corn
2020	Corn	Corn
2021	Corn	Corn
2022		Corn
2023		



# MANURE NUTRIENT AVAILABILITY





# MANURE NUTRIENT AVAILABILITY





# MANURE NUTRIENT AVAILABILITY

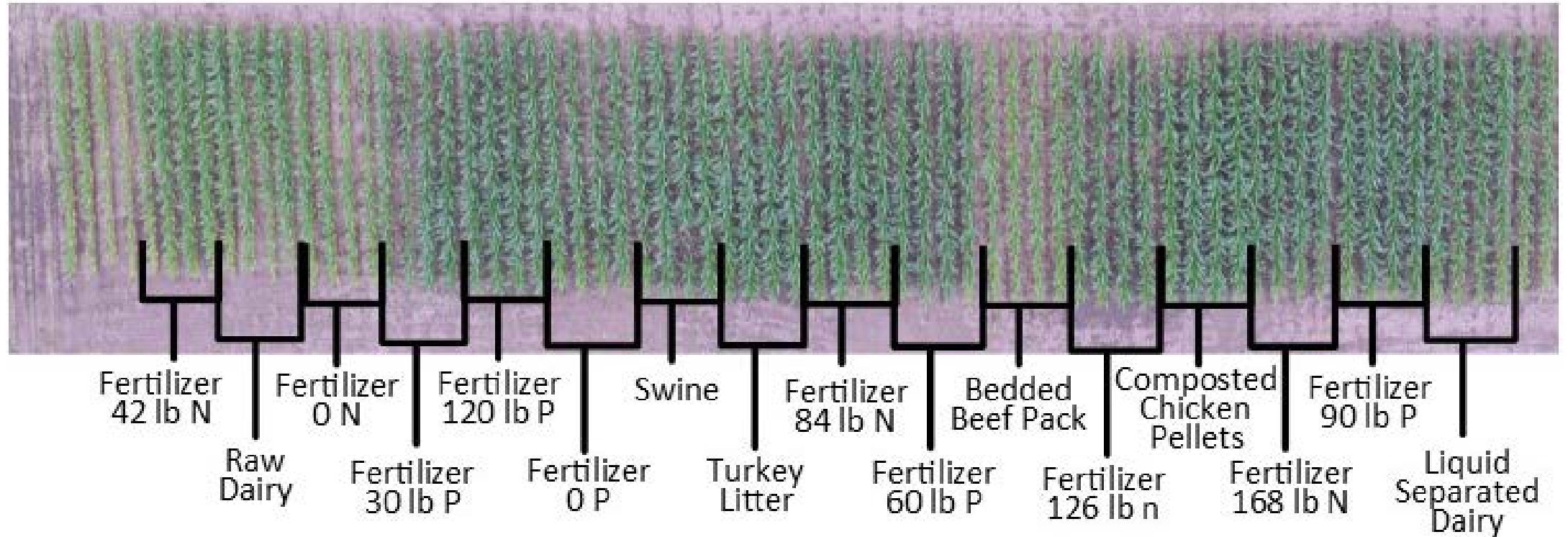


Picture taken  
June 18, 2018 at  
SROC



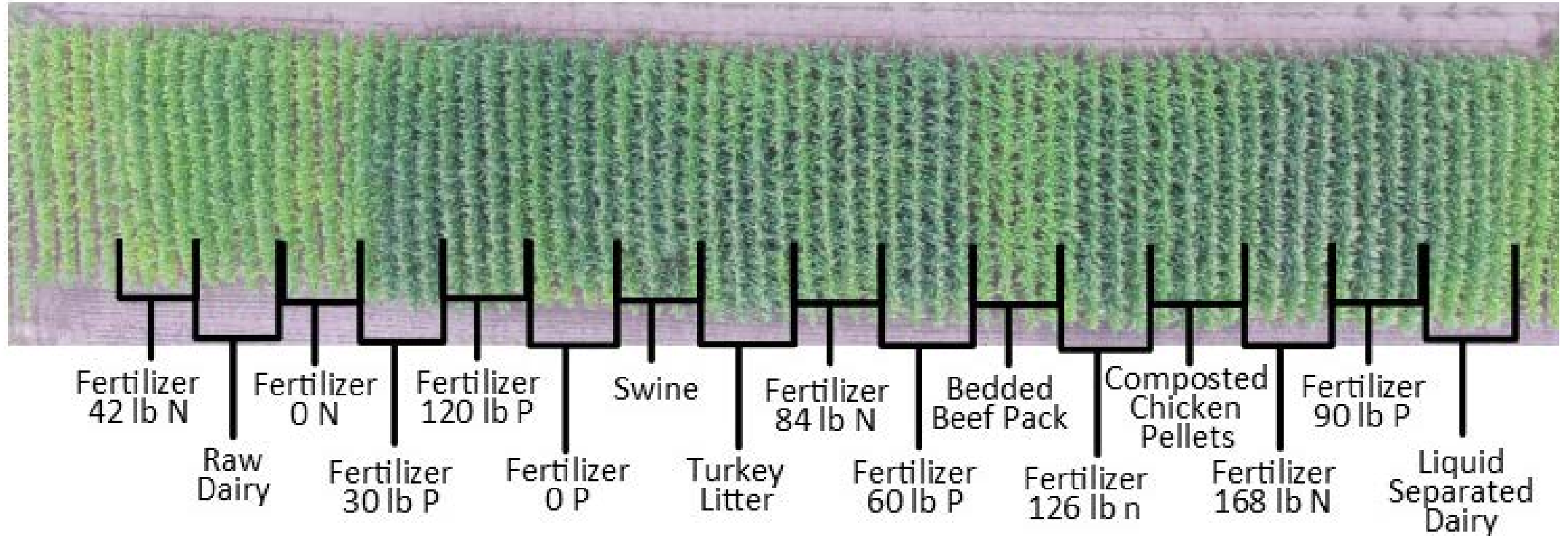
# June 28, 2018 at SWROC

Rep 1



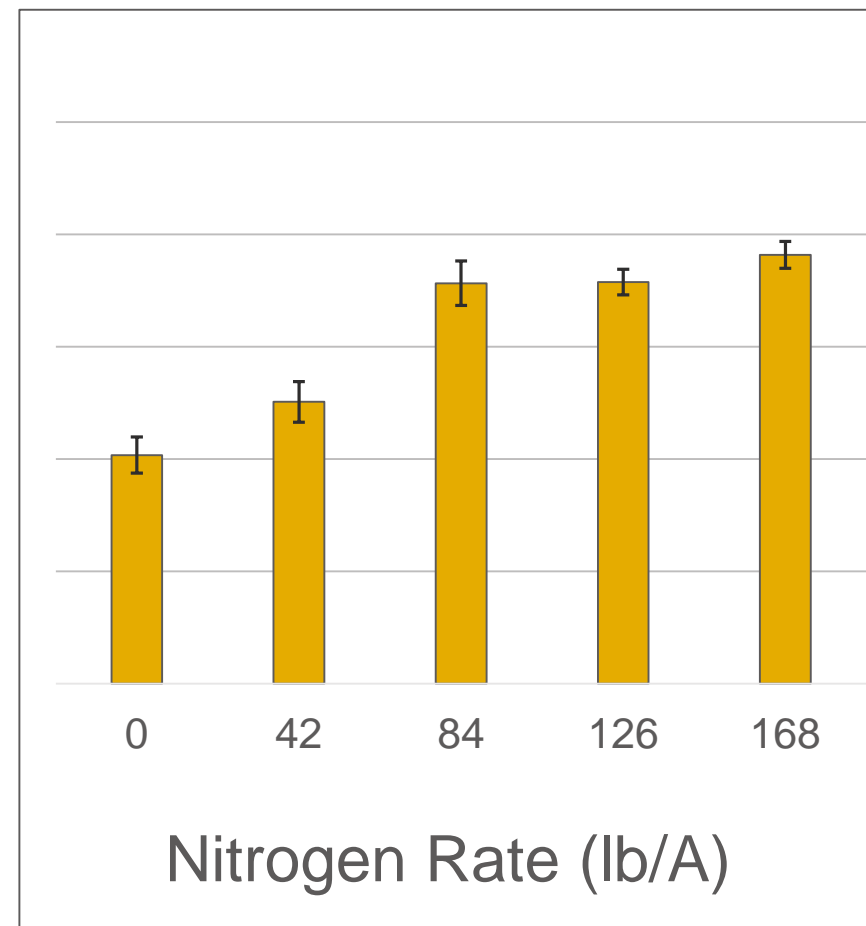
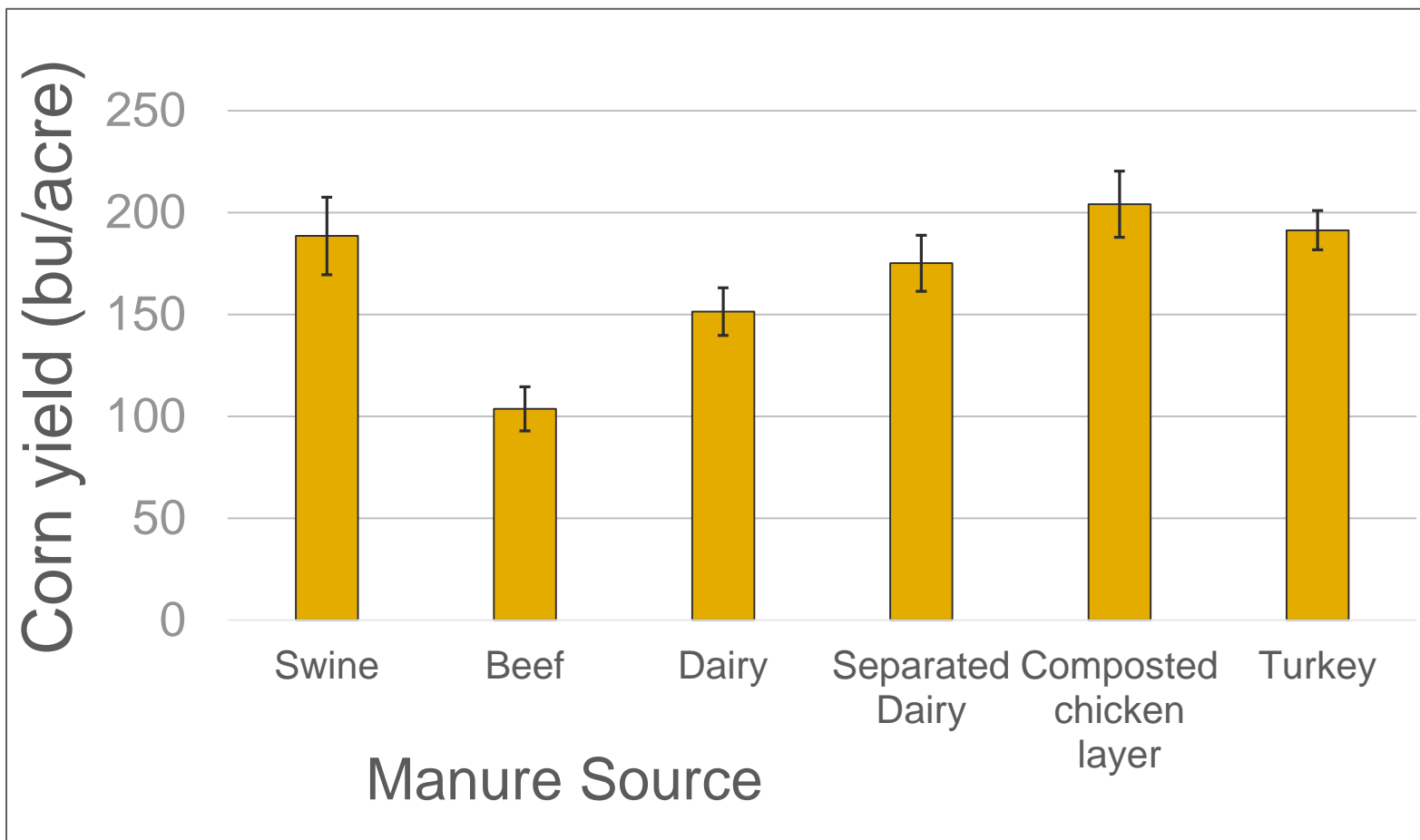
# July 26, 2018 at SWROC

Rep 1





# SPRING APPLIED MANURE IN 2018 AT WASECA





# APPLICATION TIMING: SUMMER

## Advantages

- Sidedressing: Apply nutrients to a growing crop
- Post-harvest: Easy to apply following early-harvested crops



## Disadvantages

- Can damage standing crops, especially in end rows
- High potential for salt damage when topdressing perennial crops
- $\text{NH}_3$  volatilization losses from surface applications are high
  - Warm, dry conditions

# SUMMER APPLICATIONS - SIDEDRESSING

- On-farm experiment to test N sources



## Corn-corn-soybean

- 40 lbs N in starter
- Sidedressed 140 lbs N at V4/V5 stage
- Compared:
  - Swine manure with dragline (3,500 gal per acre)
  - Anhydrous ammonia
  - Liquid UAN (32%)
  - No N sidedressed



# SIDEDRESSING MANURE INTO CORN





# SIDEDRESSING MANURE INTO CORN





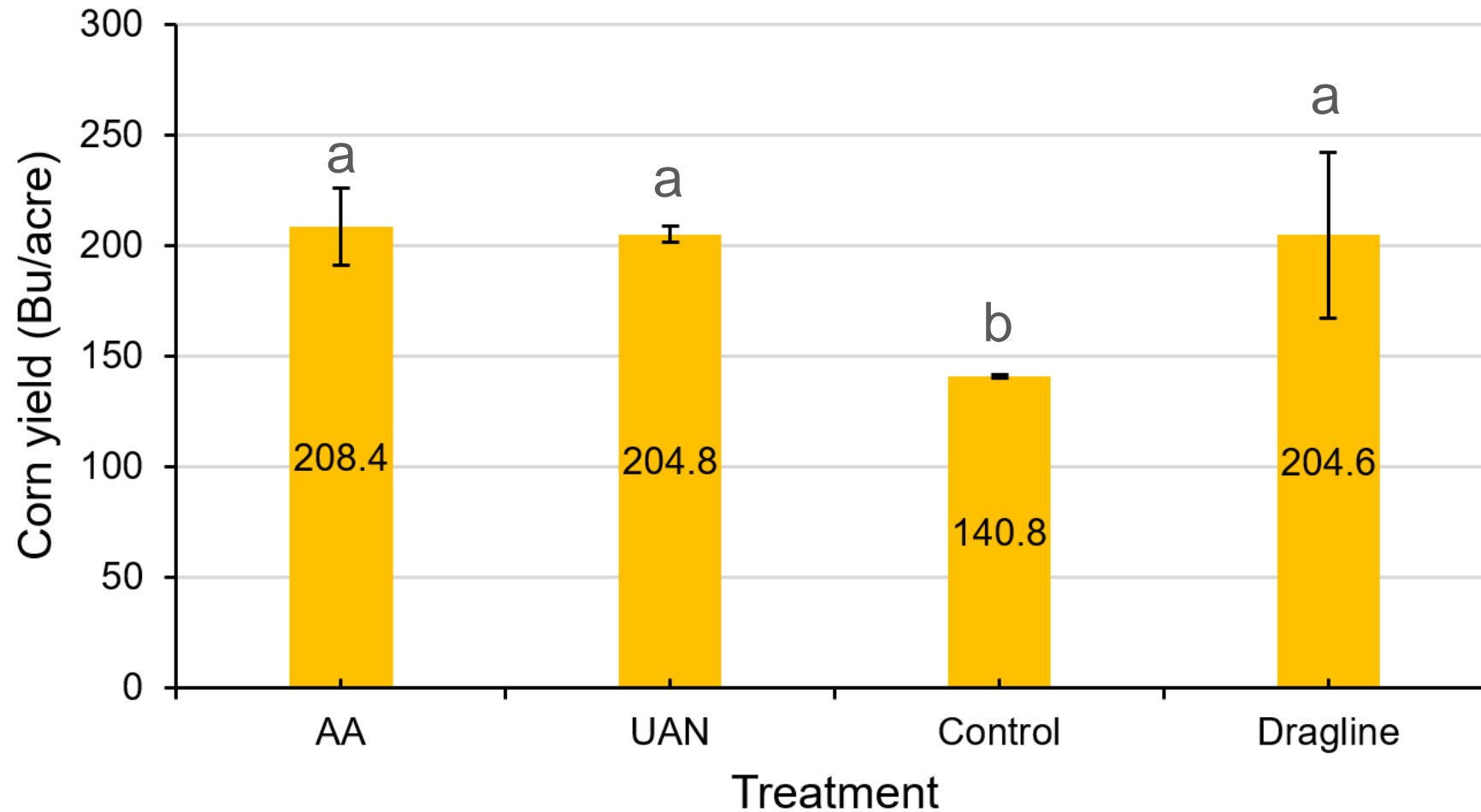
# SIDEDRESSING MANURE



Anhydrous Swine Control UAN Control UAN Swine Anhydrous



# SIDEDRESSING MANURE





# APPLICATION TIMING: FALL

## Advantages

- Logistics
- Soil generally less subject to compaction
- More time for organic matter mineralization

## Disadvantages

- More time for nutrient losses:
  - Do not fall apply on sandy soils
  - Other soils, apply when soil temperatures  $< 50^{\circ}\text{F}$  (to reduce nitrification)
- Surface fall application subject to same snowmelt losses as winter application

# APPLICATION TIMING: WINTER

## Advantages

- Avoid compaction if on frozen ground?



## Disadvantages

- Cannot incorporate
- High nutrient loss potential
  - Snowmelt runoff, frozen ground
- Potential to burn perennial crops
- If winter application necessary:
  - Apply only on level ground
  - Fields with more residue are best
  - Most inorganic N will still be lost



# WINTER MANURE APPLICATIONS



# First runoff event

Collected samples:  
Jan. 28, 2018



**14% Solids**



**3% Solids**



**No Manure**





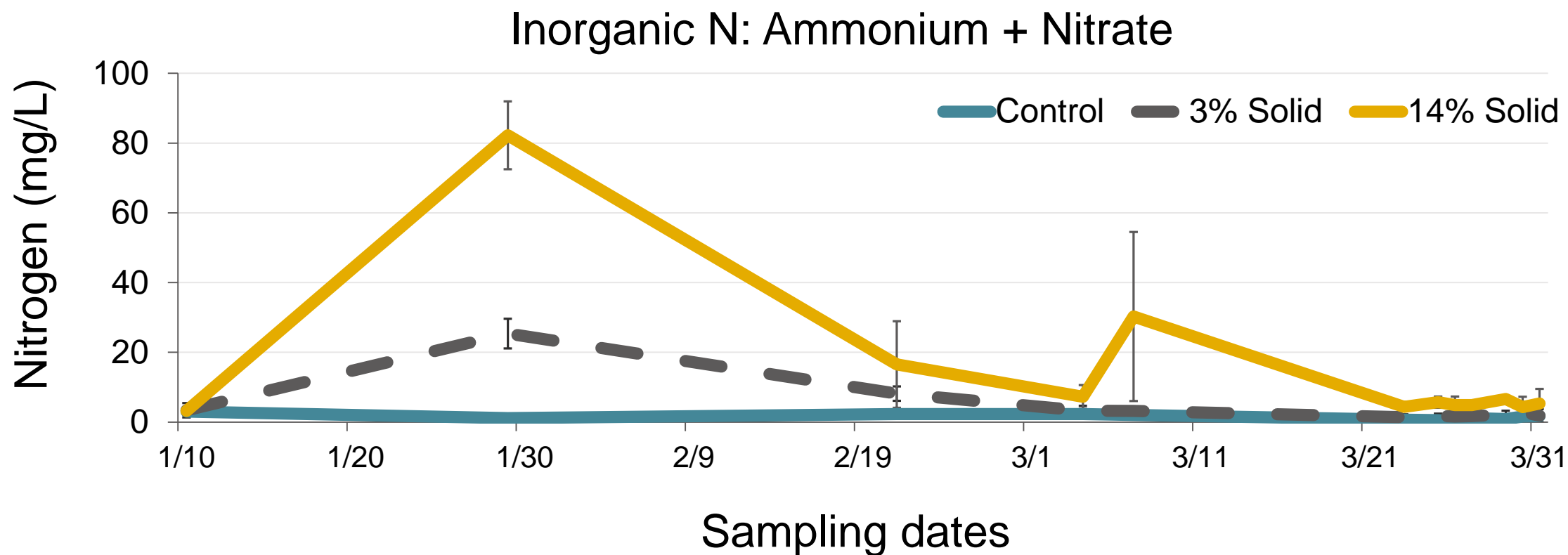
# Third runoff event

Collected samples  
mid-event after a  
rainfall:  
Mar. 4, 2018



# WINTER RUNOFF NUTRIENT LOSSES

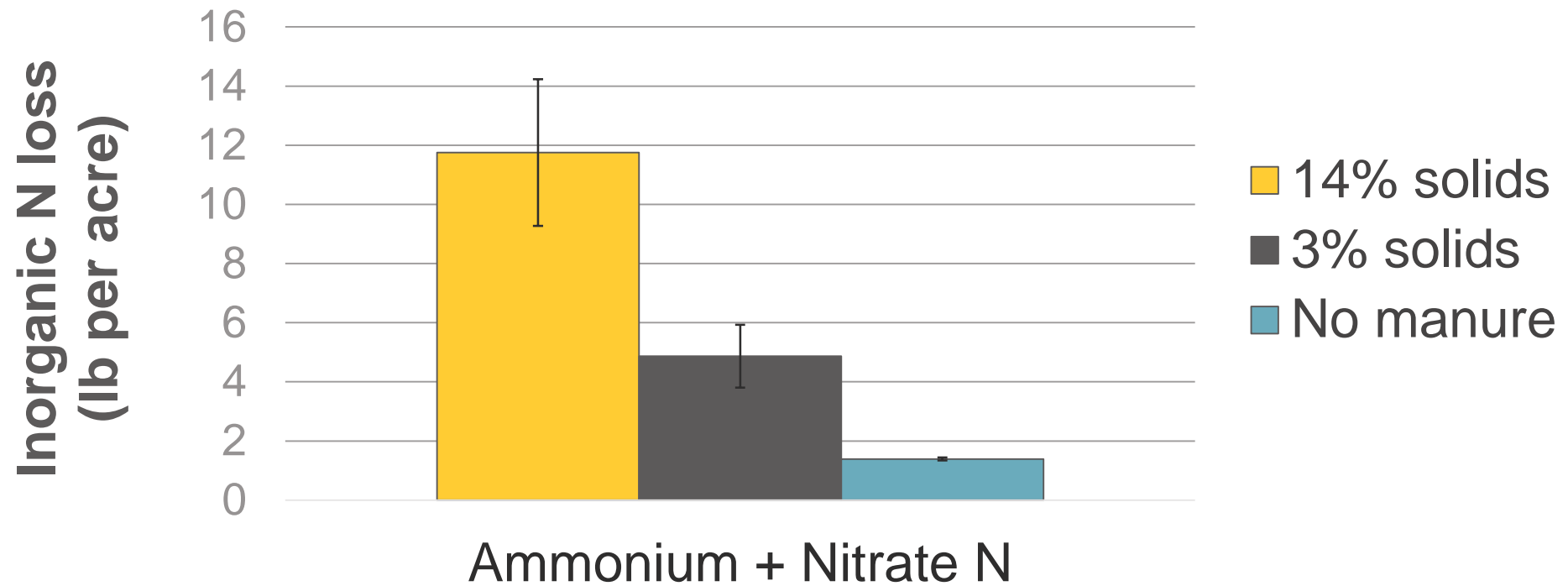
- Nutrient loss timing through the end of March





# WINTER RUNOFF NUTRIENT LOSSES

- Cumulative nutrient losses through the end of March



# TAKE HOME MESSAGES

- Large proportion of nitrogen is lost during housing and storage
- Distribution of manure nitrogen between organic and inorganic pools impacts availability
  - Liquid manures tend to be closer to 50% inorganic N, except swine which is 60% inorganic N
  - Solid manures tend to have only 10-20% inorganic N

# TAKE HOME MESSAGES

- Application equipment also impacts N availability
  - The faster manure is mixed with soil, the more N is conserved
- Timing of manure application during the year determines N availability, too
  - More research is being conducted to open up the window of opportunity for application





# Thank you! Questions?

## Contact Info:

- Email:  
mlw@umn.edu
- Follow me on  
**twitter**:  
@ManureProf



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