Proceedings of the 5th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference

University of Minnesota Extension

Nitrogen Management with Manure

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University of Minnesota

Photo credit: MPCA

AGENDA

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

NITROGEN LOSSES FROM MANURE

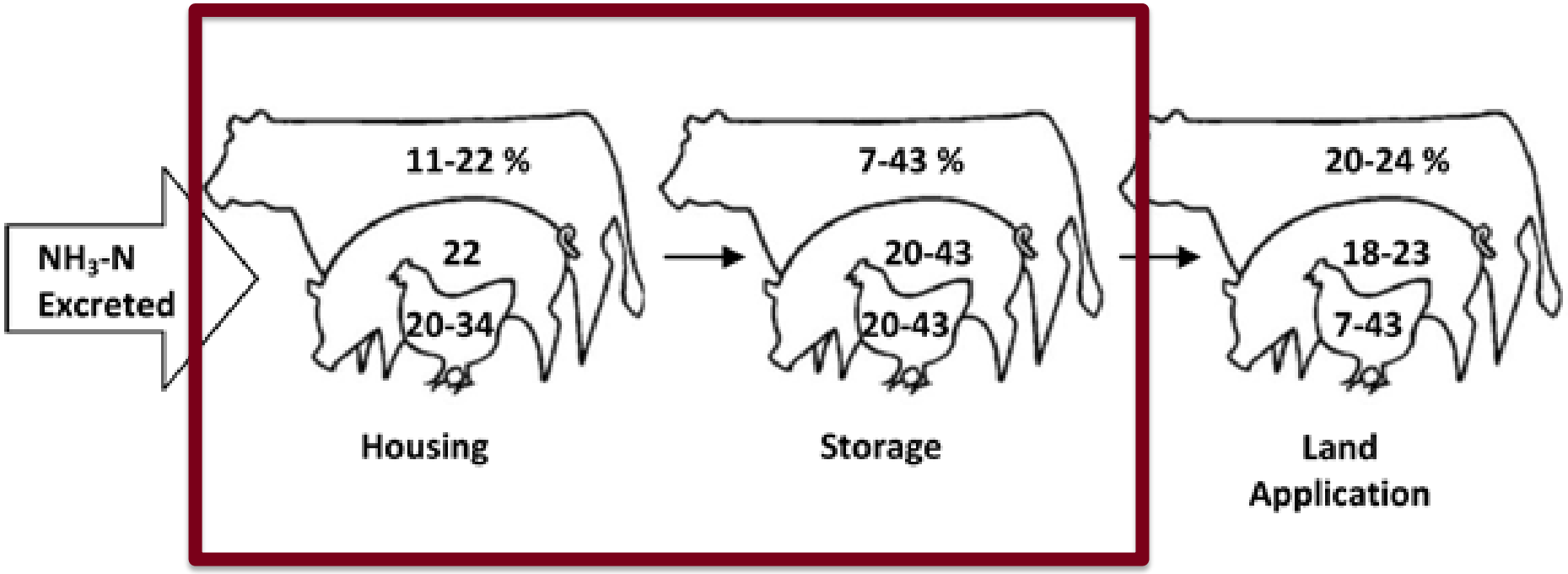


Figure 1. Percent NH_3 emissions from total manure-NH_3 in each component of livestock operation (EPA National Emissions Estimates, 2005)

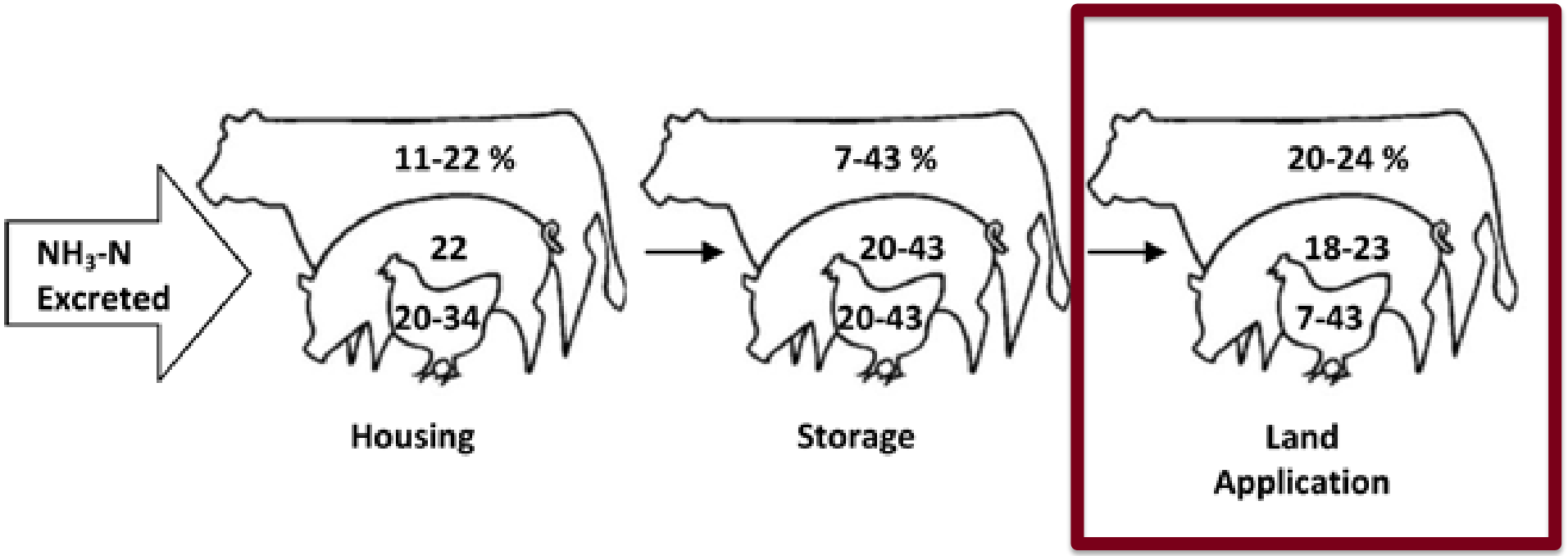
MANURE STORAGE AND HANDLING

- 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



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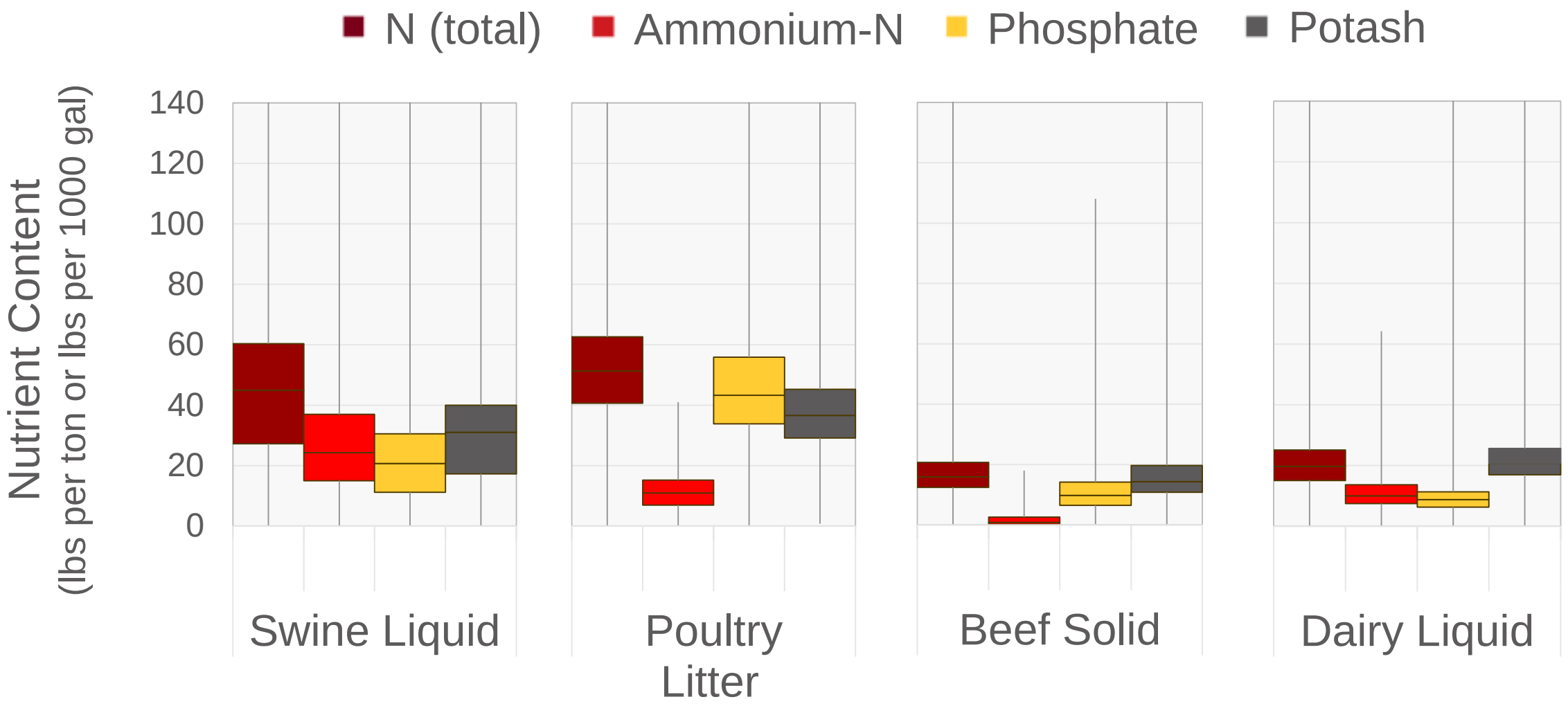
NUTRIENT CONTENT VARIES BY ANIMAL TYPE



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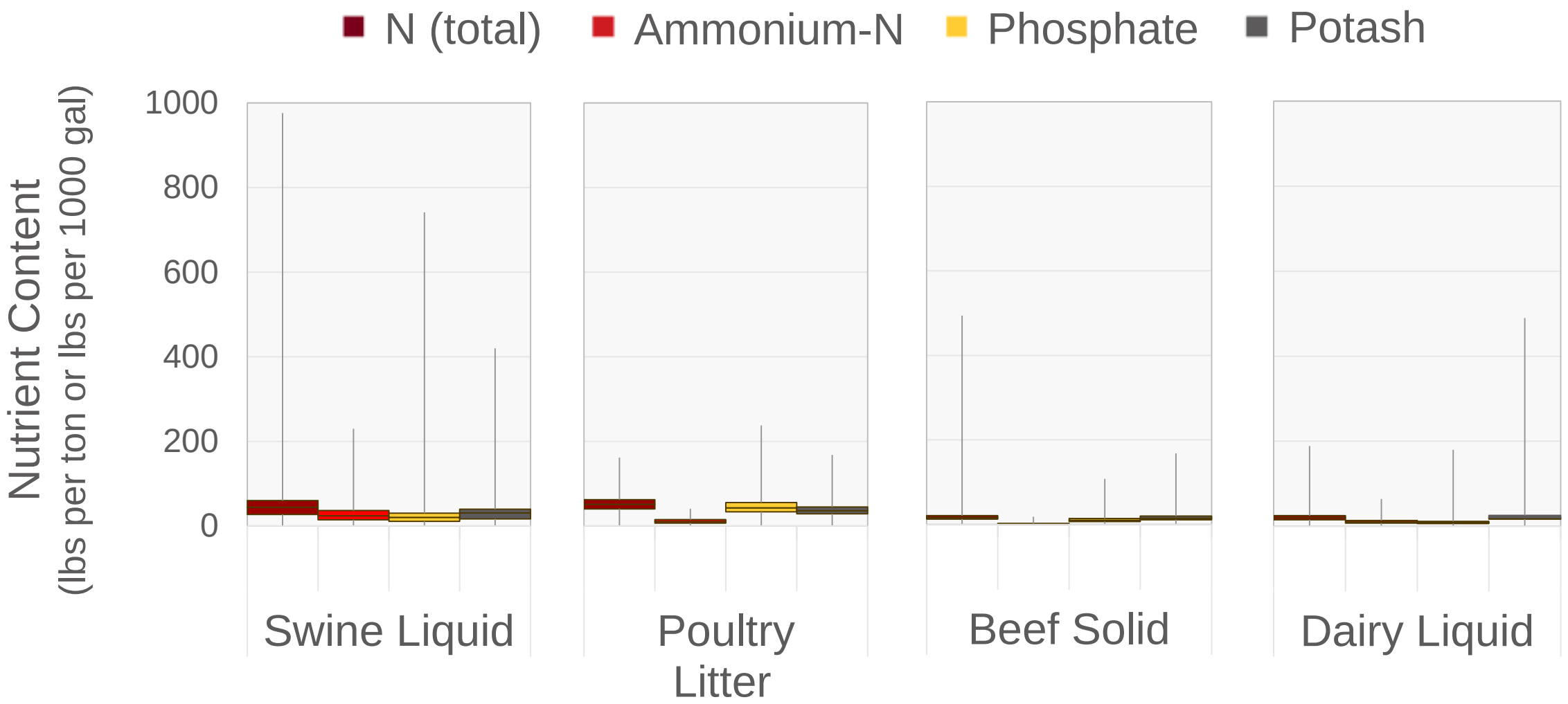
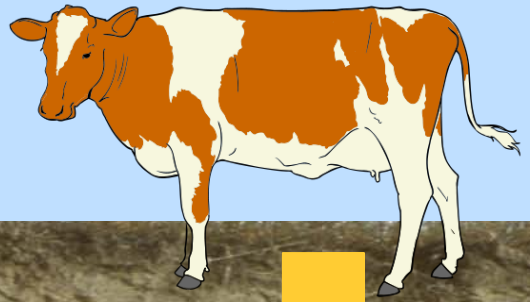


NITROGEN CYCLING



Plant Uptake

Organic N

Ammonium N

Nitrate N

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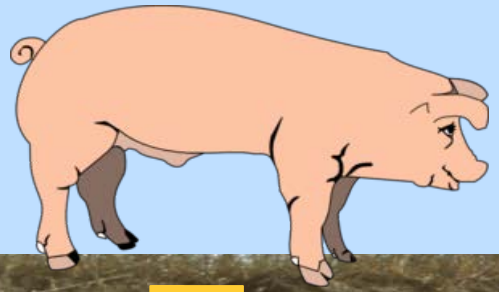

Plant Uptake

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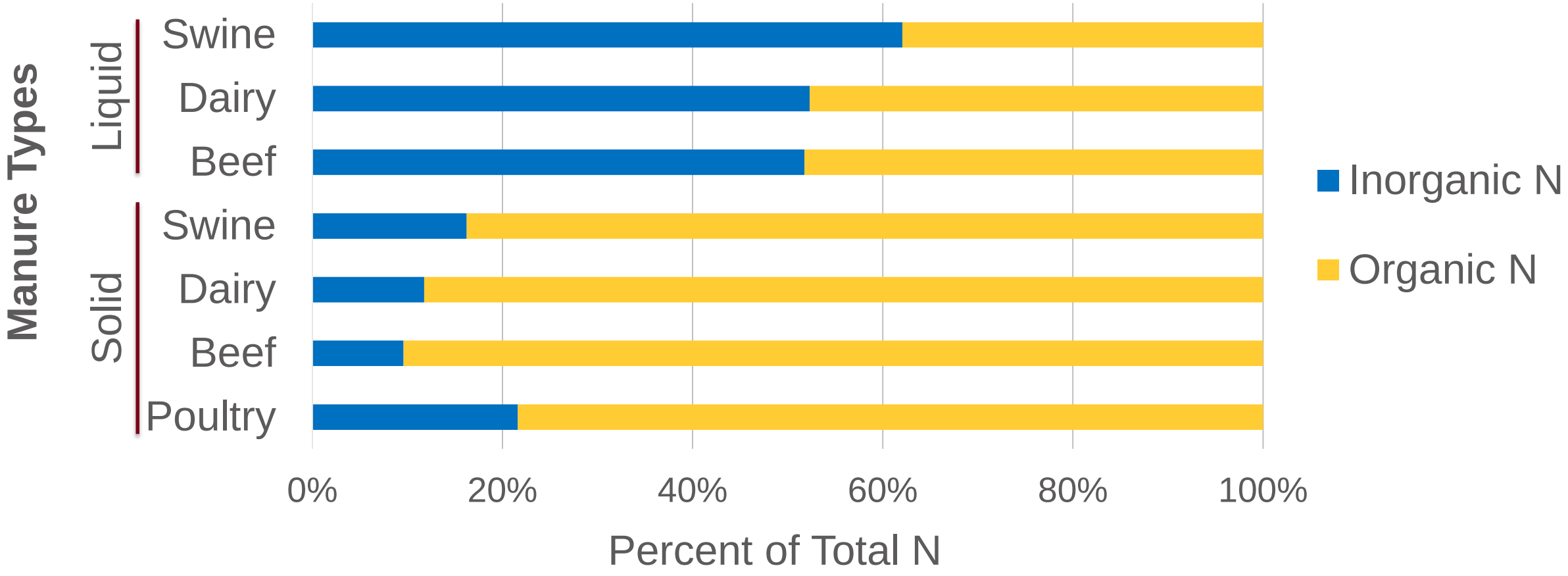
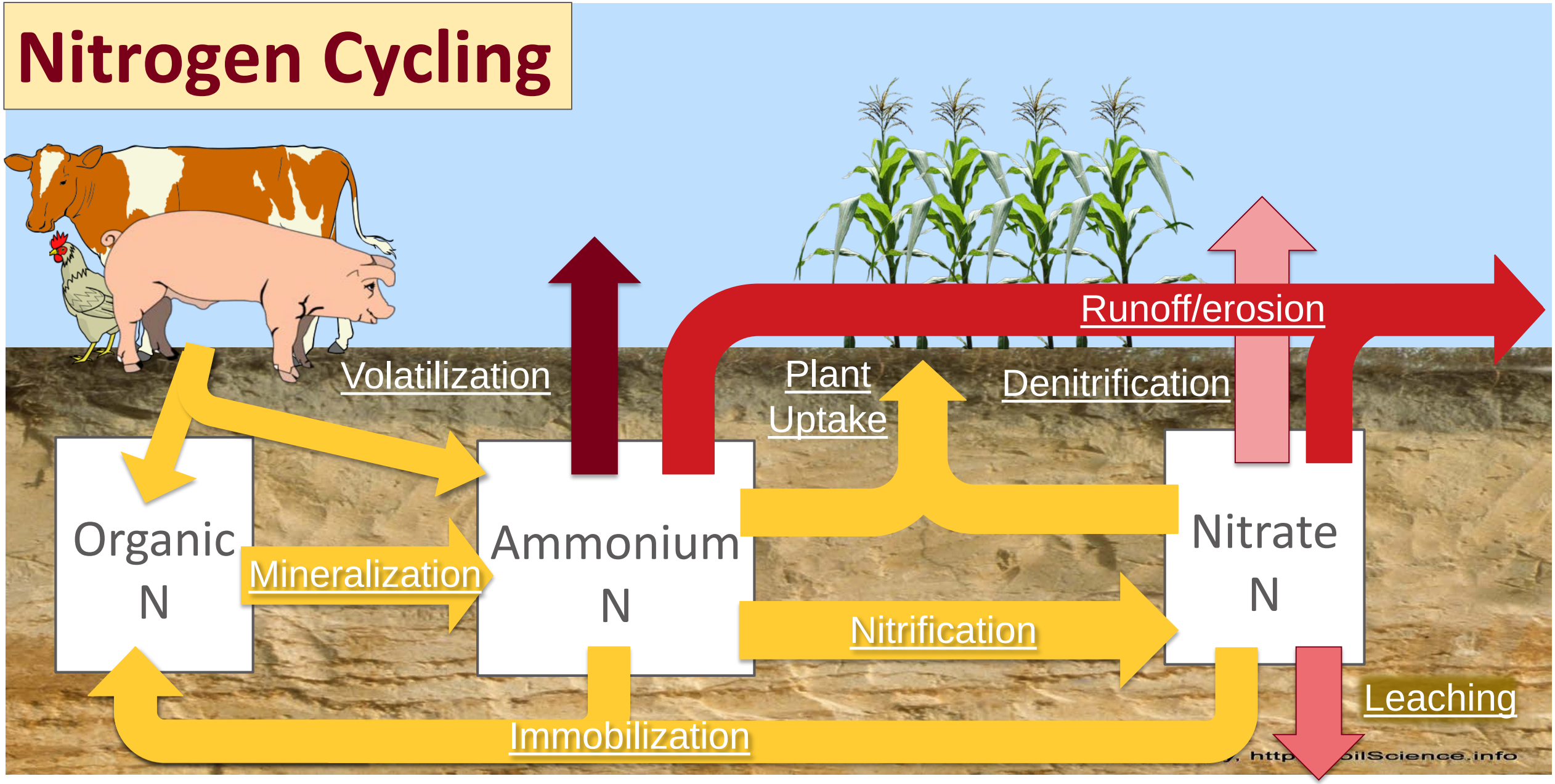
MANURE N DISTRIBUTION



Nitrogen Cycling



IMPACTS ON NUTRIENT AVAILABILITY

- Animal species
- Application method

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

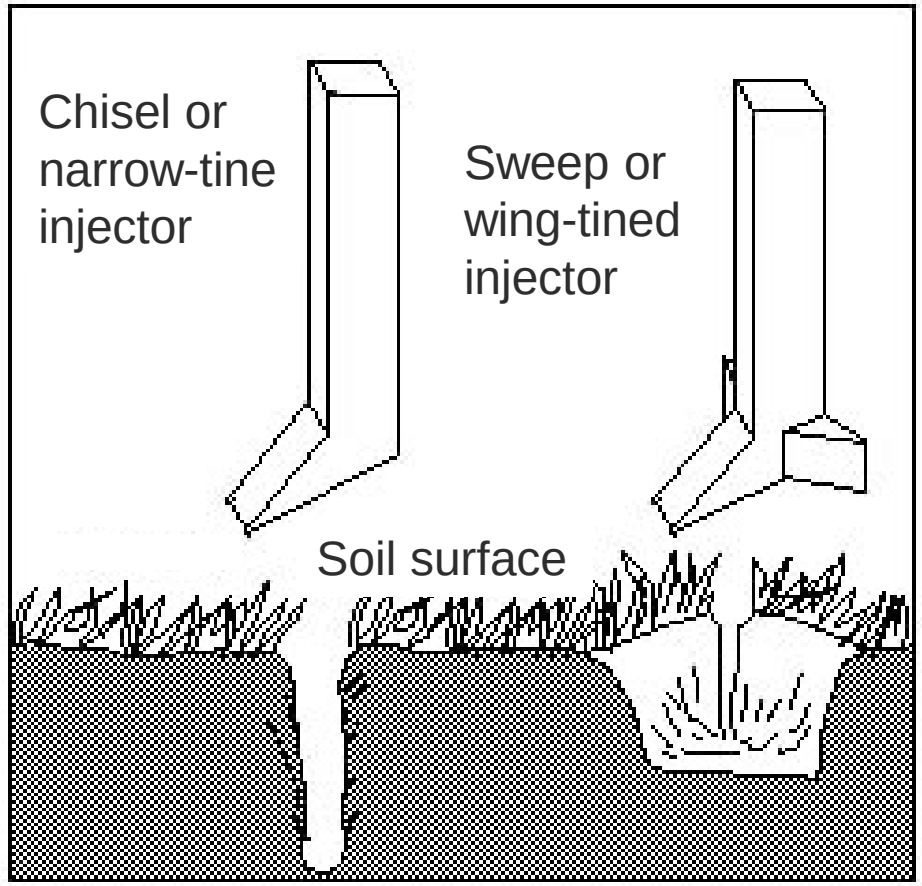
2: Incorporation and injection

- 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 -

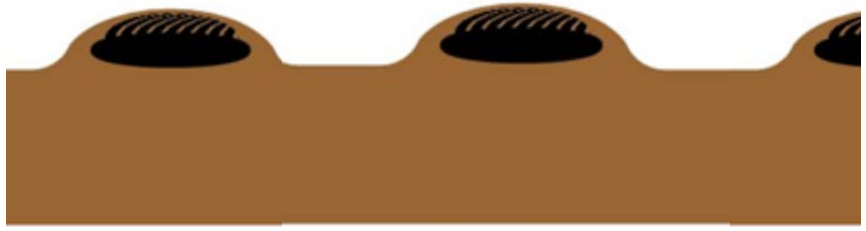
INJECTION

- 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?

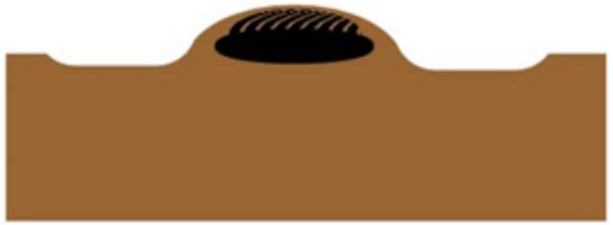
Double disk applicators



Aerway (soil aerators)

DOUBLE DISK APPLICATORS

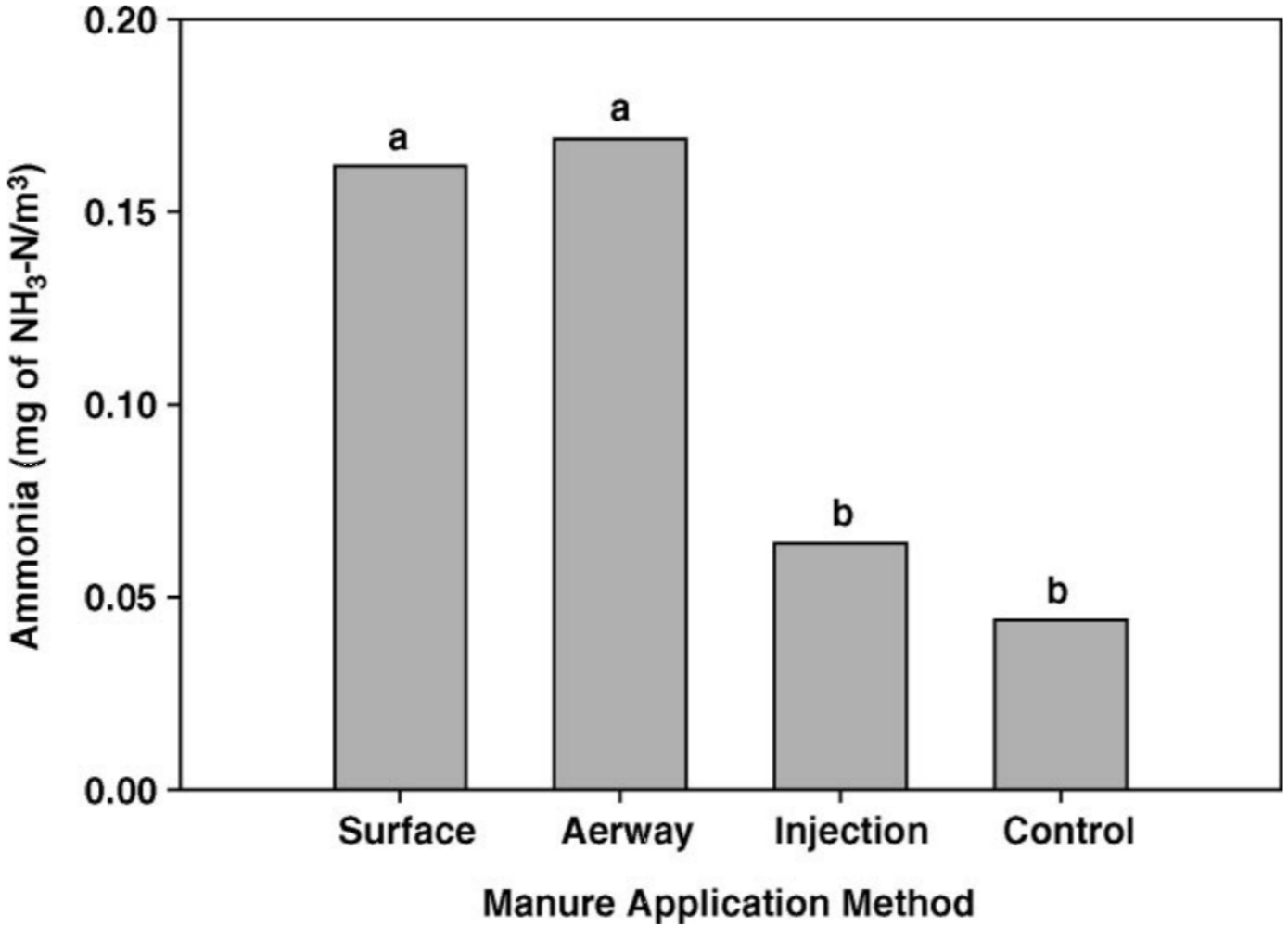
- Essentially, it bands manure and immediately incorporates it
  - Shallow incorporation



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



Leytem et al. 2009. Prof. Anim. Sci. 25: 93-98.

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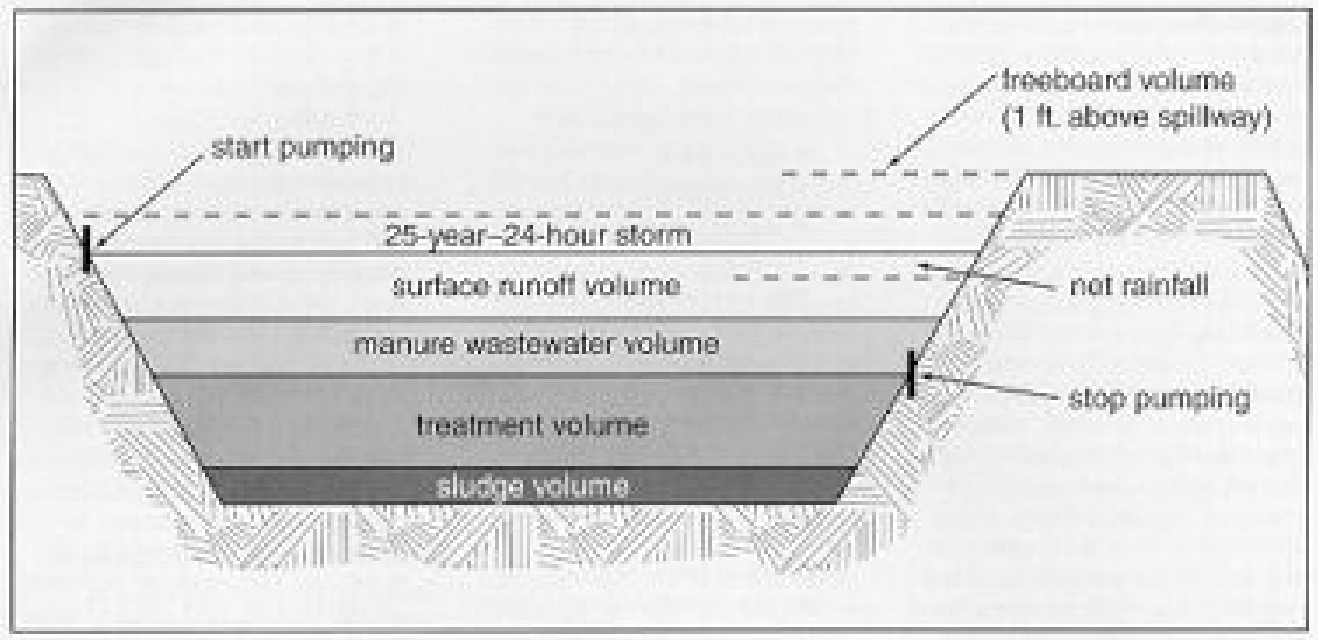
1	35	55	75
2	15	15	15
Lost	50	30	10
Poultry			
1	45	55	70
2	25	25	25
Lost	30	20	5

APPLICATION METHOD

3: Irrigation

- Lagoon effluent alkaline -> NH_3 concentration high
- Large volatilization losses
- Need to monitor salt levels in effluent to avoid burning plants



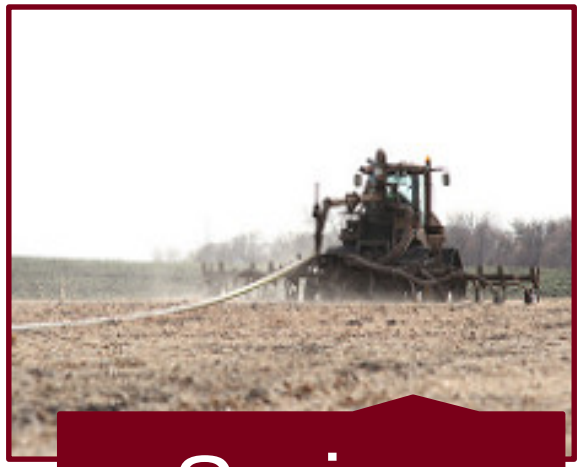
APPLICATION METHOD

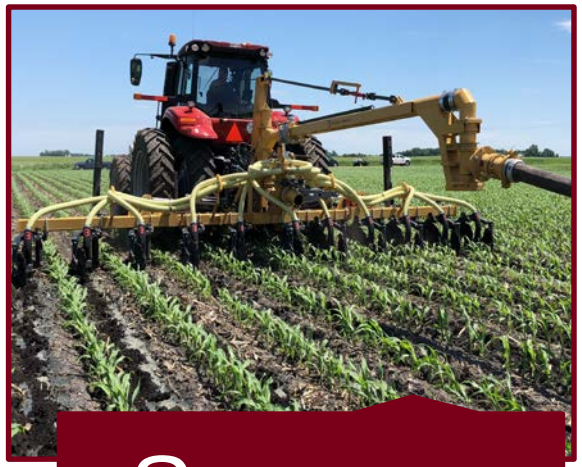
Application method	Manure type	NH_4-N loss* (% of total)
Surface	Solid	15-30
Surface	Liquid	10-25
Incorporate†	Solid	1-5
Incorporate†	Liquid	1-5
Injection	Liquid	0-3
Irrigation	Liquid	30-40

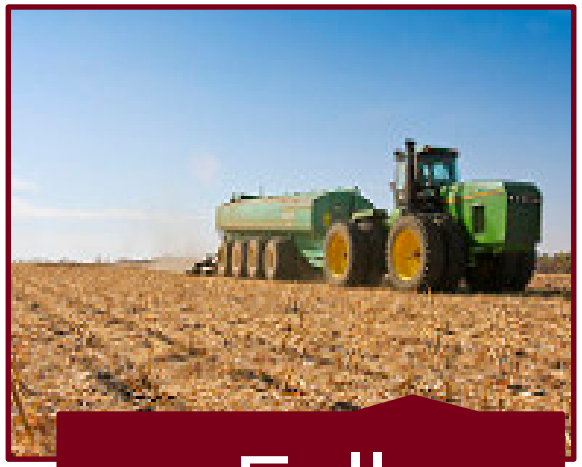
*N loss 3 days after application; †Incorporated within a few hours.
Source: Animal Manure as a Plant Nutrient Resource, Purdue CES, 2001.

WHAT ELSE IMPACTS NUTRIENT AVAILABILITY?

- Application timing


Spring


Summer


Fall


Winter

APPLICATION TIMING: SPRING

Advantage

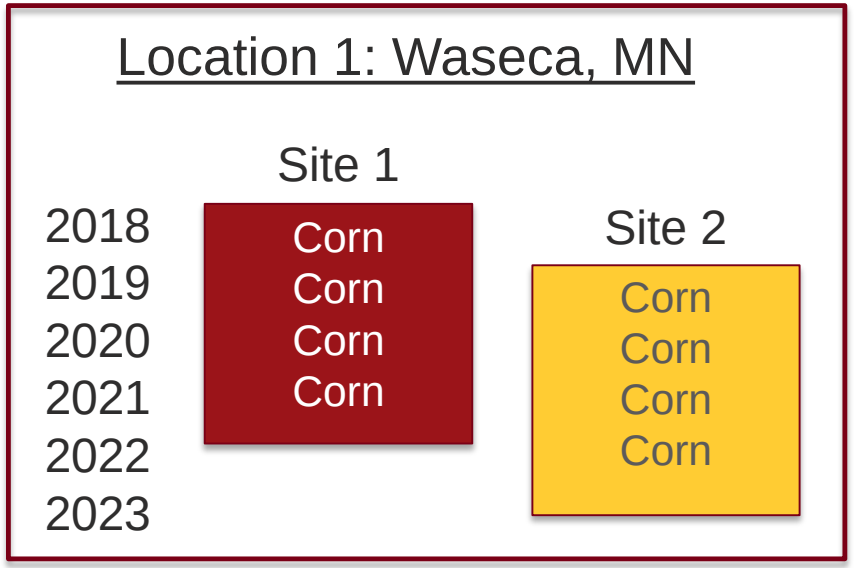
- Short window between application and uptake
  - Best time on sandy soils

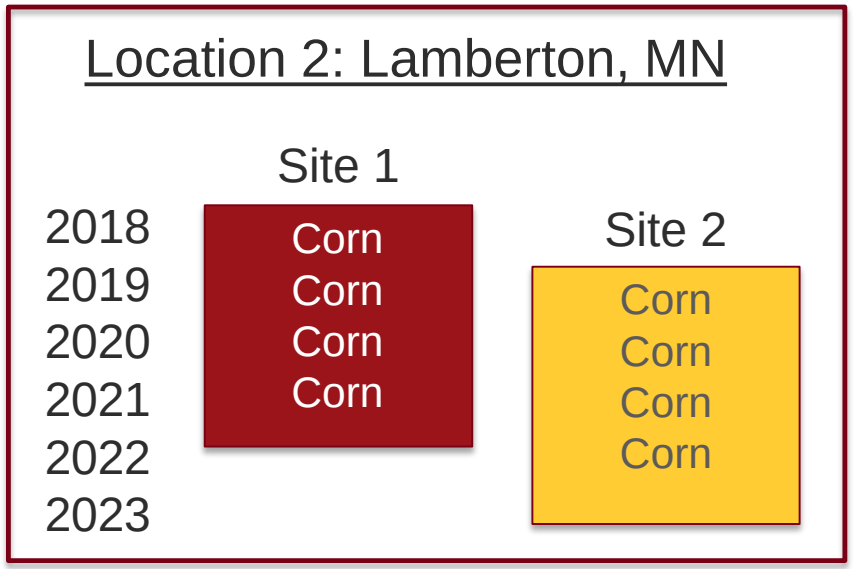
Disadvantages

- Logistics
- Greater risk of salt and 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





MANURE NUTRIENT AVAILABILITY

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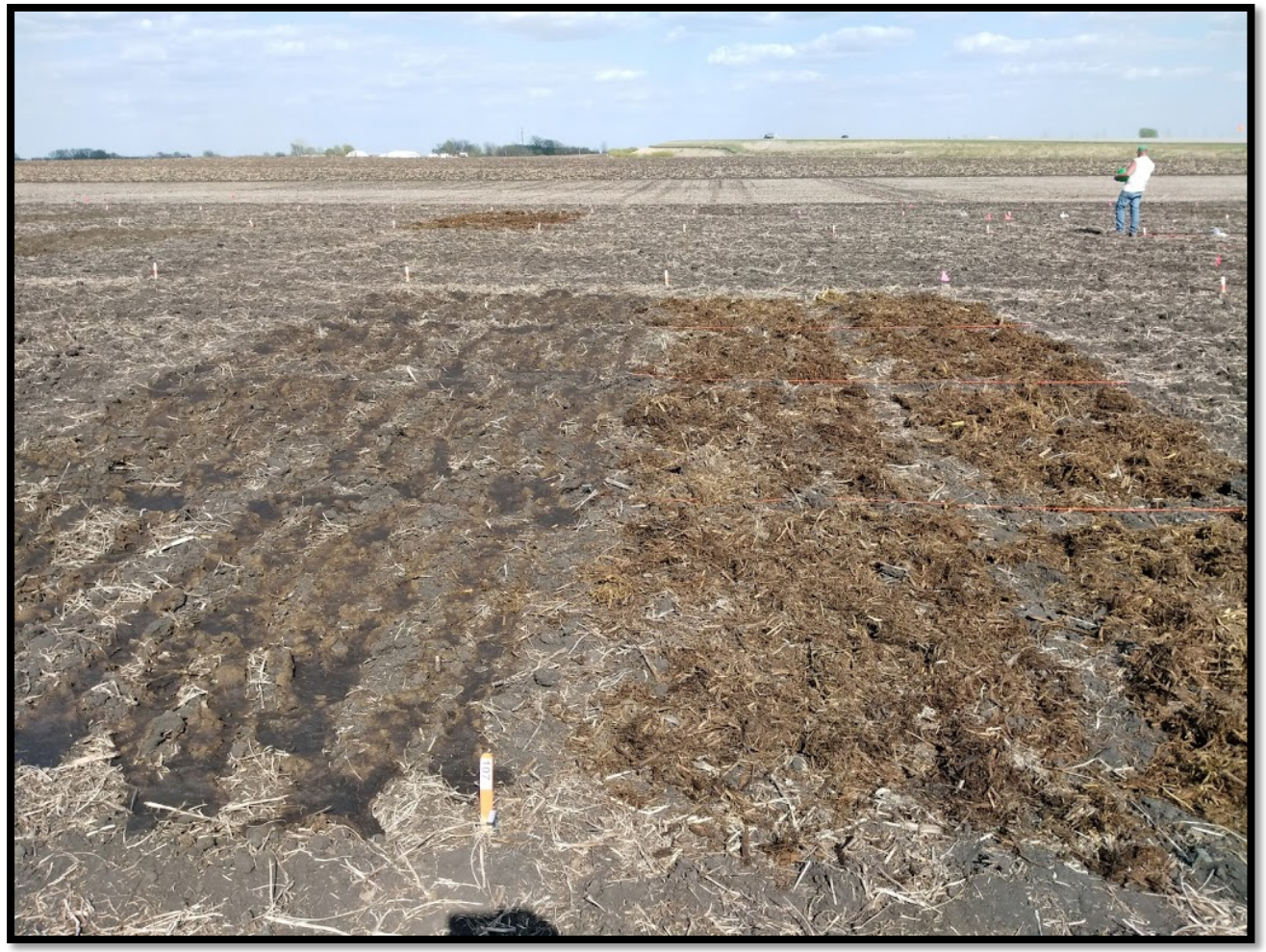
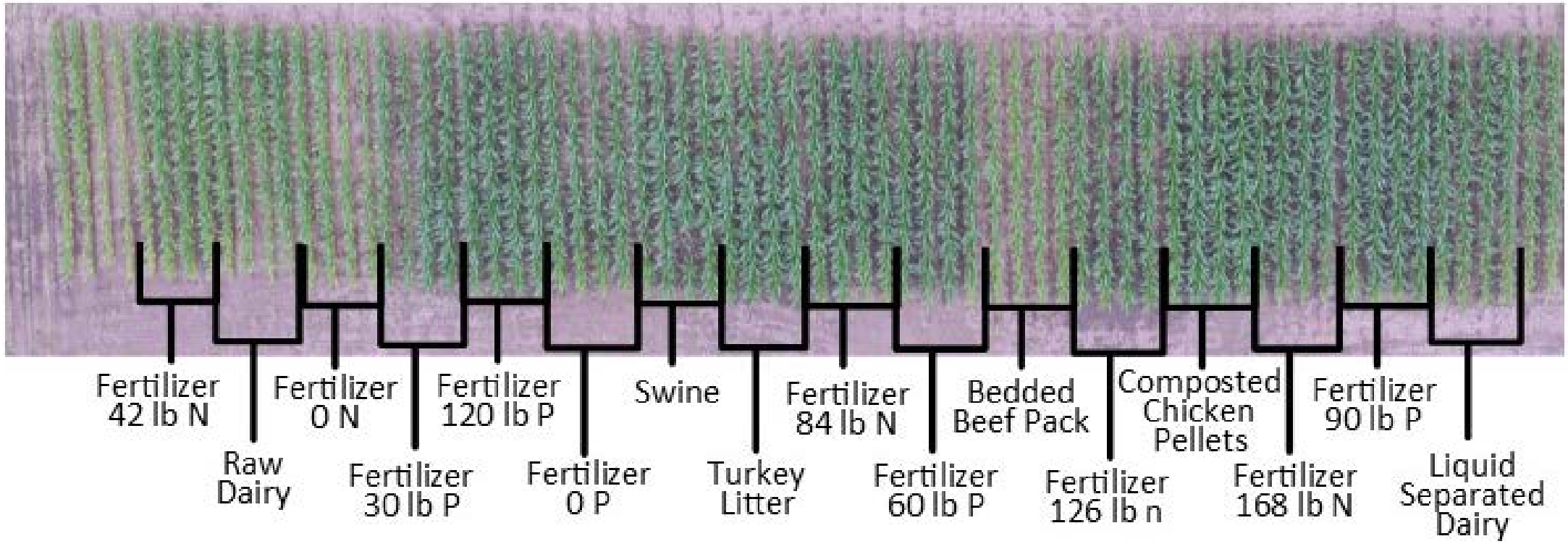


MANURE NUTRIENT AVAILABILITY

Picture taken June 18, 2018 at SROC

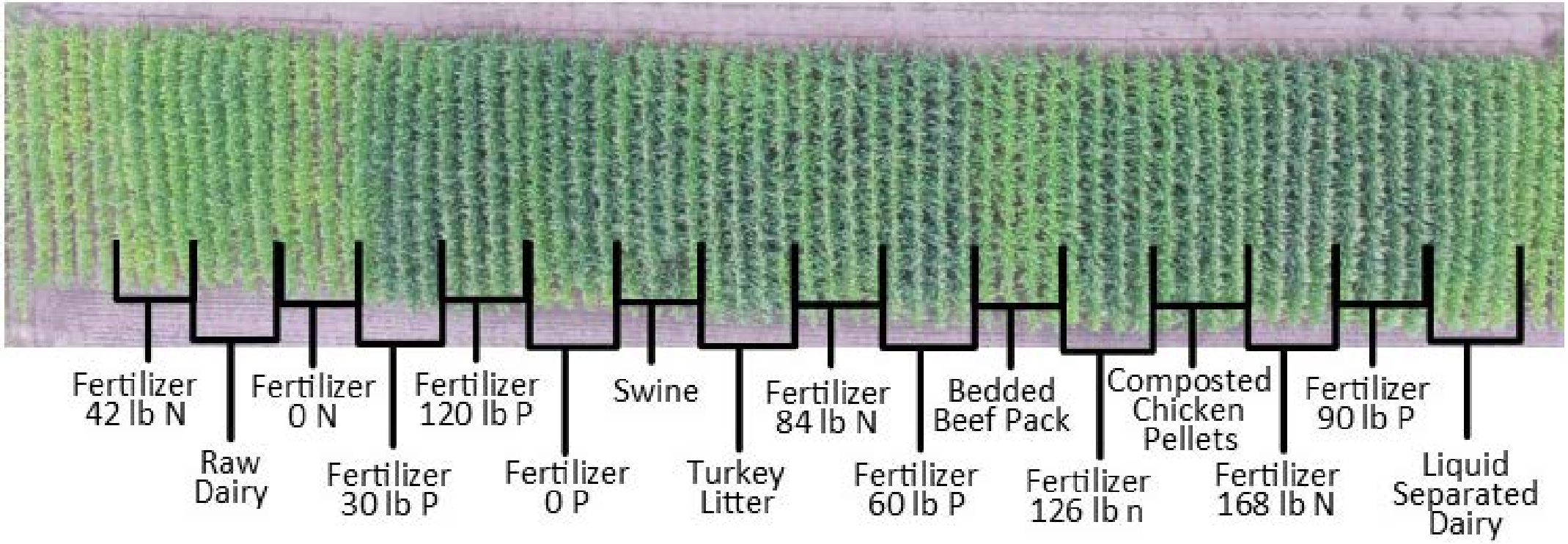
June 28, 2018 at SWROC

Rep 1

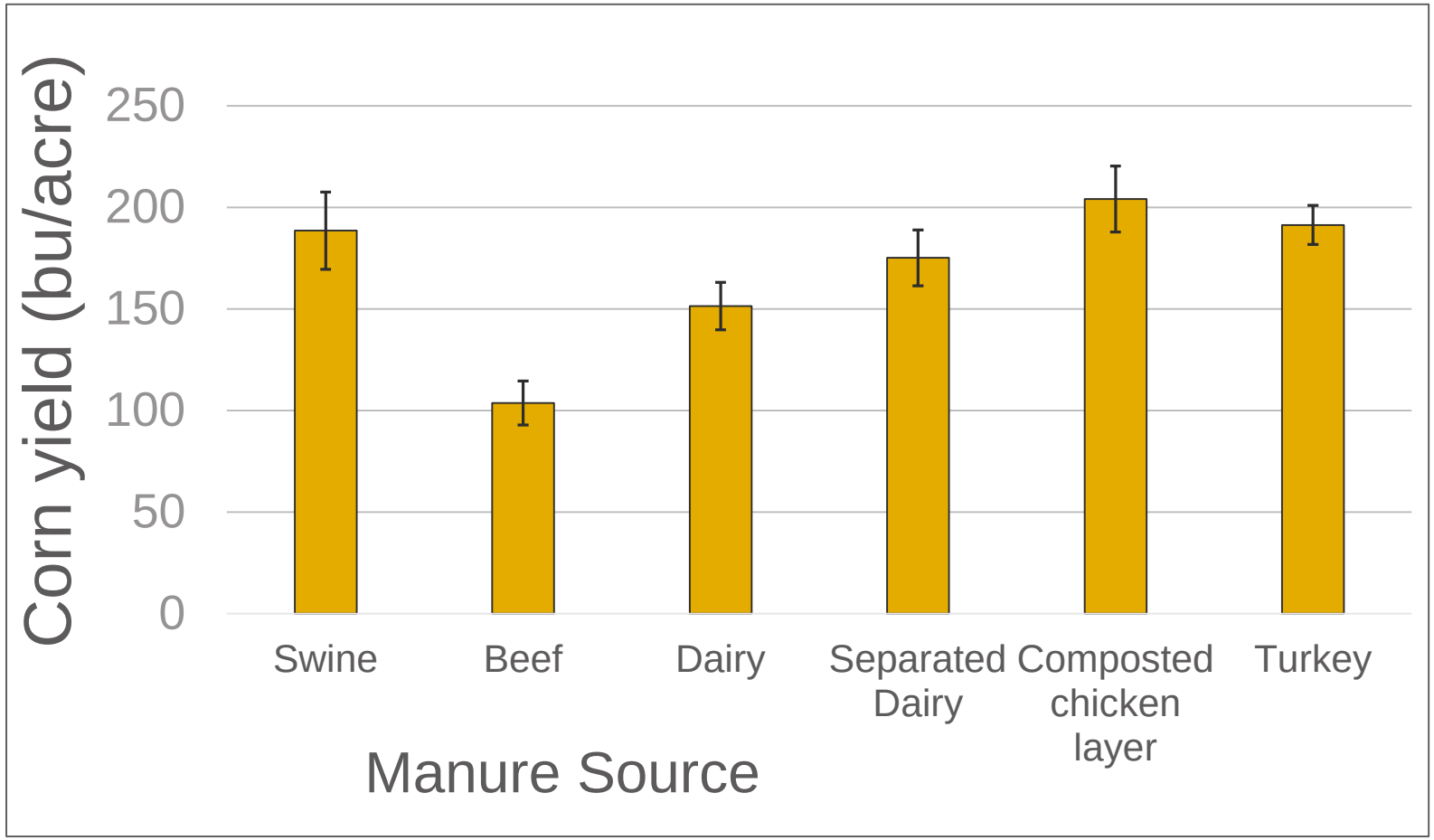


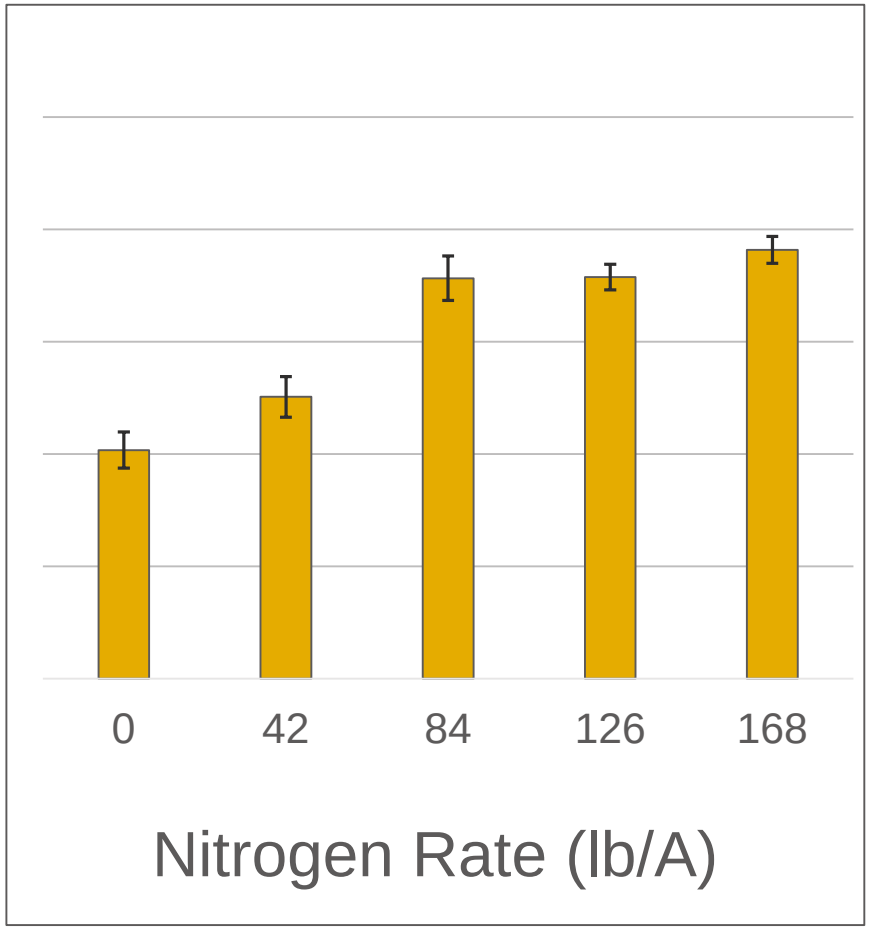
July 26, 2018 at SWROC

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
- 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

Partially funded by MN Pork Board and MN Soybean Research and Promotion Council

SIDEDRESSING MANURE INTO CORN

Partially funded by MN Pork Board and MN Soybean Research and Promotion Council

SIDEDRESSING MANURE INTO CORN

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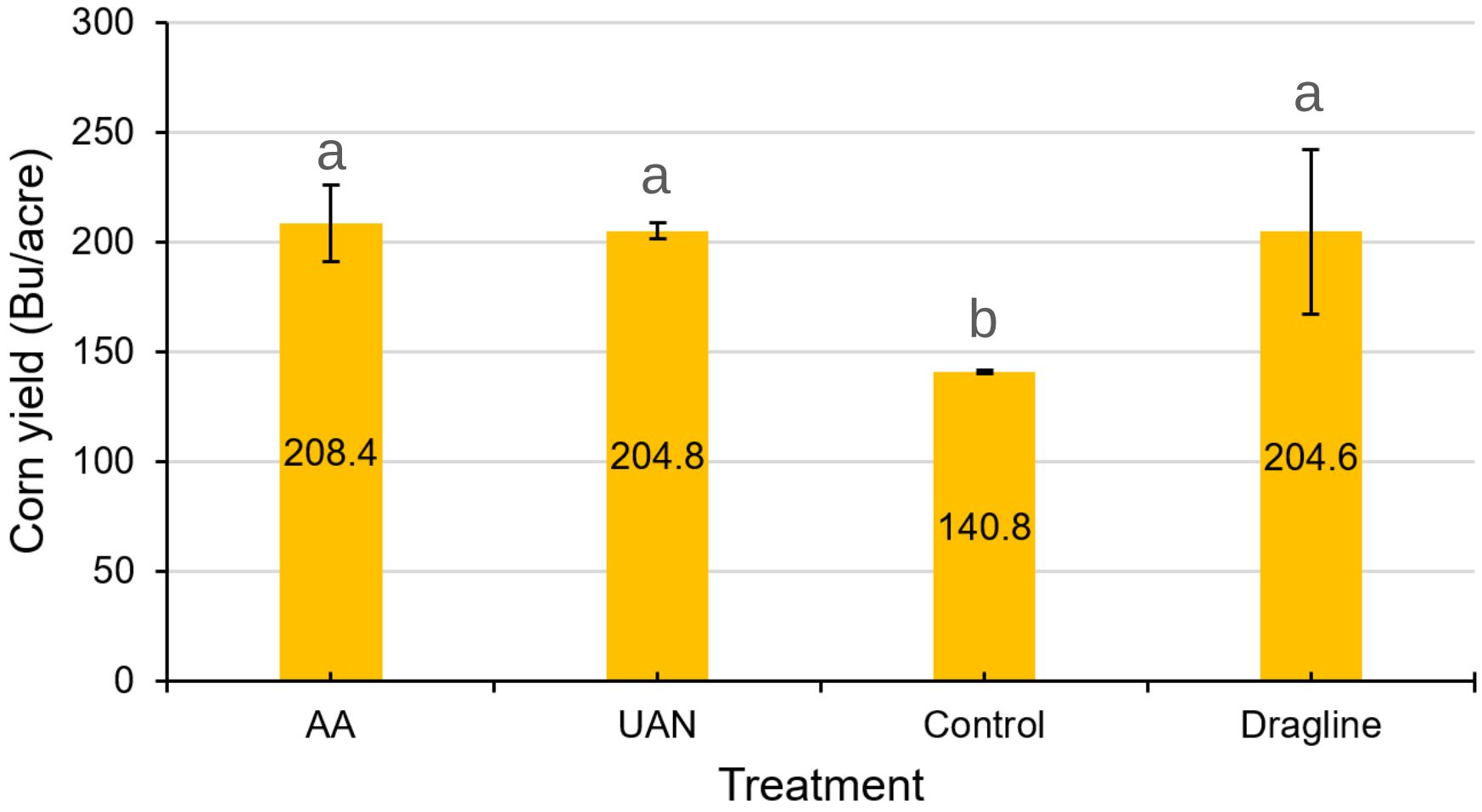


APPLICATION TIMING: FALL

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^{o}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?

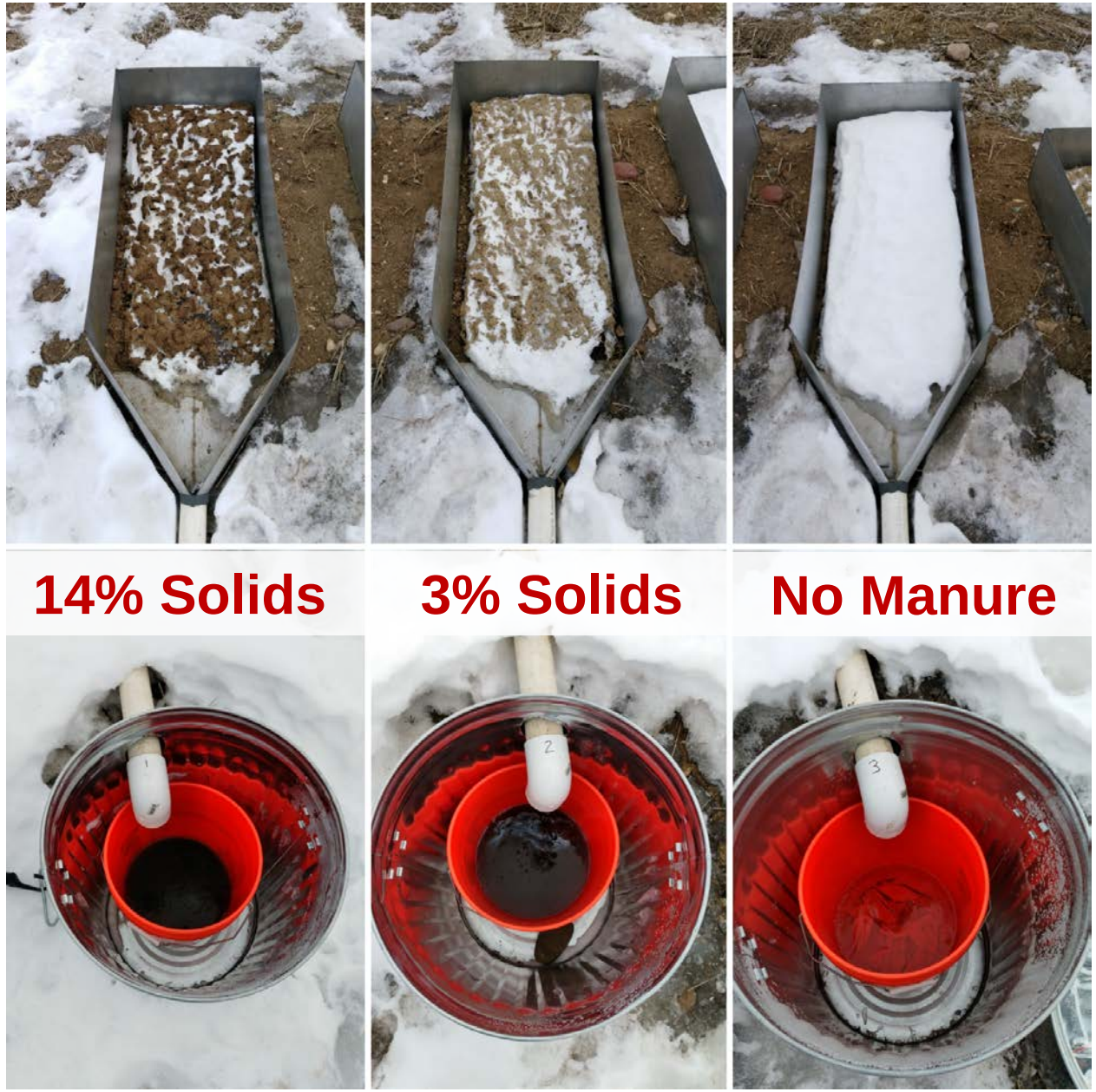
Disadvantages

- 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

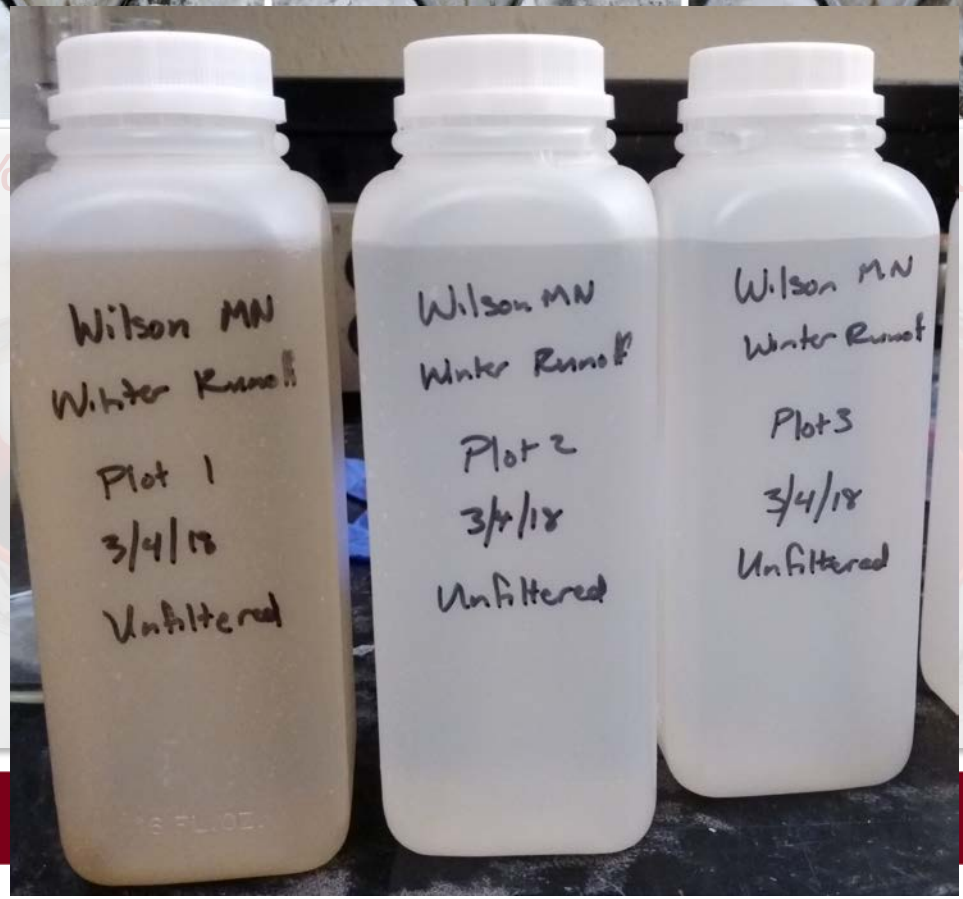
First runoff event

Collected samples: Jan. 28, 2018



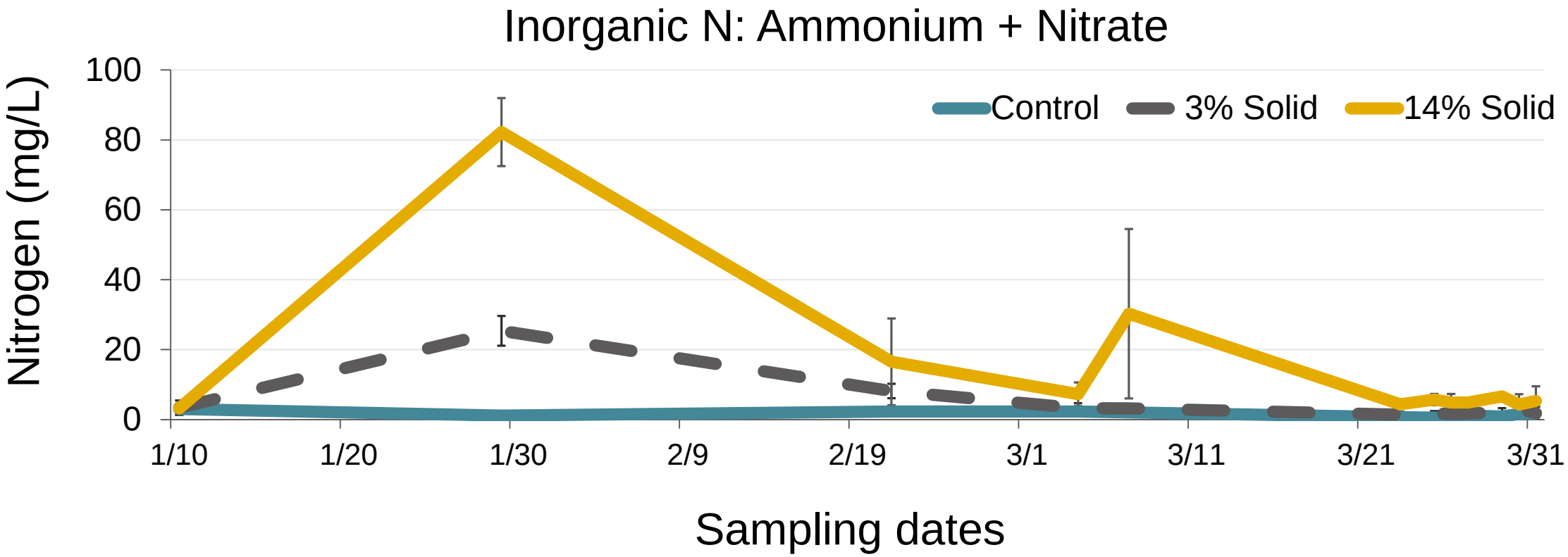
Third runoff event

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



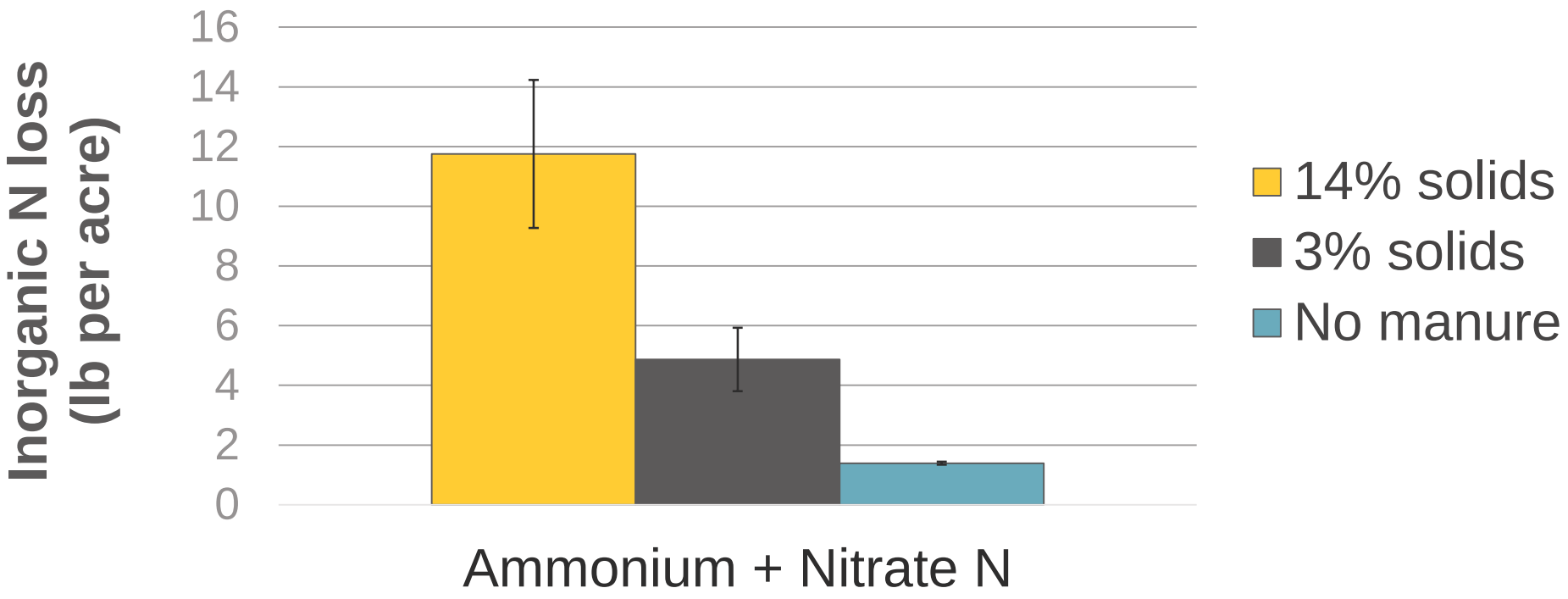
WINTER RUNOFF NUTRIENT LOSSES

- 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

Research Sponsors:

- Ag. Fertilizer Research and Education Council (AFREC)
- MN Pork Board
- MN Soybean Research and Education Council