Proceedings of the 4th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference

Managing Manure Nitrogen:

Uncertainties & how to deal with them

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AGENDA

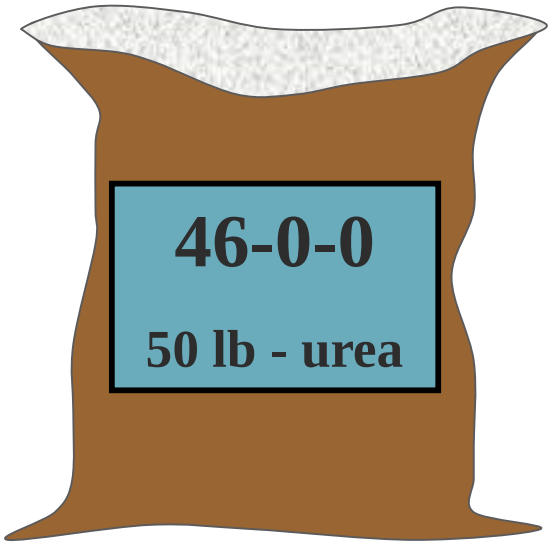
- Why use manure?
- Uncertainties
- Manure research at the U

WHY USE MANURE FOR CROPS?

- Builds soil health
- Provides nutrients
- Likely to be cheaper than commercial fertilizers

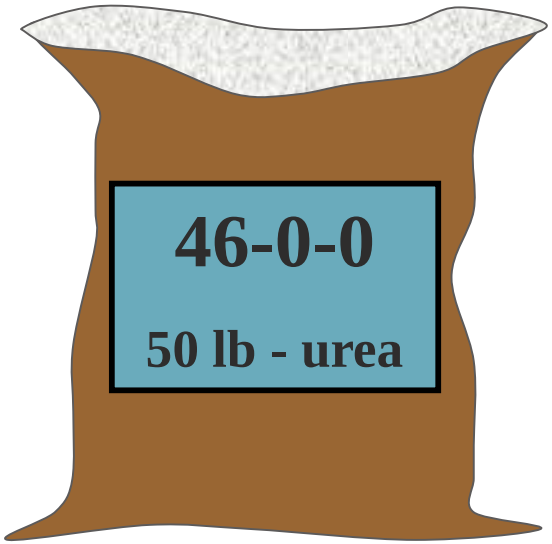
BUT…

IT'S COMPLICATED



- There are many uncertainties with manure
- Nutrient ratios may not necessarily match crop needs

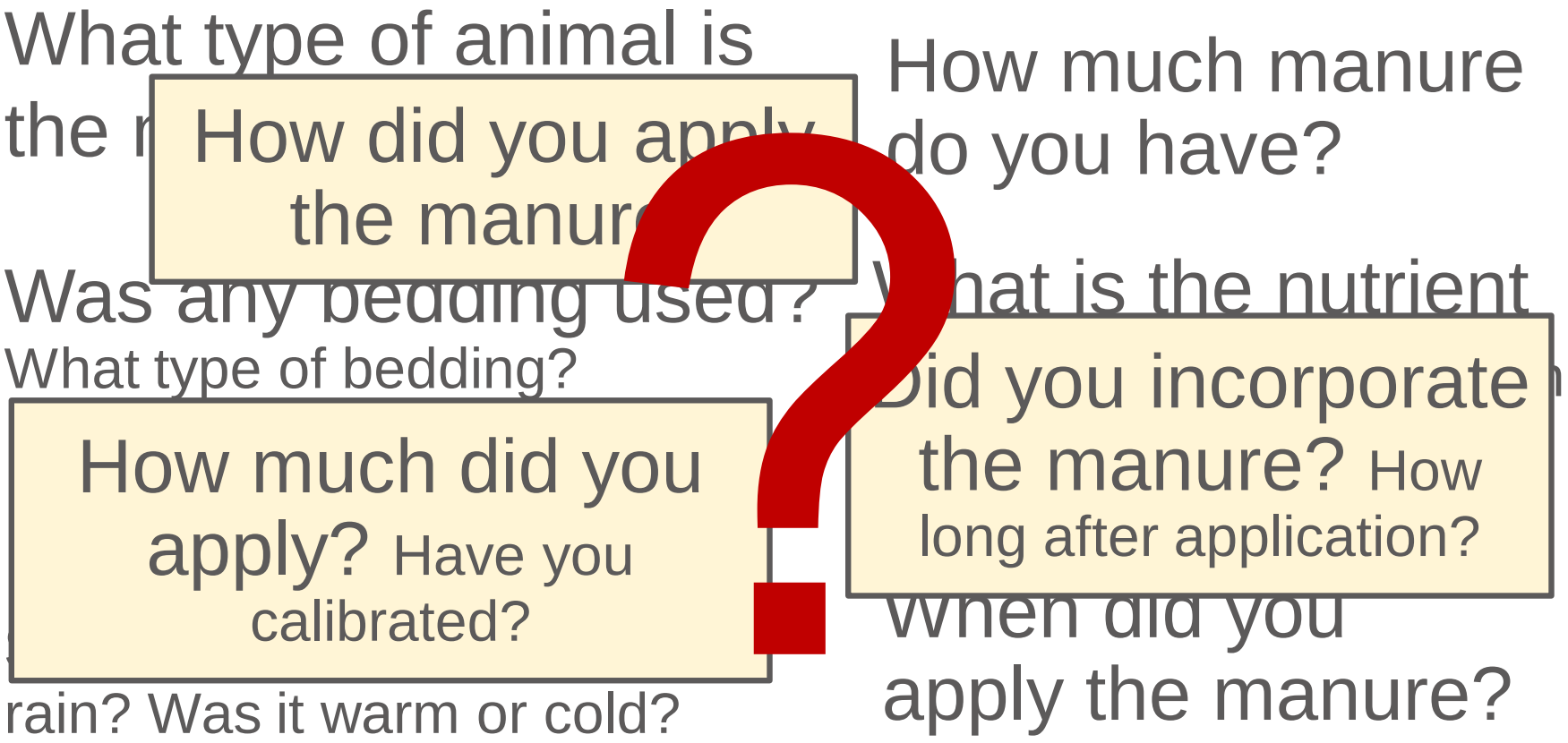
IT'S COMPLICATED



- **There are many uncertainties with manure**

- Nutrient ratios may not necessarily match crop needs

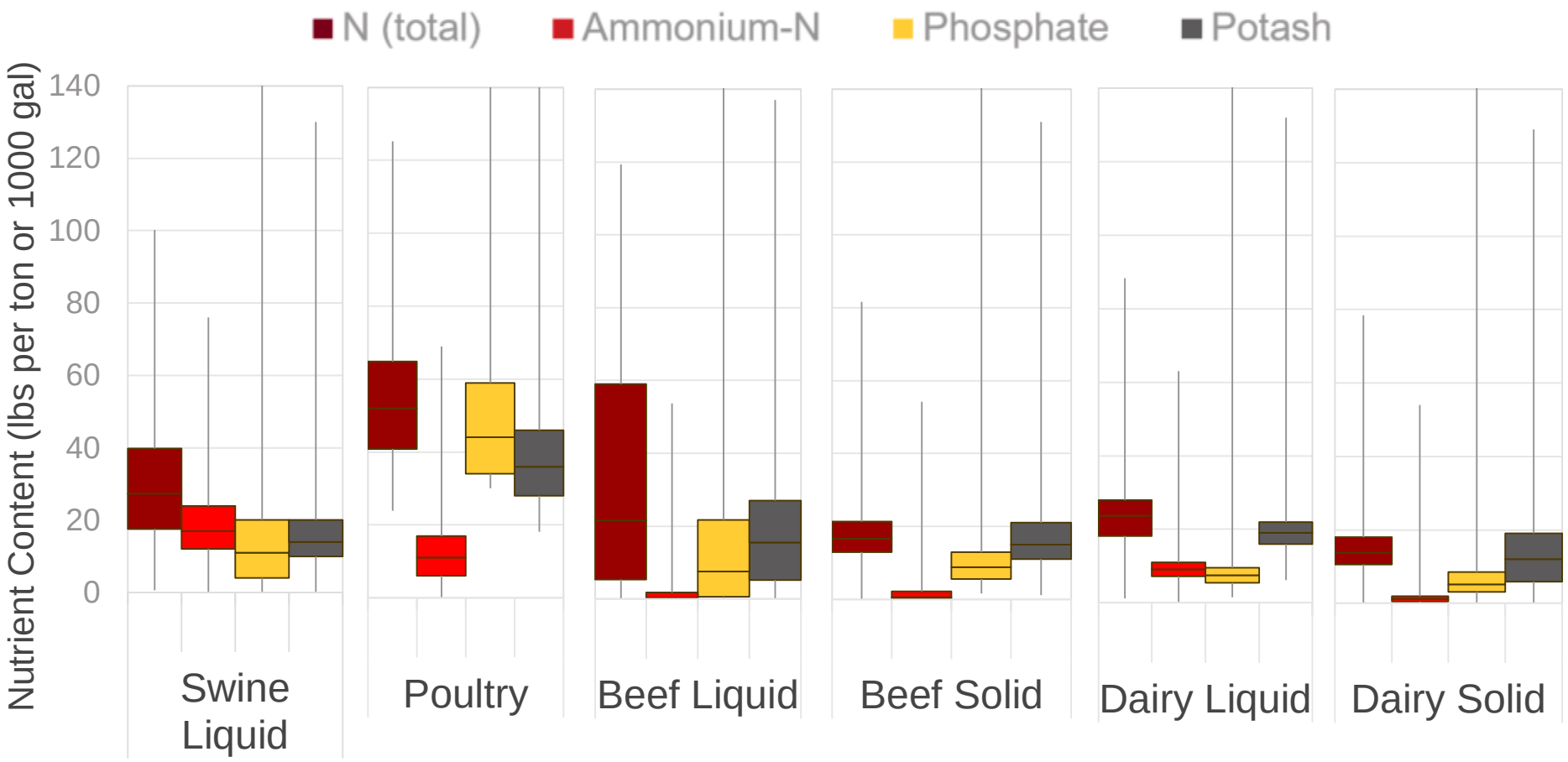
UNCERTAINTY IN USING MANURE



UNCERTAINTY IN USING MANURE

- Problems:
  1. Nutrient content varies by animal type
  2. Nutrient availability is inconsistent
  3. Application rates can be variable

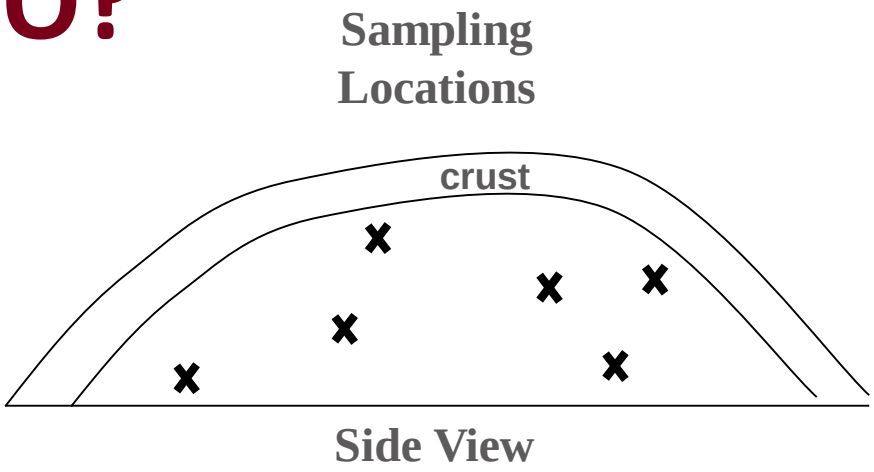
1. NUTRIENT CONTENT VARIES BY ANIMAL TYPE

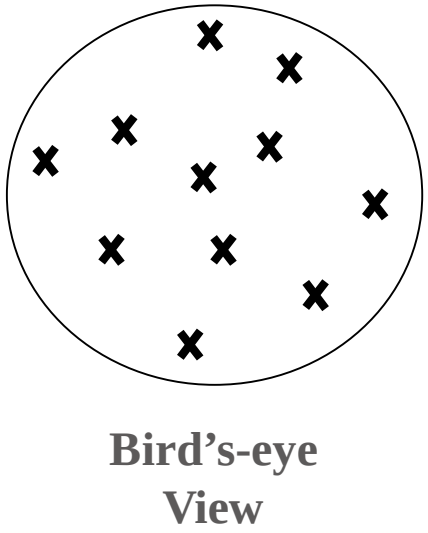


WHAT CAN YOU DO?

- Take manure samples regularly

- Make sure sample is representative
  - Mix well and then mix some more



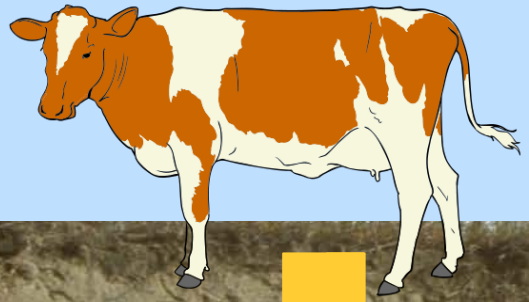


2. NUTRIENT AVAILABILITY VARIES

- P is 80% and K is 90% available first year (for raw manures)

- N availability is more complicated
  - Plant available N (PAN) comes from:
    - mineralized Organic N + Ammonium-N

NITROGEN CYCLING



Plant Uptake

Organic N

Ammonium N

Nitrate N

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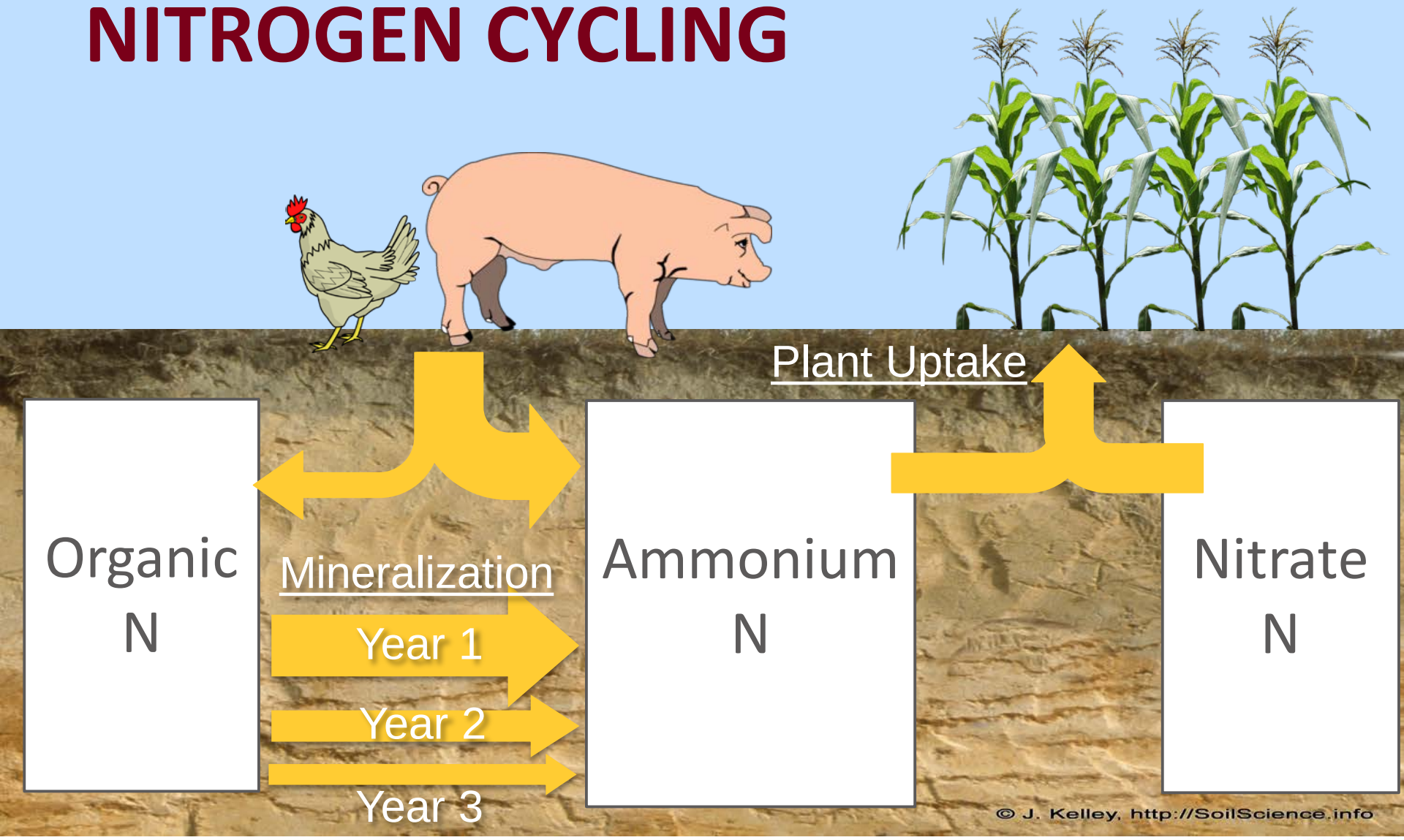
NITROGEN CYCLING



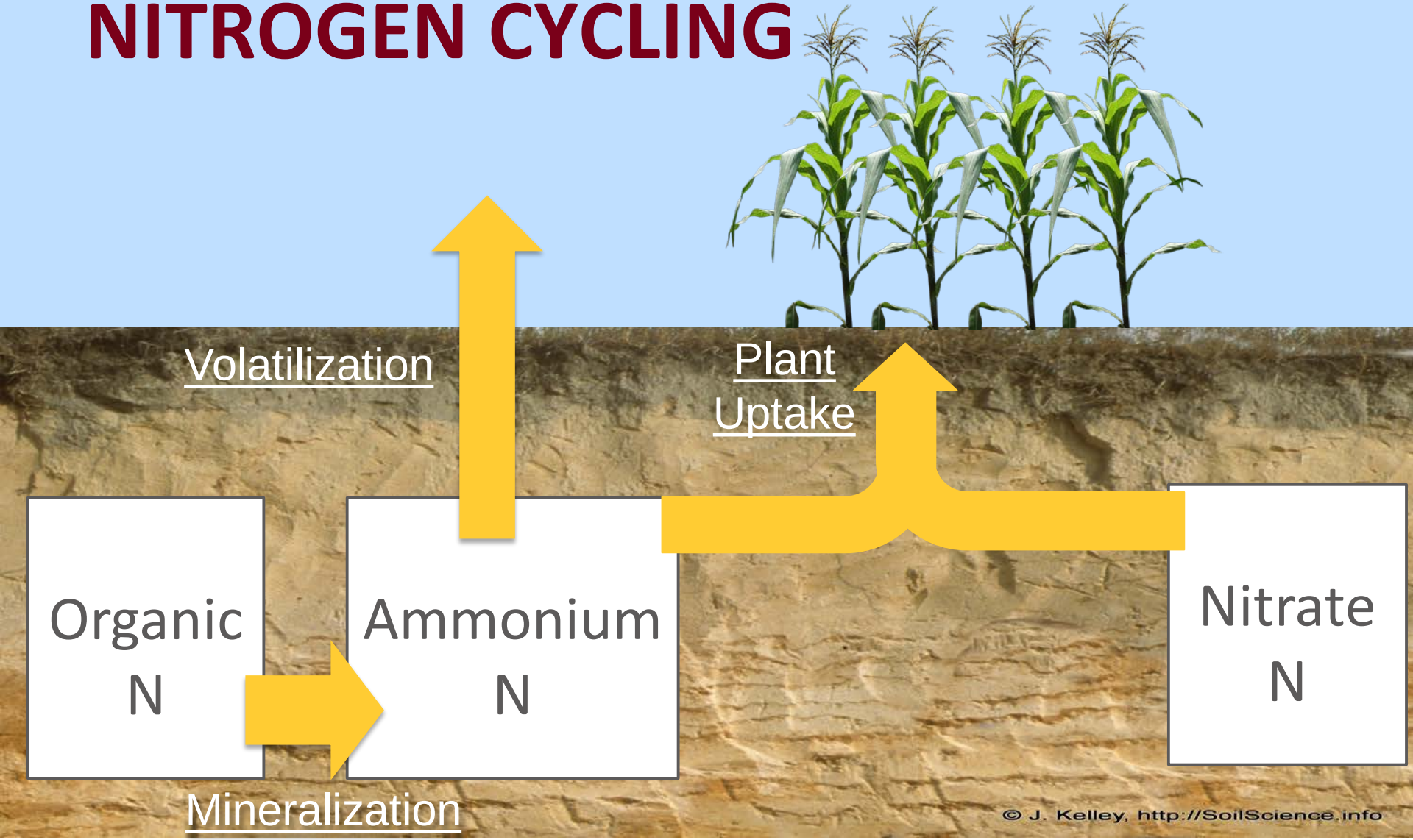
PLANT AVAILABLE NITROGEN (PAN)

- Organic N in manure
  - Not available to plants initially
  - Must be converted (mineralized) by microbes into ammonium
  - Process occurs over several years

MINERALIZATION RATES VARY

- Within animal types
  - Delaware study of 20 litters from commercial broiler houses incubated with same soil
    - range was 21% to 100%
  - USDA study of 107 dairy manures in Northeast
    - mineralization ranged from 0% to 55%
- By soil types
  - In a Georgia study with one broiler litter and 9 soils under controlled conditions
    - ranged from 41% to 80%
    - loamy sands > sandy loams > clays

NITROGEN CYCLING



PLANT AVAILABLE NITROGEN

- Ammonium N
  - Available to plants
    - If not incorporated immediately, can be lost as a gas (volatilization)

NITROGEN AVAILABILITY FOR MN

Table A4. Nitrogen availability and loss as affected by method of manure application and animal type

Year Available	Broadcast Incorporation Timing[2]			Injection	
	> 96 hrs	12 - 96 hrs	< 12 hrs	Sweep	Knife
Beef	Percent of Total Nitrogen Available Per Year				
Year 1	25	45	60	60	50
Year 2	25	25	25	25	25
Lost	*40*	*20*	*5*	*5*	*10*
Dairy					
Year 1	20	40	55	55	50
Year 2	25	25	25	25	25
Lost	*40*	*20*	*10*	*5*	*10*
Swine					
Year 1	35	55	75	80	70
Year 2	15	15	15	15	15
Lost	*50*	*30*	*10*	*5*	*15*
Poultry					
Year 1	45	55	70	NA	NA
Year 2	25	25	25	NA	NA
Lost	*30*	*20*	*5*		

Adapted from: Manure Planning Record Keeping Guide, BU-6957, University of Minnesota Extension Service, 2001

1. Third year available N is not listed but can be computed by adding years 1 and 2 and lost percentages and subtracting this sum from 100.
2. Timing categories: length of time between application and incorporation.

Conversion Factors

1 acre = 43,560 ft^2
1 cubic ft = 7.48 gallons
1 gal of water = 8.33 lbs

Soil Testing Conversions

Plow layer (6-7 in.) = ppm x 2 = lb/acre
Top 12 in. = ppm x 4 = lbs./acre
Top 24 in. = ppm x 8 = lbs./acre
P_2O_5 x 0.44 = P
P x 2.29 = P_2O_5
K_2O x 0.83 = K
K x 1.20 = K_2O

Fertilizer Conversions

1 gal of UAN (28%) = 10.66 lbs
1 gal (10-34-0) = 11.65 lbs
1 gal (7-21-7) = 11.0 lbs
1 gal (9-18-9) = 11.11 lbs

PLANT AVAILABLE NITROGEN

- Other issues to consider:
  - Ammonium-N can convert to nitrate (by microbes)
    - Nitrate can easily be lost from root system
  - Most of N cycling relies on microbes
    - Directly impacted by soil moisture and temperature conditions

NITROGEN CYCLING

Volatilization

Plant Uptake

Denitrification

Organic N

Ammonium N

Nitrate N

Mineralization

Nitrification

Leaching

WHAT CAN YOU DO?

- Inject or incorporate as soon as possible
- Apply as close to crop needs as possible
  - If applying in the fall, wait until soil temperatures are below 50ºF
- Calculate PAN when determining application rates
  - Don’t use Total N and assume it’s 100% available

CALCULATING PLANT AVAILABLE N

- Plant Available N (PAN)

Total N content of manure (from manure analysis)	X	N availability factor	=	**PAN**

CALCULATING PLANT AVAILABLE N

- Example: Swine manure

ANALYTE	ANALYSIS AS RECEIVED		TOTAL NUTRIENTS lbs/1000 gal	lbs/Ton
Moisture, Total	92.8	%		
Nitrogen, Total	0.65	%	54.3	13.0
Phosphorus as P2O5	0.37	%	30.9	7.4
Potassium as K2O	0.35	%	29.2	7.0

$$\frac{54.3 \text{ lbs}}{1000 \text{ gal}} \times \text{N availability factor} = \textbf{PAN}$$

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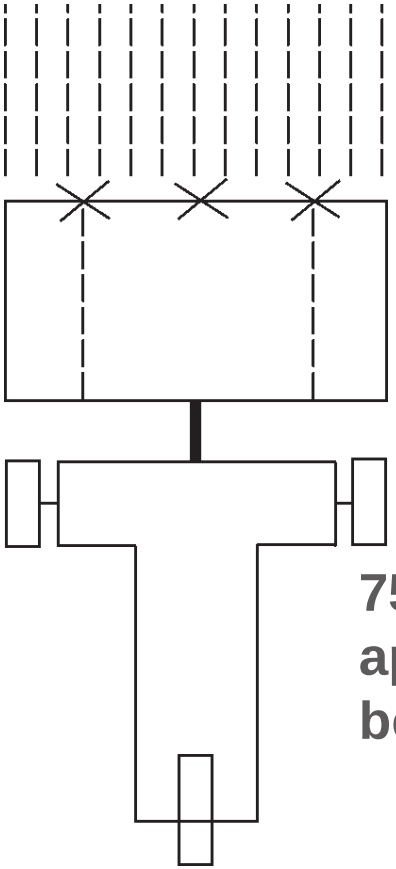
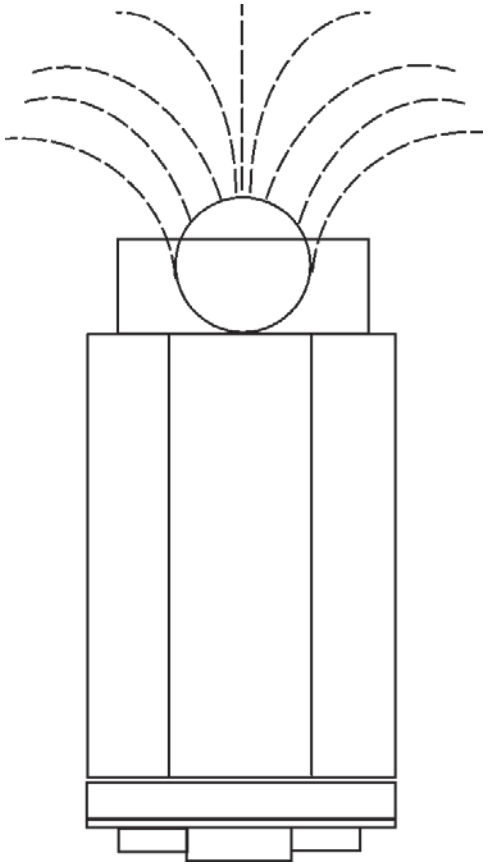
$$\frac{54.3 \text{ lbs}}{1000 \text{ gal}} \times 0.80 = \frac{43.4 \text{ lbs}}{1000 \text{ gal}}$$

3. APPLICATION CAN BE VARIABLE



75% of material applied directly behind spreader

Spread pattern of a box spreader

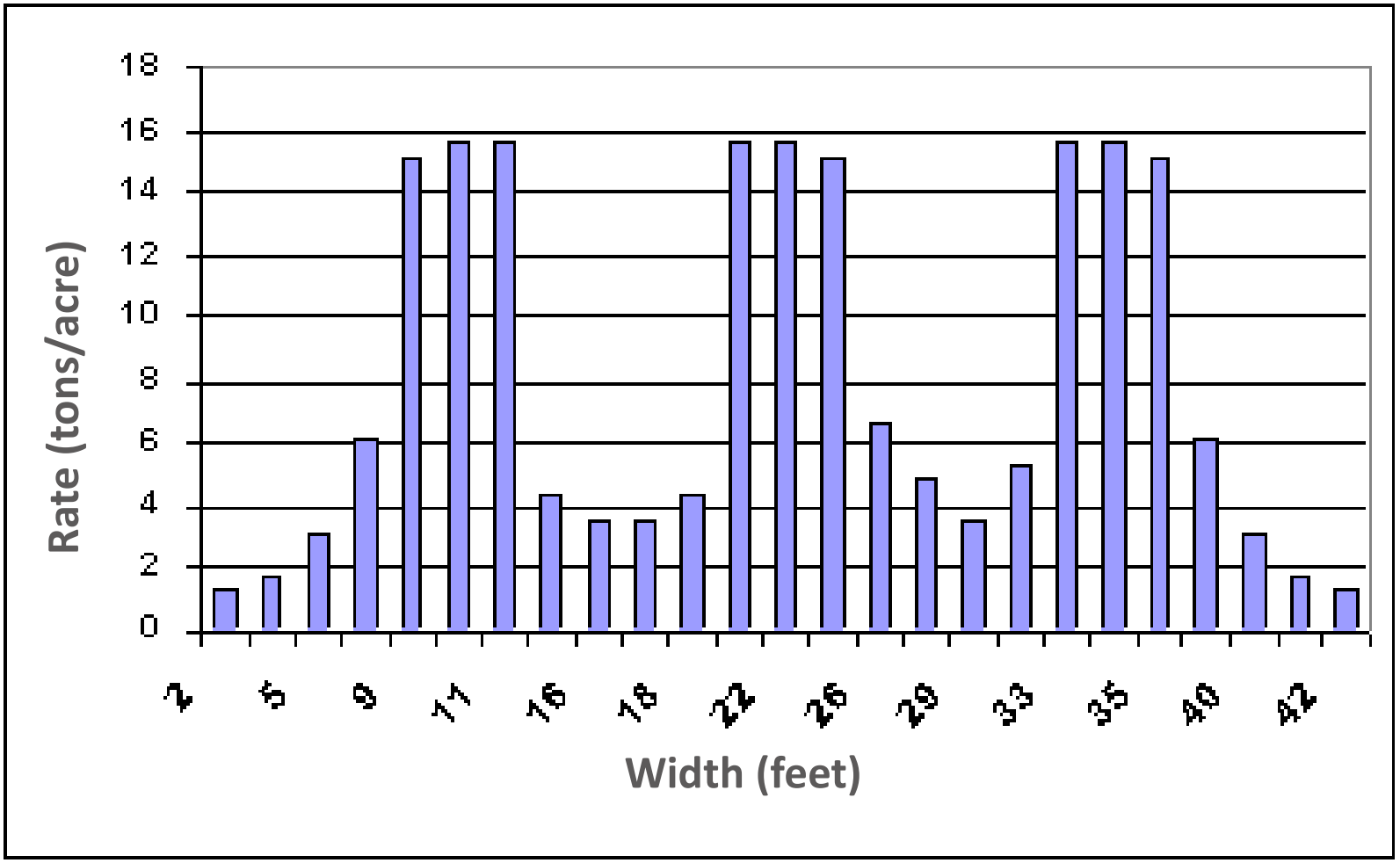


1/3 of material directly behind spreader

Spread pattern of a spinner spreader

SPINNER SPREADER DISTRIBUTION PATTERN

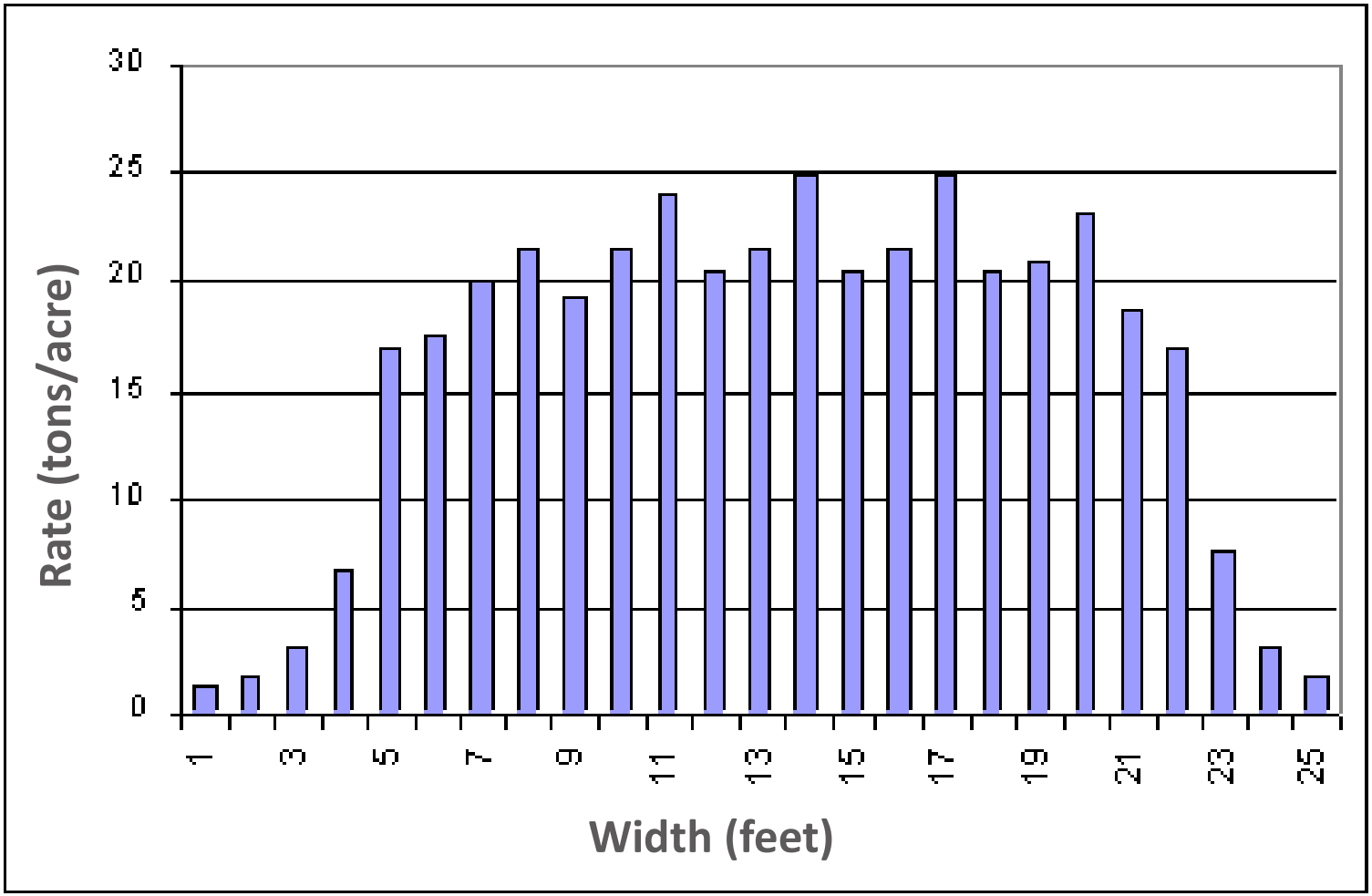
3 passes of a spreader; 12 feet apart



Source: Iowa State University

SPINNER SPREADER DISTRIBUTION PATTERN

3 passes of a spreader; 6 feet apart



Source: Iowa State University

LIQUID SPREADER VARIABILITY

Manifold 1 – Crescent Moon

Manifold 2 – Outlets on Full Circumference

Manifold 3 – Outlets on 2/3 Circumference

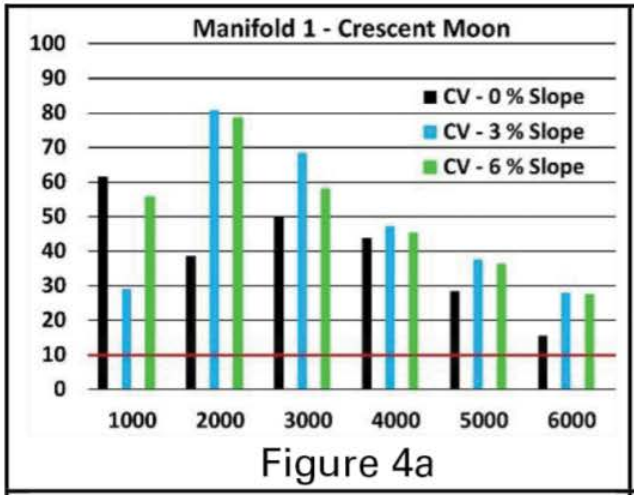


Figure 4a

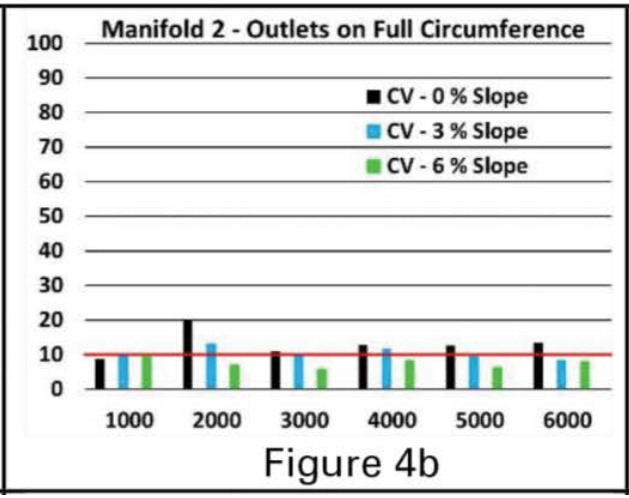


Figure 4b

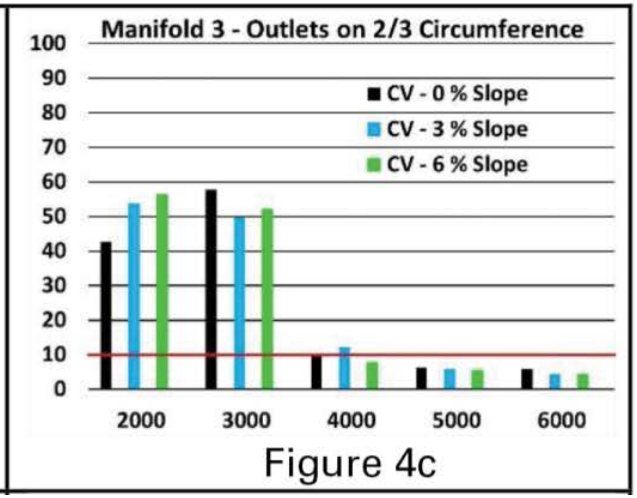


Figure 4c

Source: Arora and Anderson. 2016. Distribution of Liquid Manure Application. Iowa State University.

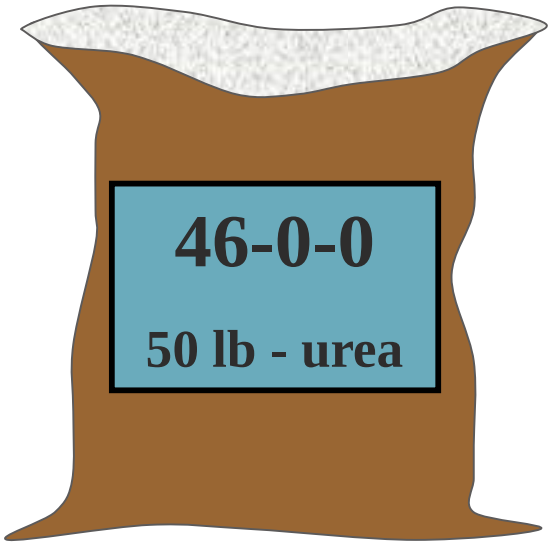
WHAT CAN YOU DO?

- Calibrate your equipment
  - Resources are available online

- Understand limitations of your equipment
- Check for leaks and/or clogs

IT'S COMPLICATED

- There are many uncertainties with manure
- Nutrient ratios may not necessarily match crop needs



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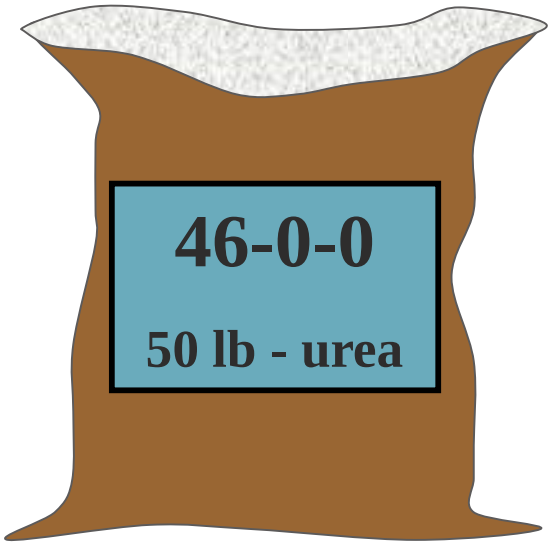
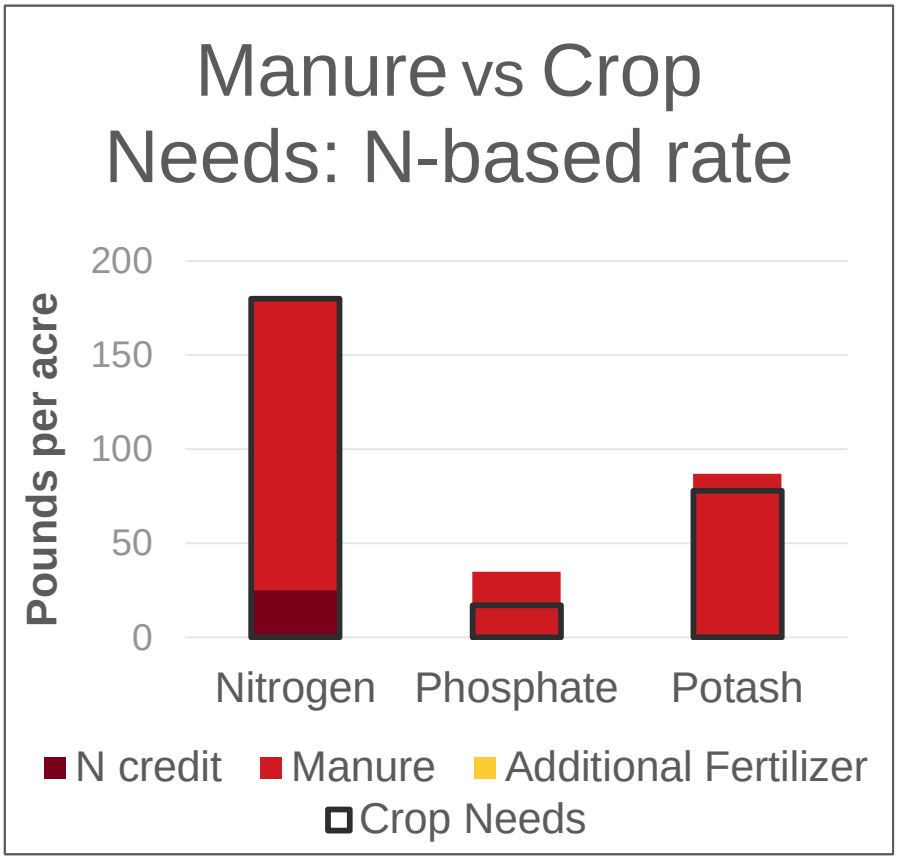


- There are many uncertainties with manure

- **Nutrient ratios may not necessarily match crop needs**

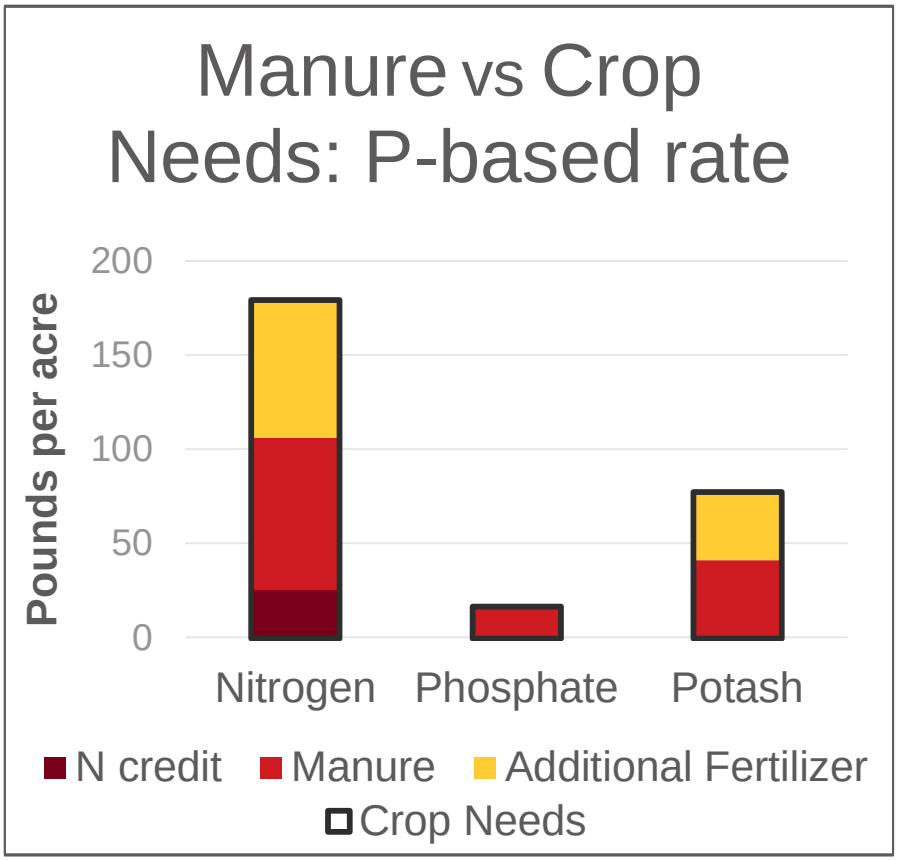
MANURE VERSUS CROP NEEDS

- Scenario:
  - Corn grain
    - Previous crop: Corn
  - Nutrient needs:
    - 180-17-78
  - Dairy liquid injected at rate to fully supply N
    - Nutrient content:
      - 155-35-87



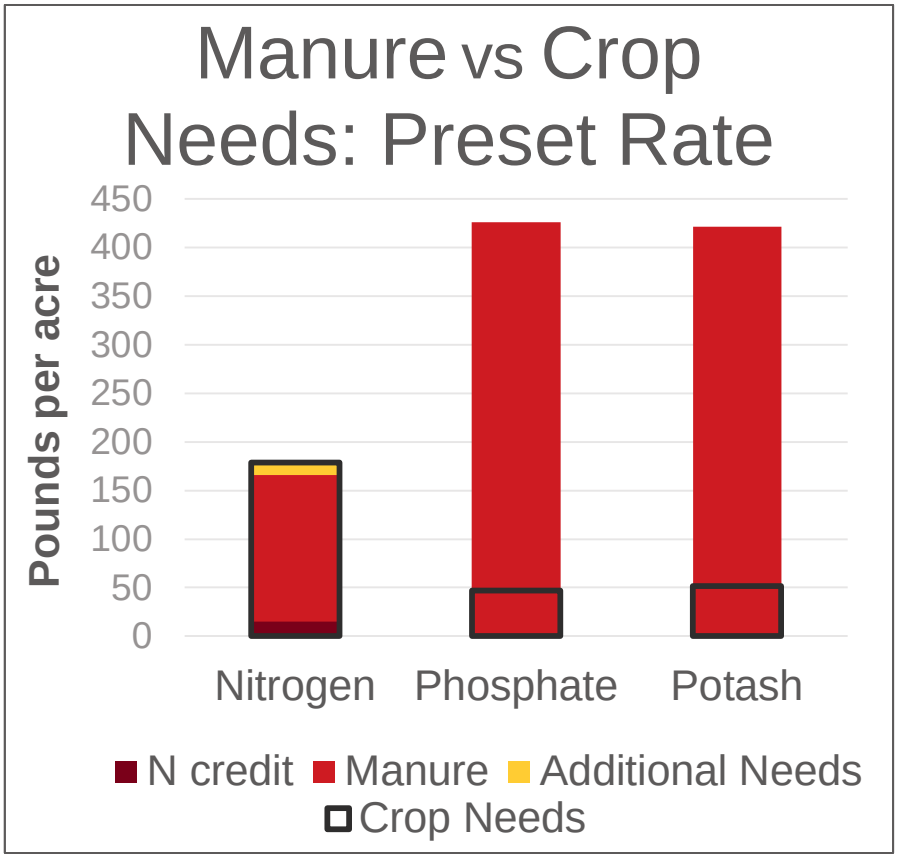
MANURE VERSUS CROP NEEDS

- Scenario:
  - Corn grain
    - Previous crop: Corn
  - Nutrient needs:
    - 180-17-78
  - Dairy liquid injected at P-based rate
    - Nutrient content:
      - 81-17-41



MANURE VERSUS CROP NEEDS

- Scenario:
  - Corn grain
    - Previous crop: Corn
  - Nutrient needs:
    - 180-47-52
  - Poultry litter at 5 tons/acre into no-till
    - Nutrient content:
      - 151-426-421



WHAT CAN YOU DO?

- Determine what your main goal for manure is
  - Want to apply all N with manure?
    - Consider ‘leftover’ P and K as credits for following crop
    - Keep an eye on soil P levels over time
  - Want to spread the manure over more acres?
    - Apply at P-based rate
    - Supplement with commercial N

MOVING ON…

Current and Future Research at the University of Minnesota

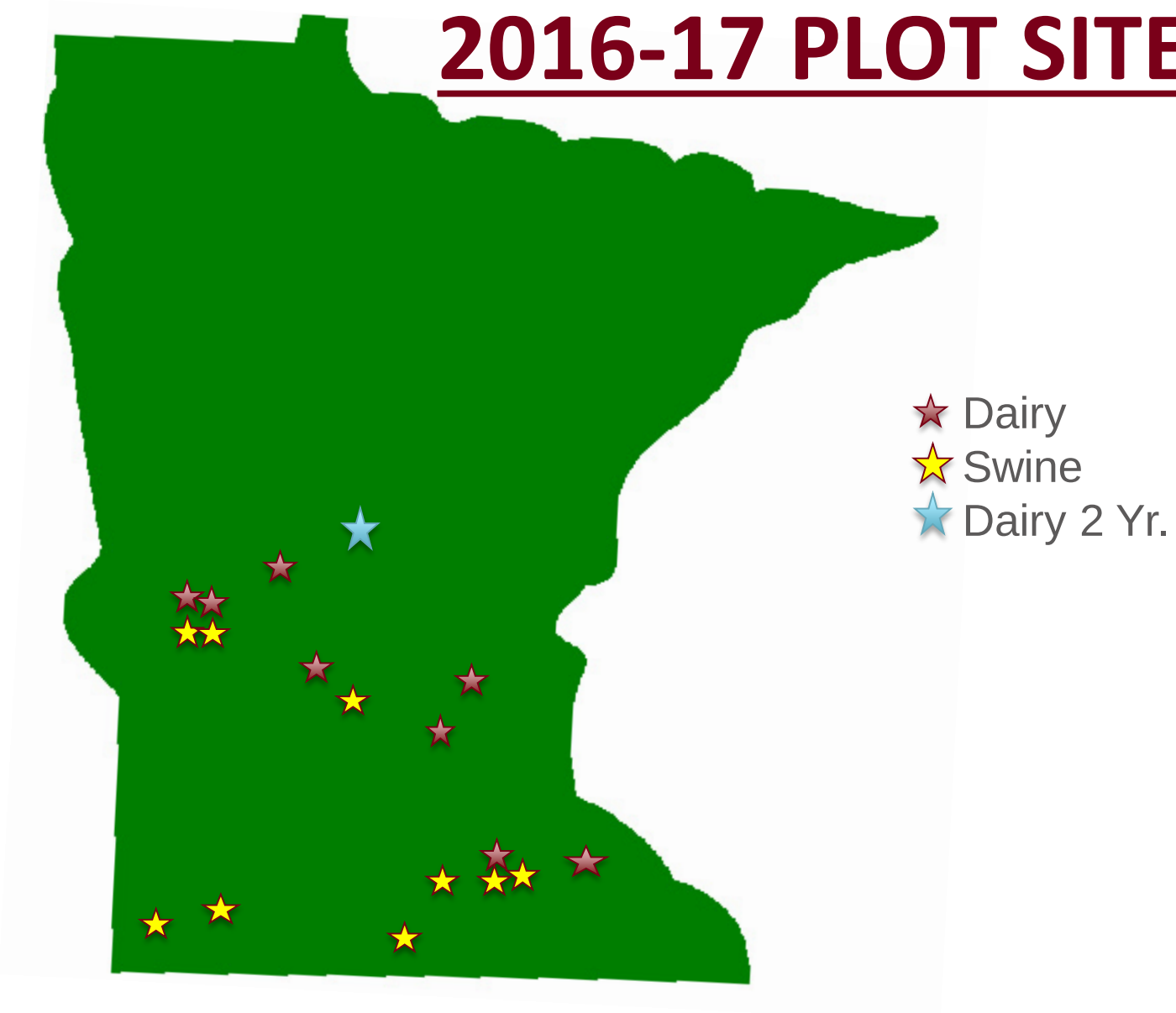
CURRENT RESEARCH AT THE U

- Integrating cover crops and manure: On-farm research

INTEGRATING COVER CROPS AND MANURE

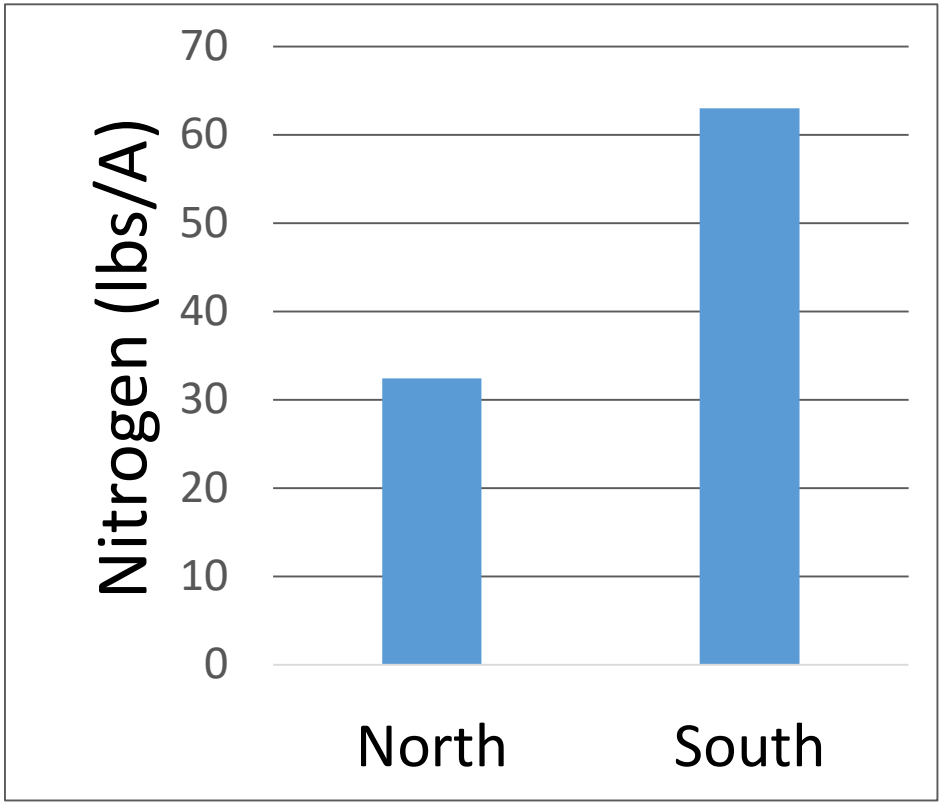
- Details:
  - Plant rye CC after harvest then inject liquid manure
  - Terminate rye in spring
    - Measure soil nitrate in top 24” of soil and in rye
  - Harvest following corn grain or silage next fall
    - Measure corn yield and nitrogen uptake
  - 2 crop years

2016-17 PLOT SITES

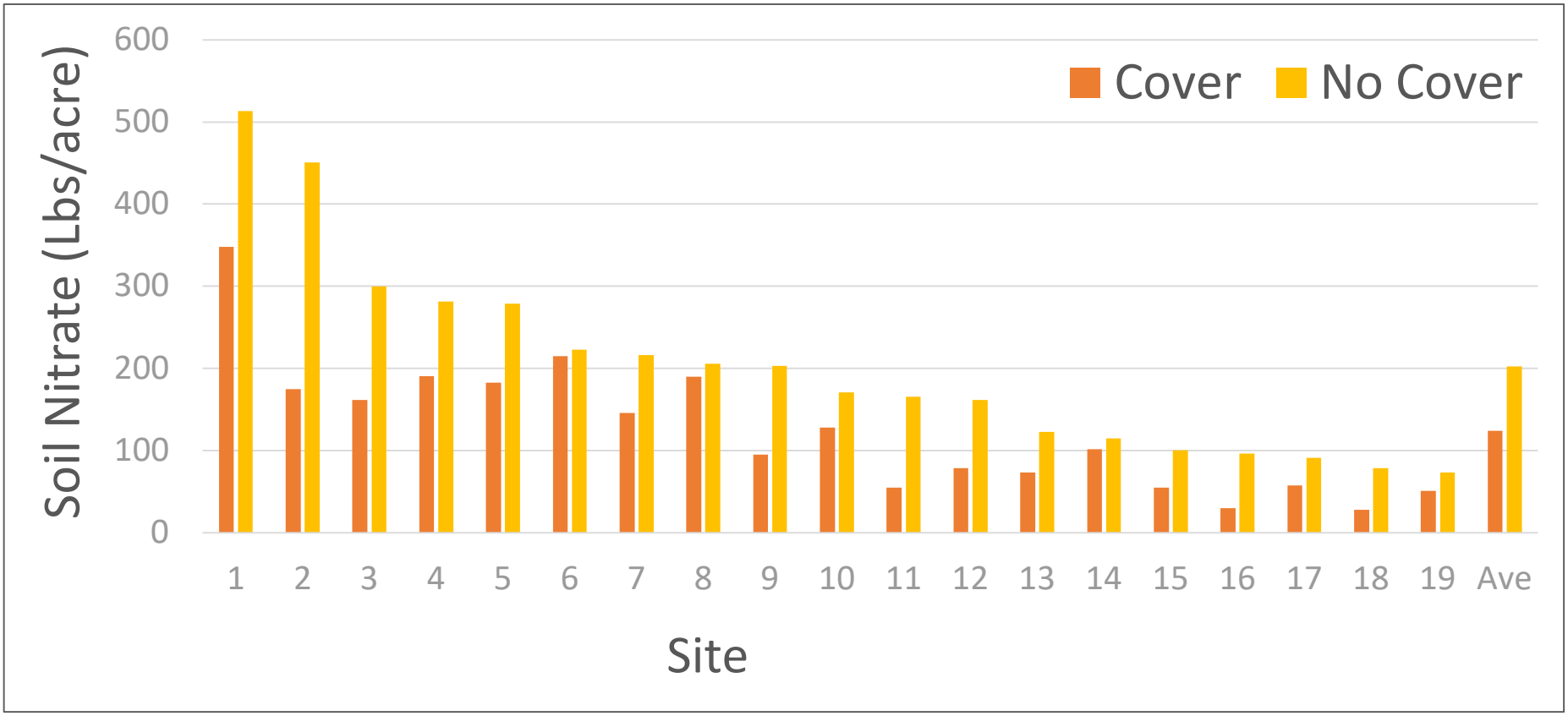


N TAKEN UP BY RYE – NORTH VS. SOUTH

- North = 32 lbs N/Acre
- South = 63 lbs N/Acre
- Average = 45 lbs N/Acre



SPRING SOIL 24" NITRATE (NO_3)

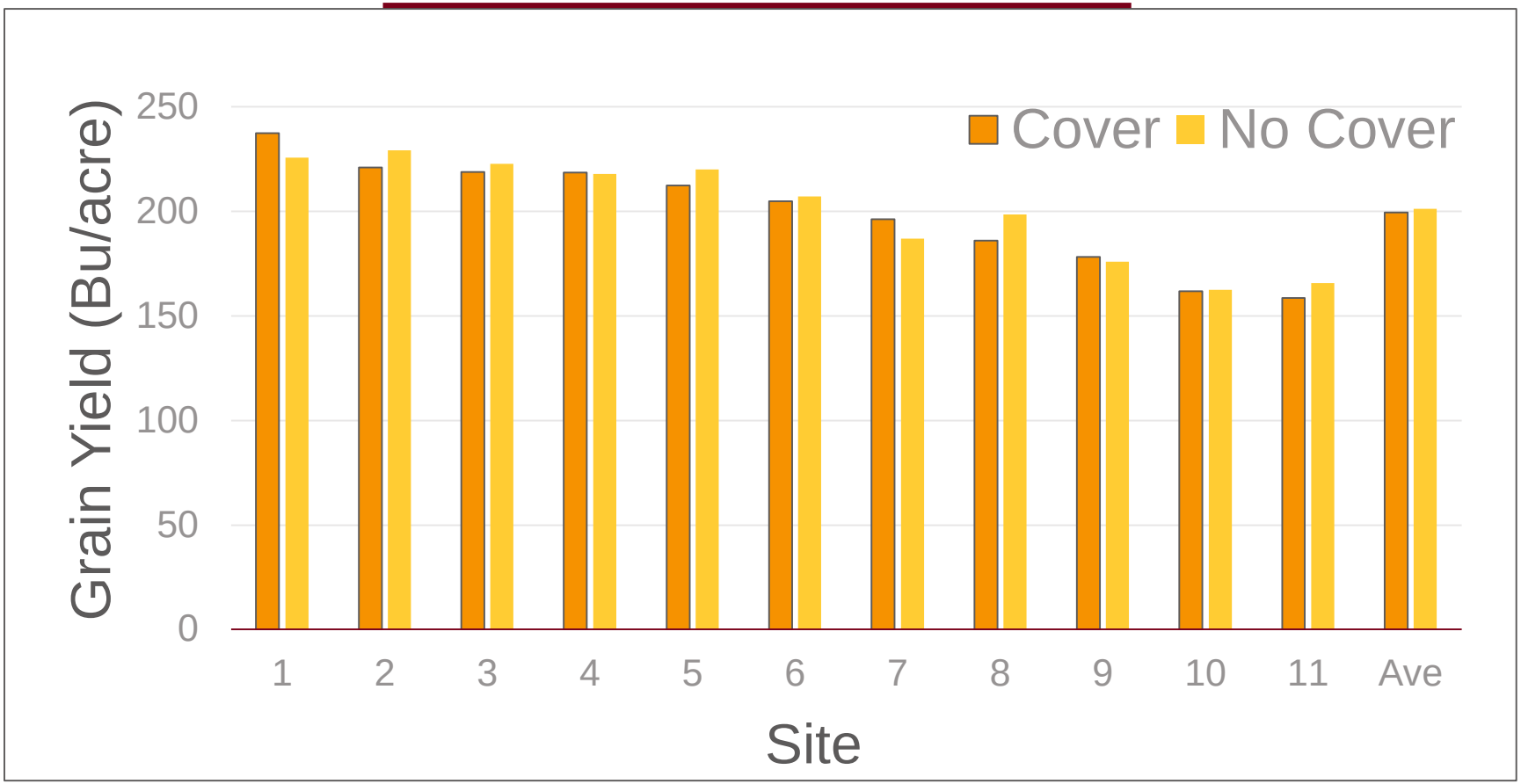


Cover Crop: 124 lbs. NO_3/Acre

No Cover: 202 lbs. NO_3/Acre

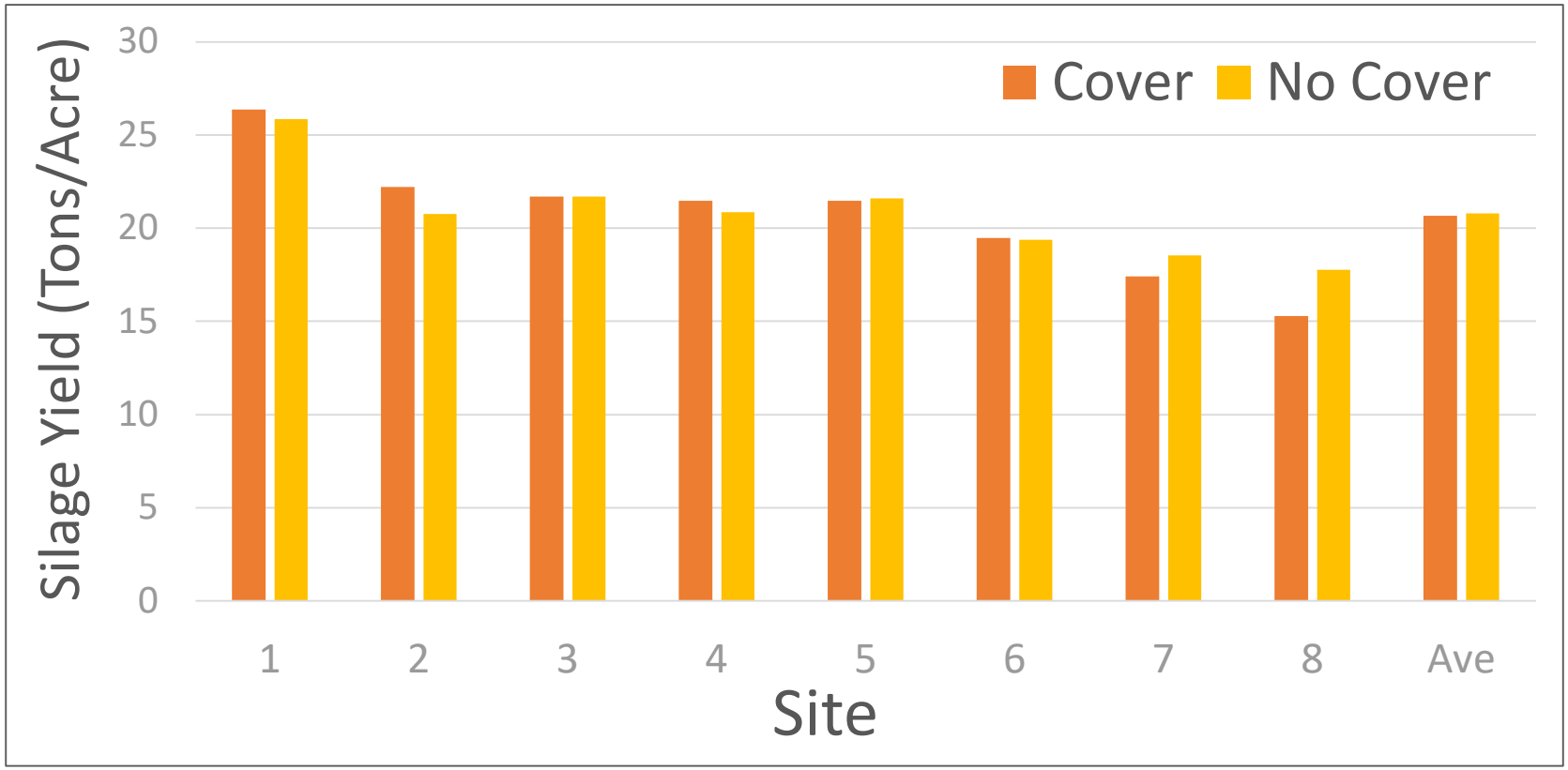
Difference: 78 lbs. NO_3/Acre

GRAIN YIELD 15%



Cover Crop: 199.5 bu/acre
No Cover: 201.2 bu/acre

CORN SILAGE YIELD 65%



Cover Crop: 20.7 Tons/acre
No Cover: 20.8 Tons/acre

INTEGRATING COVER CROPS AND MANURE

- Take home messages:
  - Winter cereal rye can be successfully planted after corn silage or soybeans
  - Winter rye sequesters manure nitrogen
  - Terminate winter cereal rye at or before it grows to 8” high in spring for no significant yield loss

CURRENT RESEARCH AT THE U

- Winter manure applications and nutrient runoff
  - Does solid versus liquid manure make a difference?

CURRENT RESEARCH AT THE U

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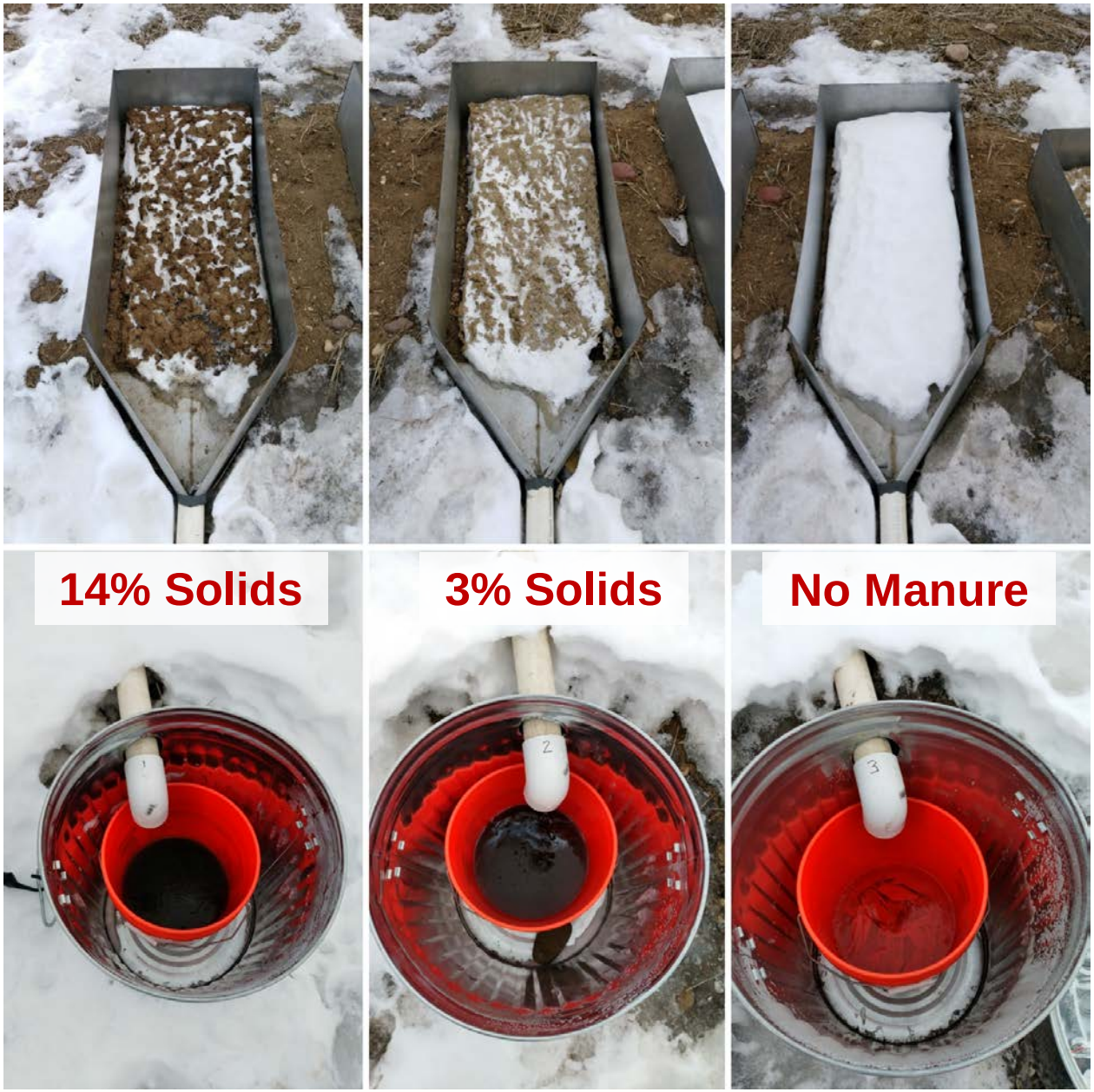
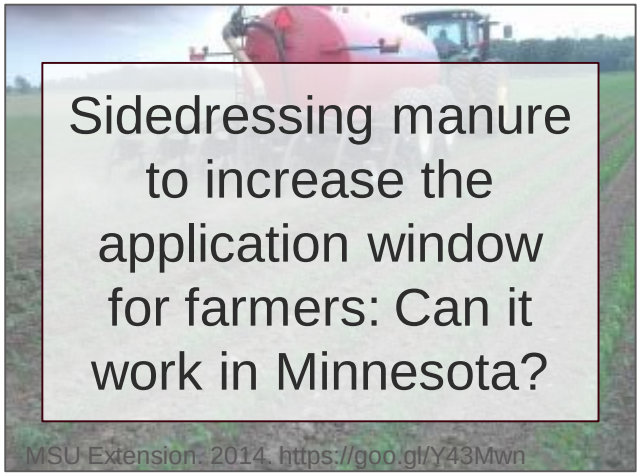


UPCOMING RESEARCH

- Themes:



Common elements:

- Does the practice work and can we fine-tune it?
- Does it reduce impacts on water quality compared with traditional practices?
- Is it economically feasible?

UPCOMING EVENT

Thank you!

Contact Info:

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

Photo by Edwin Remsberg