Proceedings of the 10th Annual Nutrient Management Conference

Managing Manure Nutrients:

Uncertainties & how to deal with them

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AGENDA

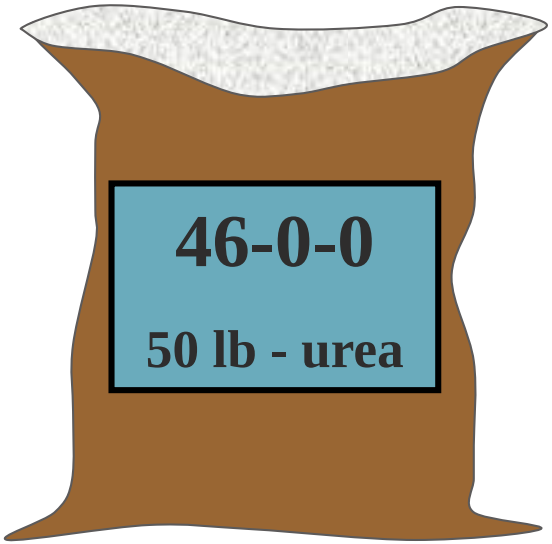
- Why use manure?
- Uncertainties
- Manure research at the U

WHY USE MANURE FOR CROPS?

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

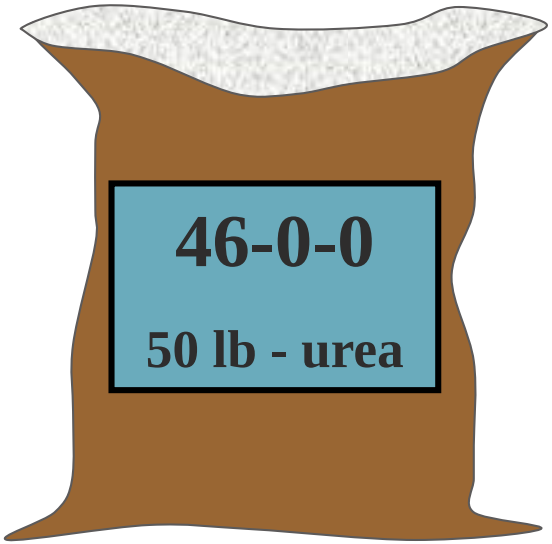
BUT…

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

What type of animal is the m

How much manure do you have?

How did you apply the manure?

Was any bedding used?

What type of bedding?

What is the nutrient

Did you incorporate the manure? How long after application?

How much did you apply? Have you calibrated?

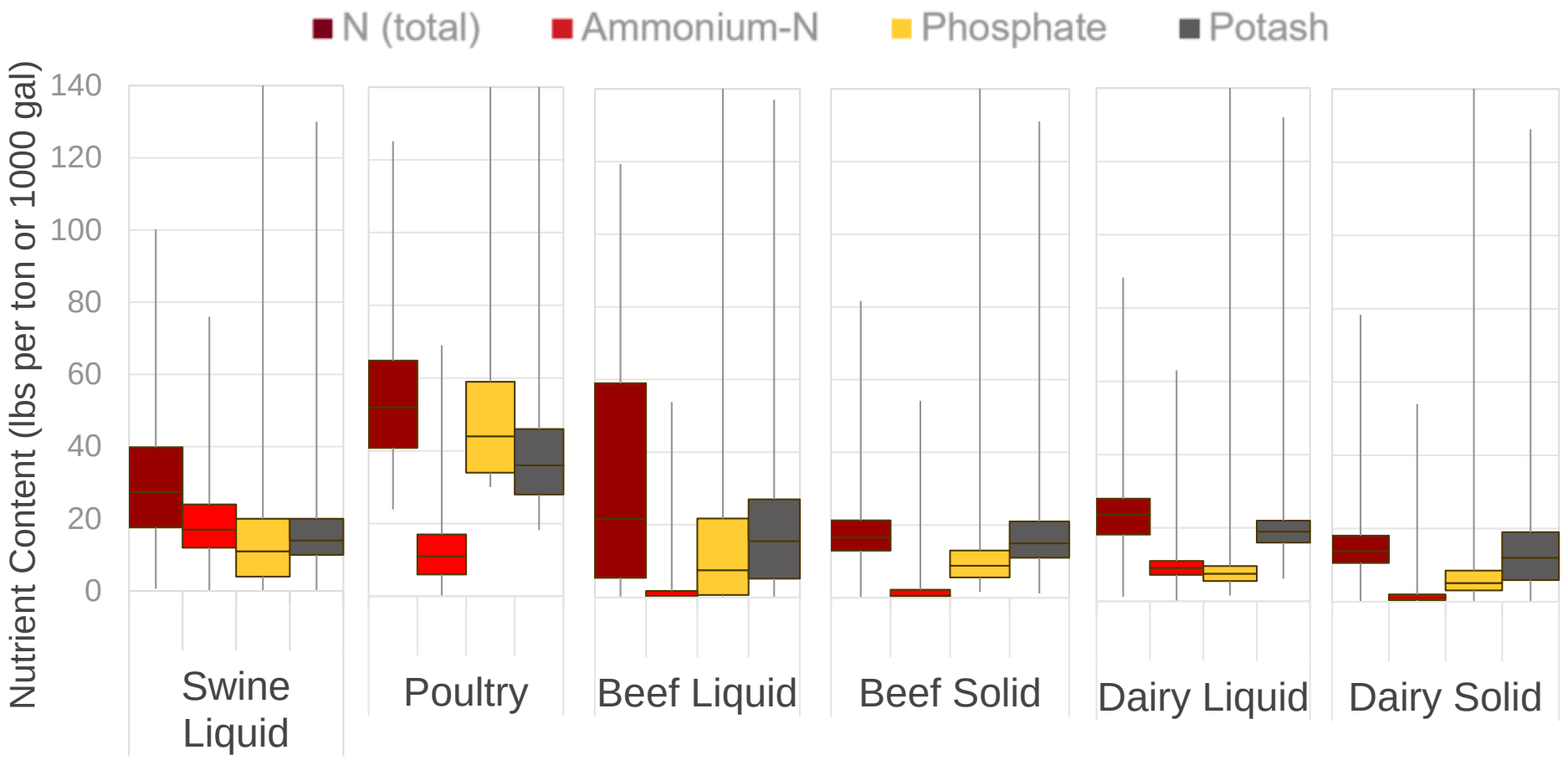
When did you apply the manure?

rain? Was it warm or cold?

UNCERTAINTY IN USING MANURE

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

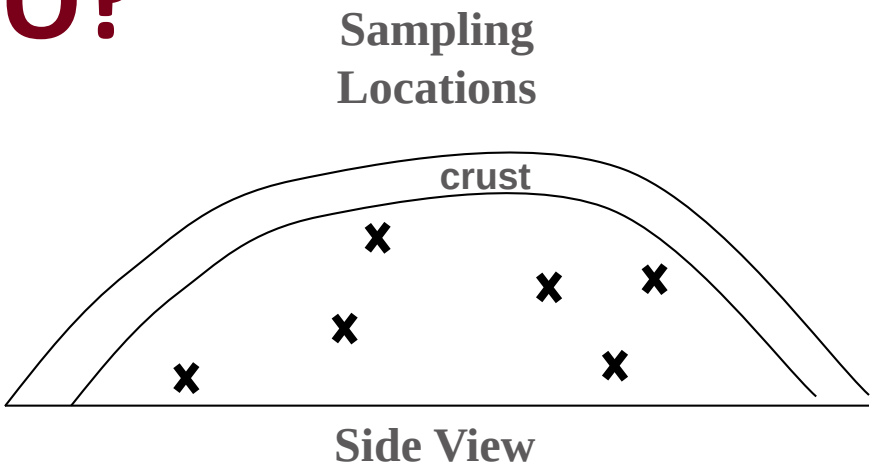
1. NUTRIENT CONTENT VARIES BY ANIMAL TYPE

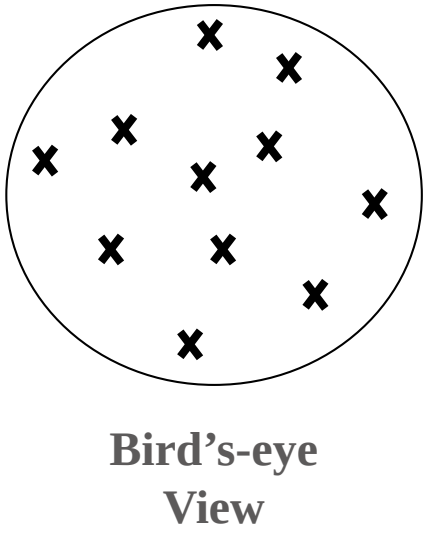


WHAT CAN YOU DO?

- Take manure samples regularly

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



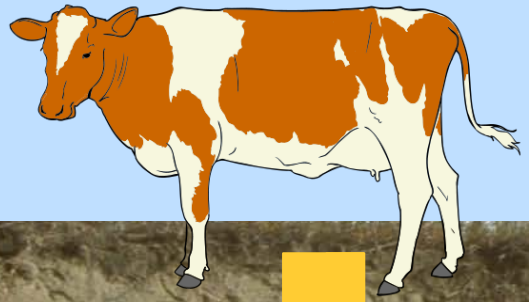


2. NUTRIENT AVAILABILITY VARIES

- 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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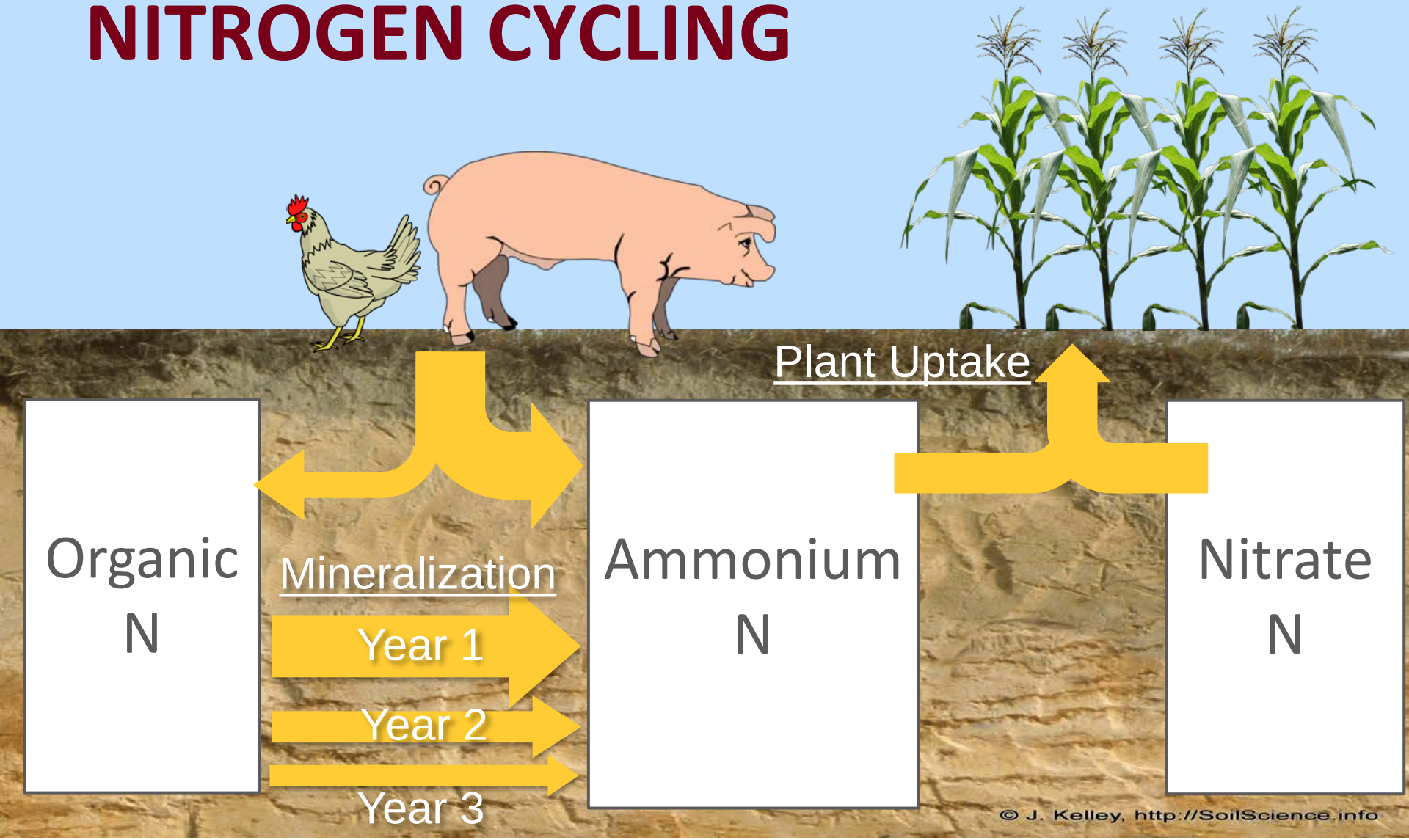
NITROGEN CYCLING



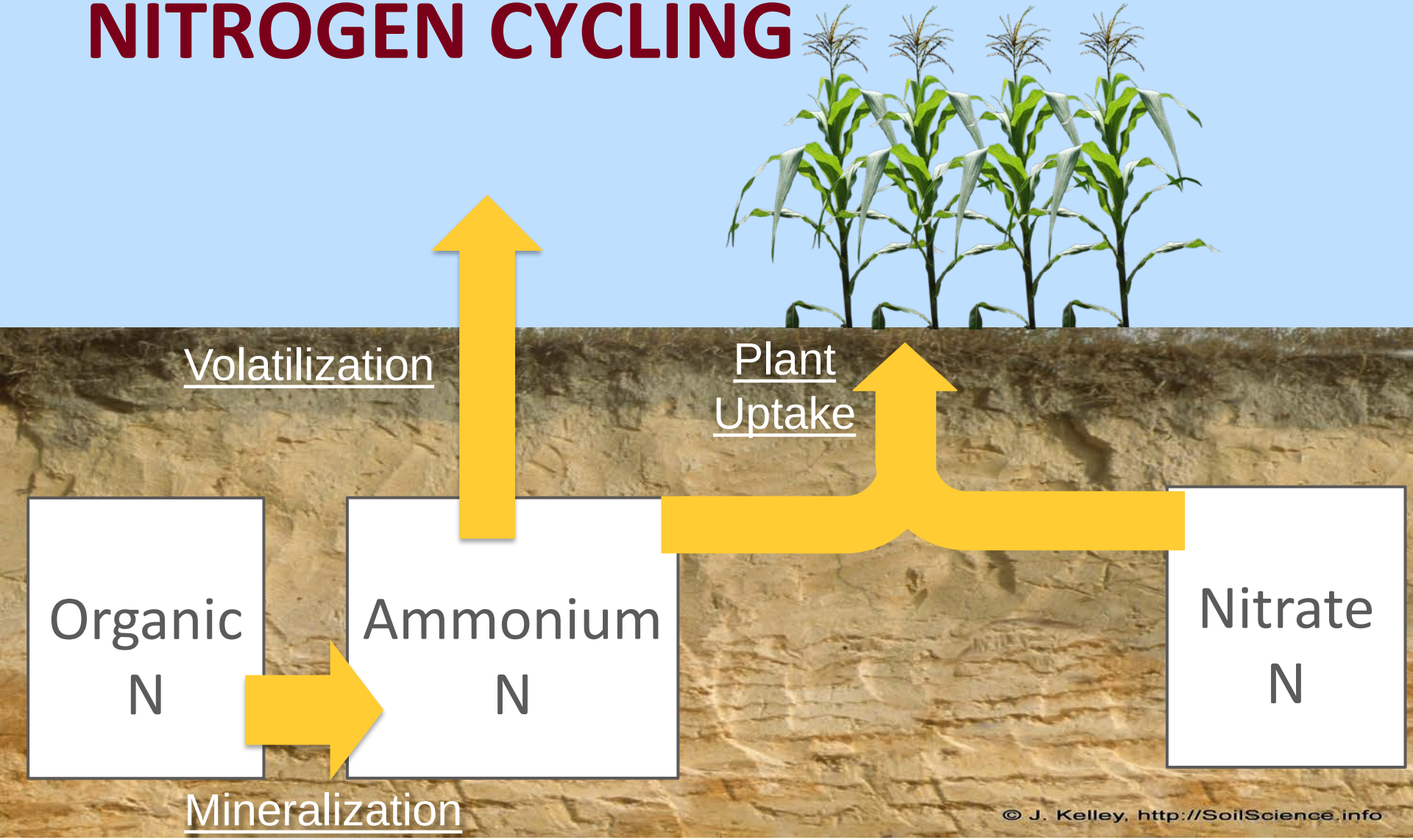
PLANT AVAILABLE NITROGEN (PAN)

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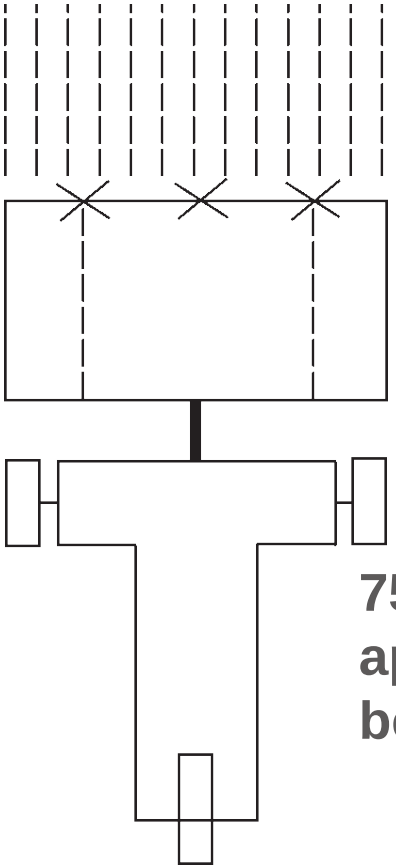
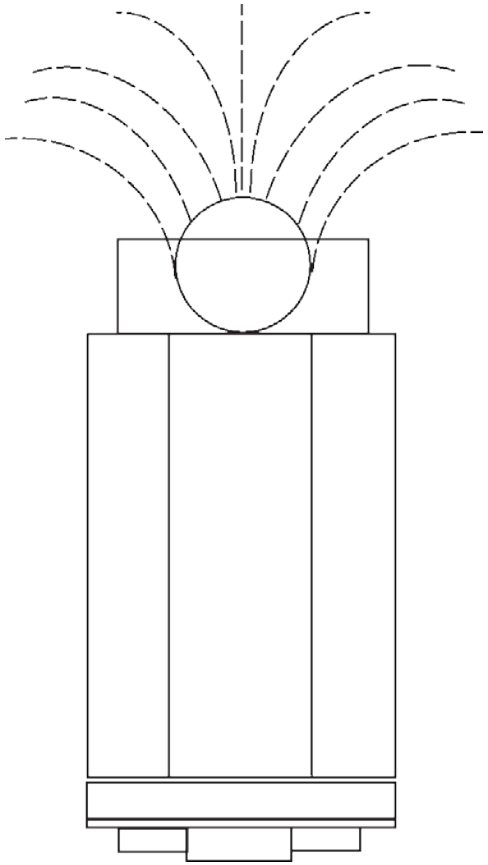
$$\frac{54.3 \text{ lbs}}{1000 \text{ gal}} \times 0.80 = \frac{43.4 \text{ lbs}}{1000 \text{ gal}}$$

3. APPLICATION CAN BE VARIABLE



75% of material applied directly behind spreader

Spread pattern of a box spreader

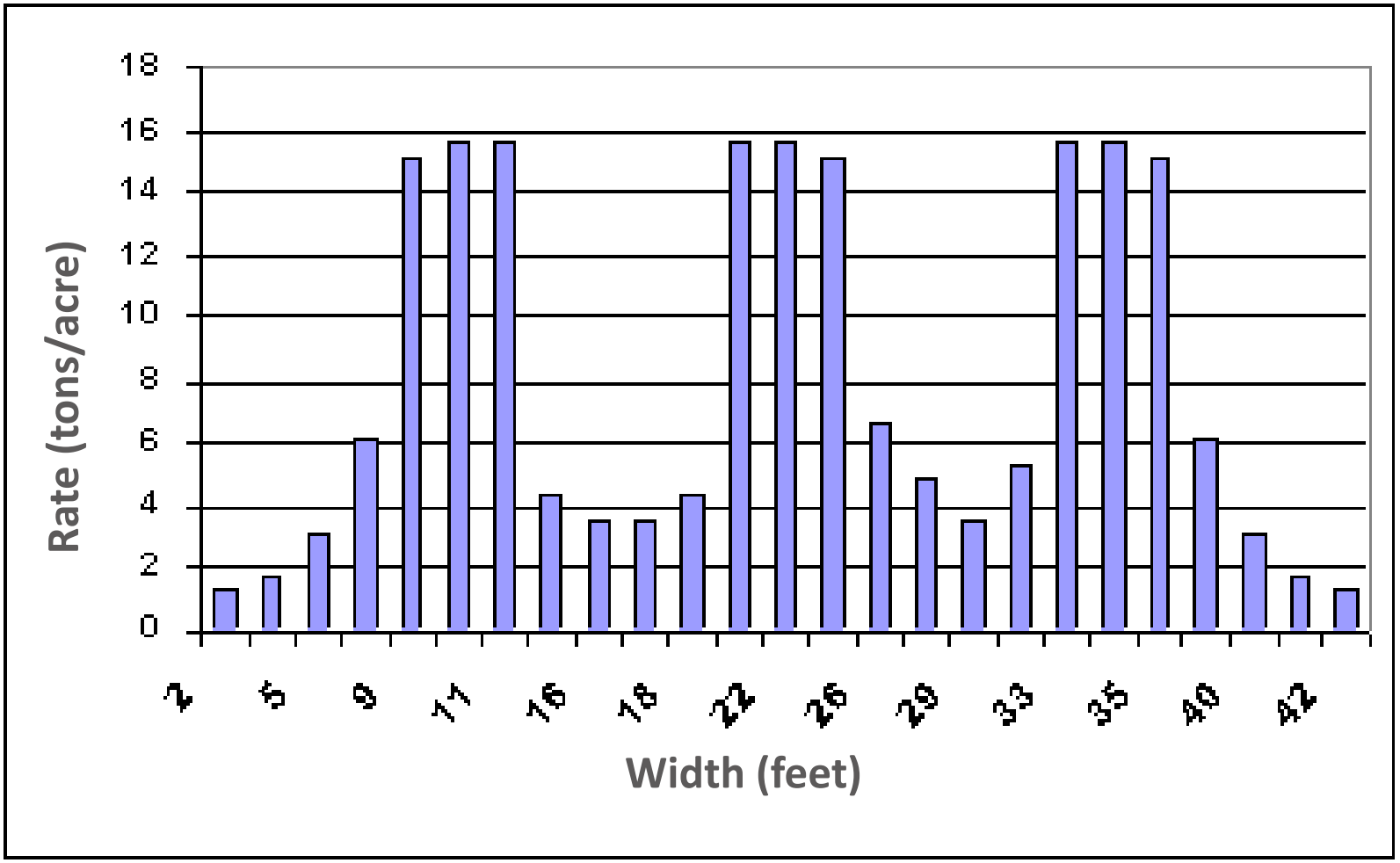


1/3 of material directly behind spreader

Spread pattern of a spinner spreader

SPINNER SPREADER DISTRIBUTION PATTERN

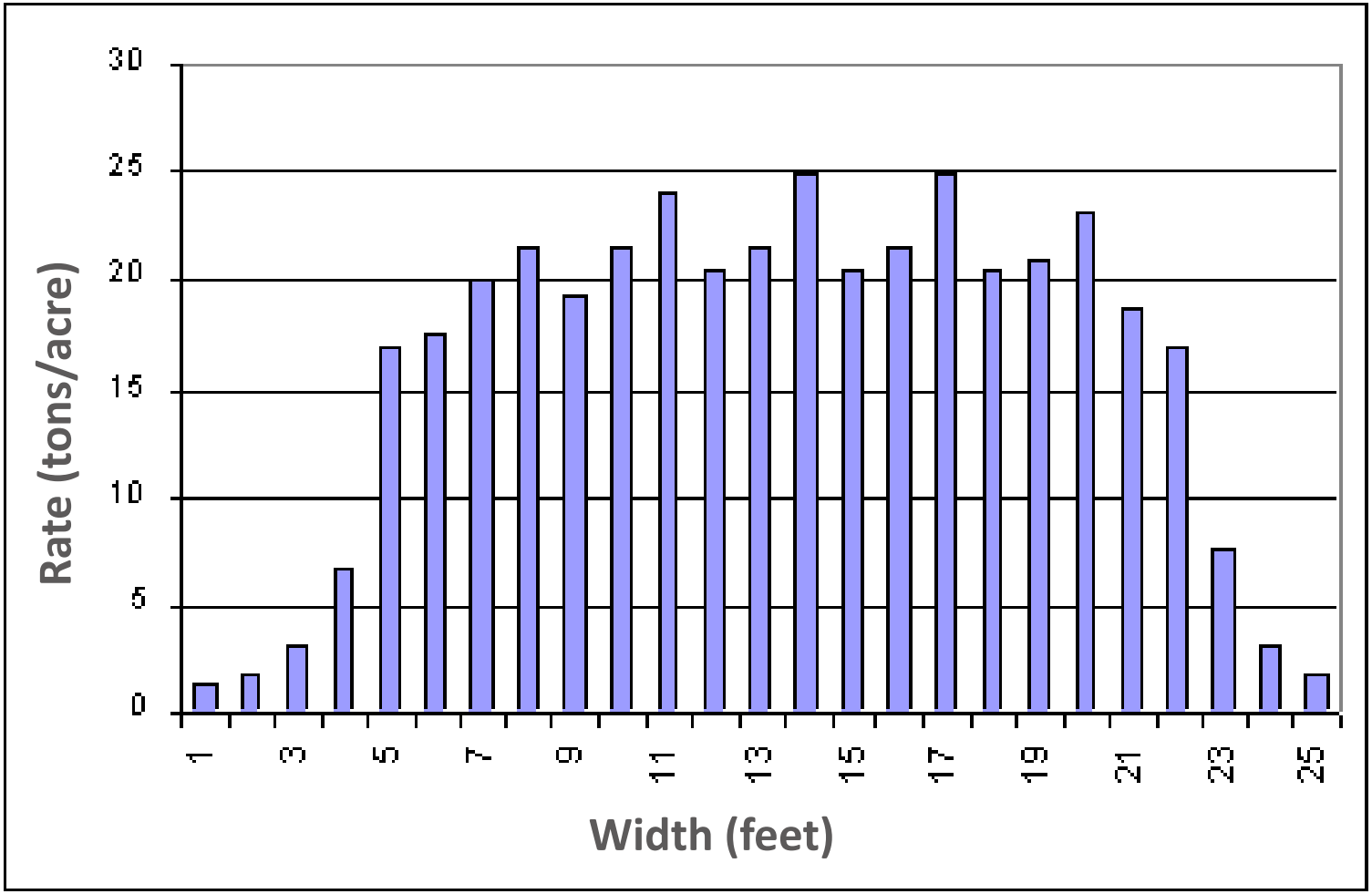
3 passes of a spreader; 12 feet apart



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

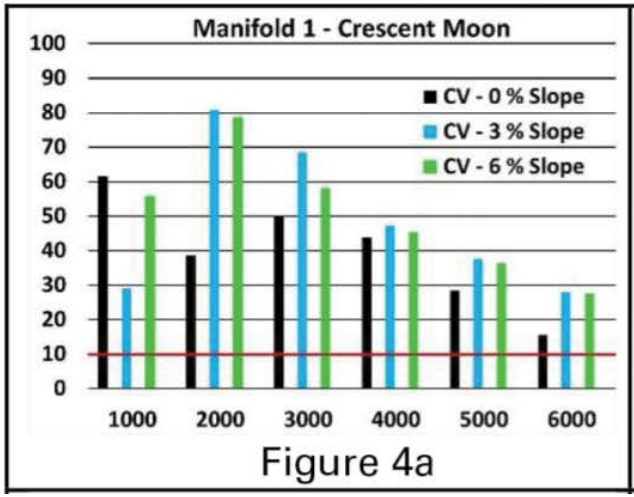


Figure 4a

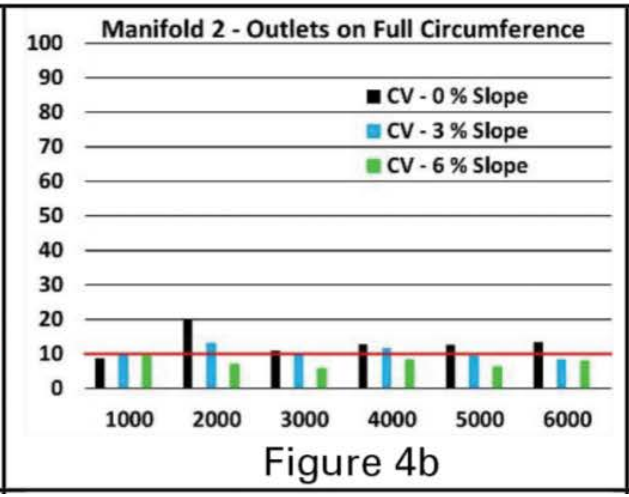


Figure 4b

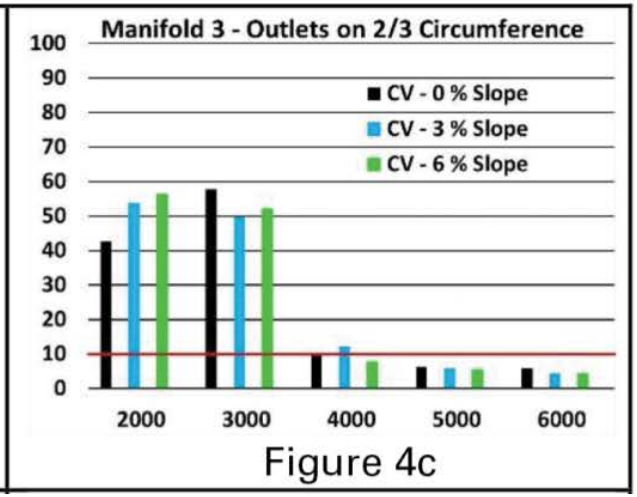


Figure 4c

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

WHAT CAN YOU DO?

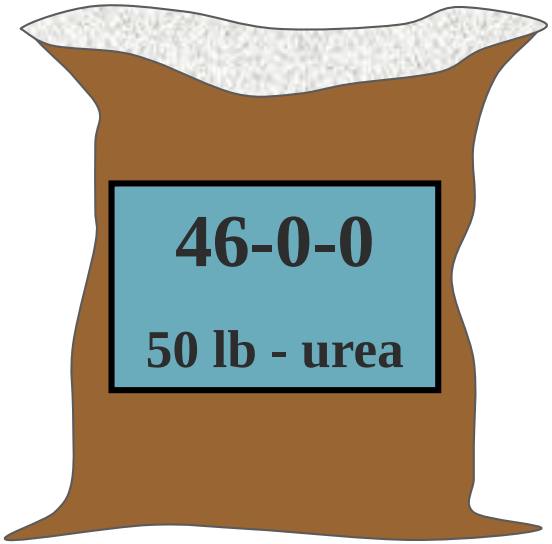
- Calibrate your equipment
  - Resources are available online

- 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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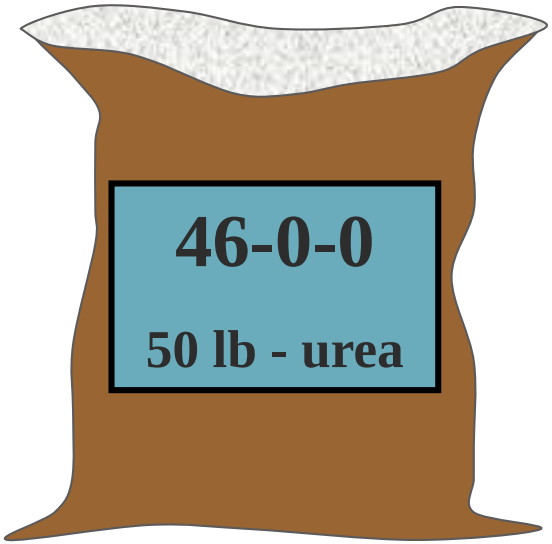
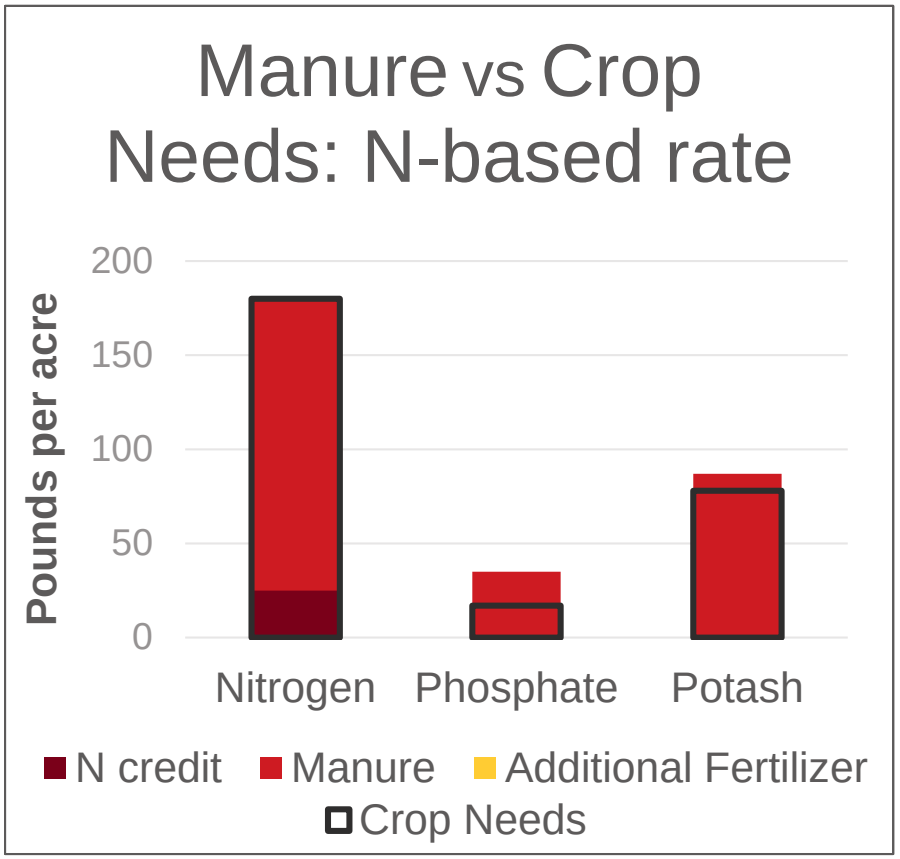


- There are many uncertainties with manure

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

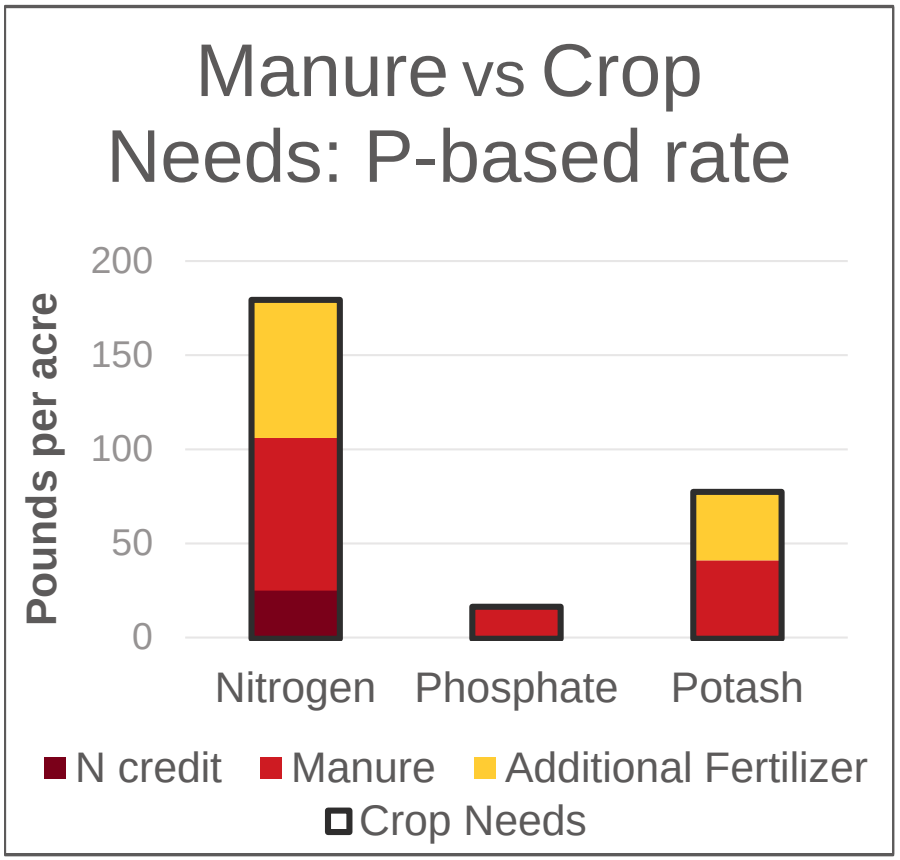
MANURE VERSUS CROP NEEDS

- 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



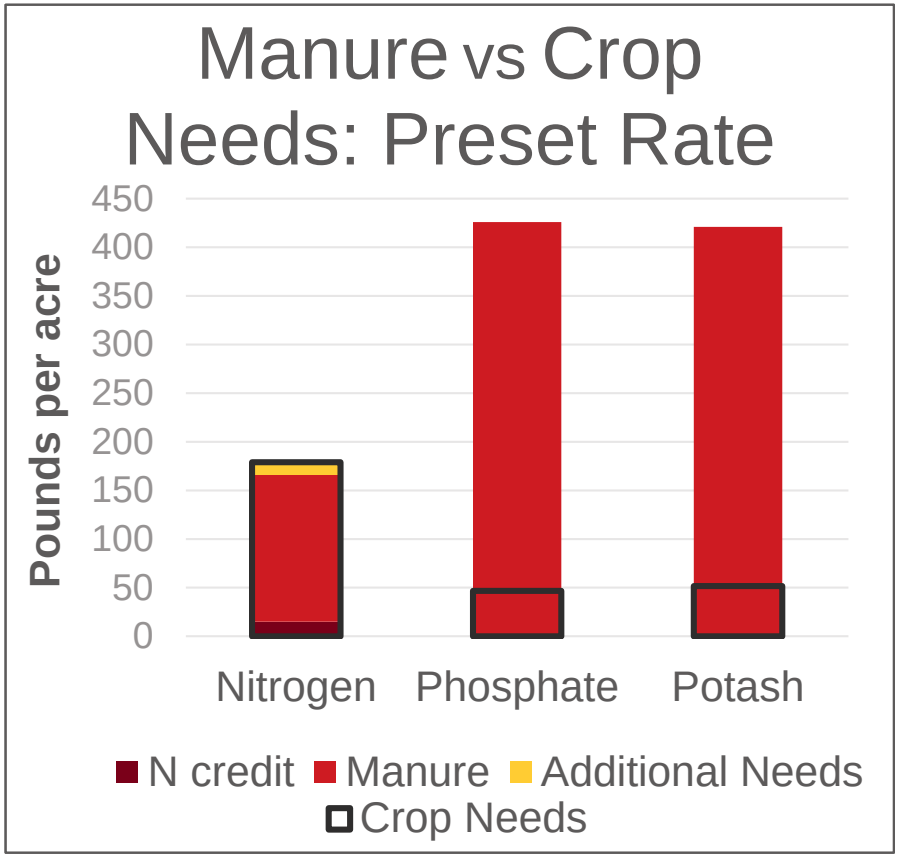
MANURE VERSUS CROP NEEDS

- 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

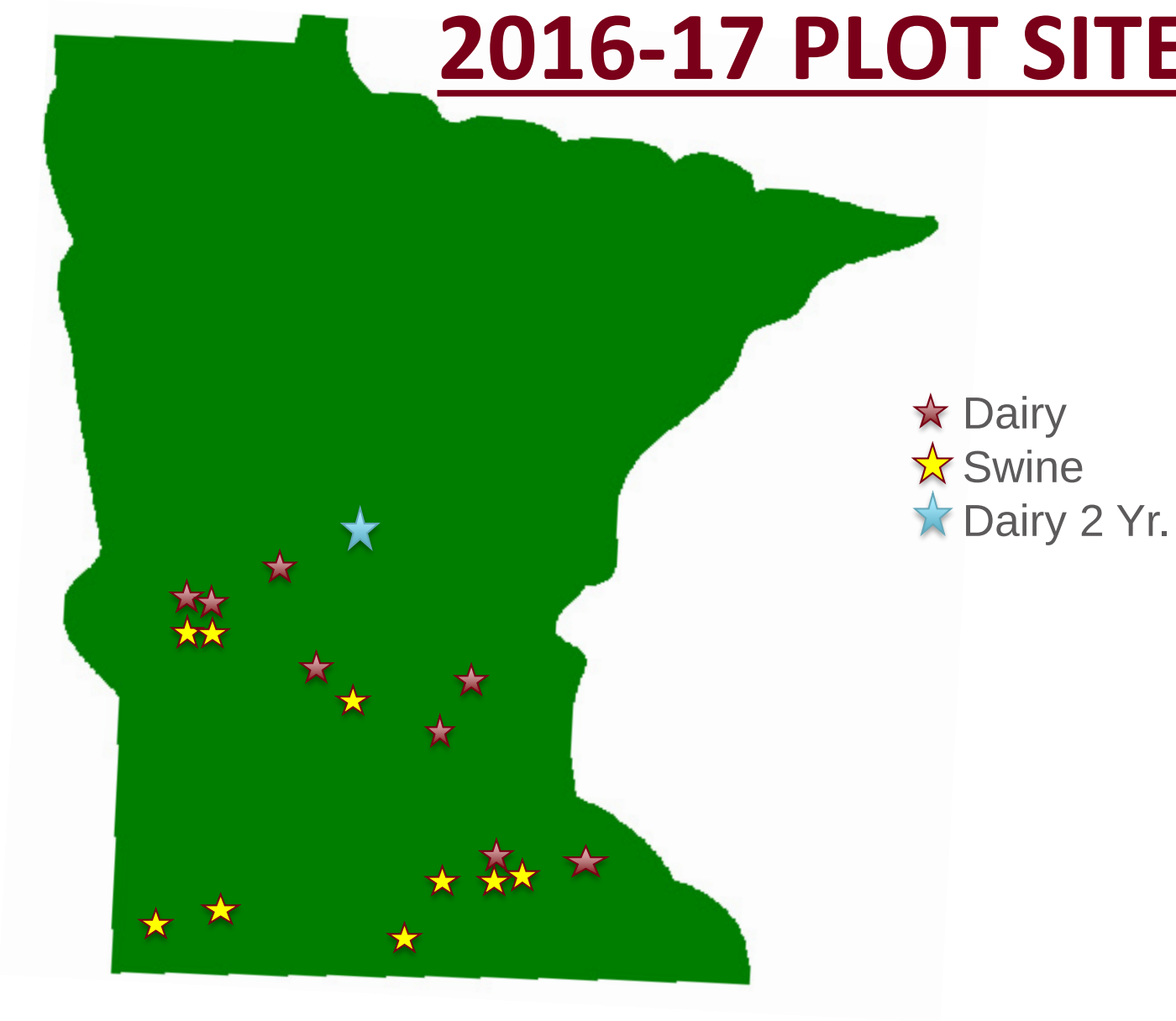
CURRENT RESEARCH AT THE U

- Integrating cover crops (CC) and manure: On-farm research

INTEGRATING COVER CROPS AND MANURE

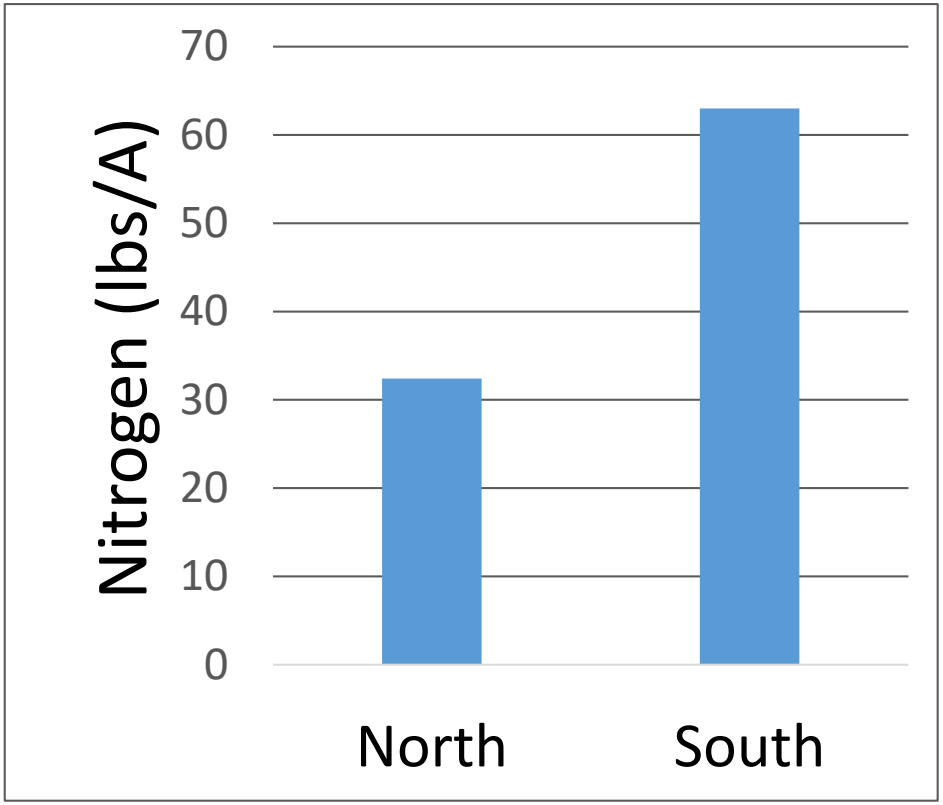
- Details:
  - Plant rye CC after harvest then inject liquid manure
  - Terminate rye in spring
    - Measure soil nitrate in top 24” of soil and in rye
  - Harvest following corn grain or silage next fall
    - Measure corn yield and nitrogen uptake
  - 2 crop years

2016-17 PLOT SITES

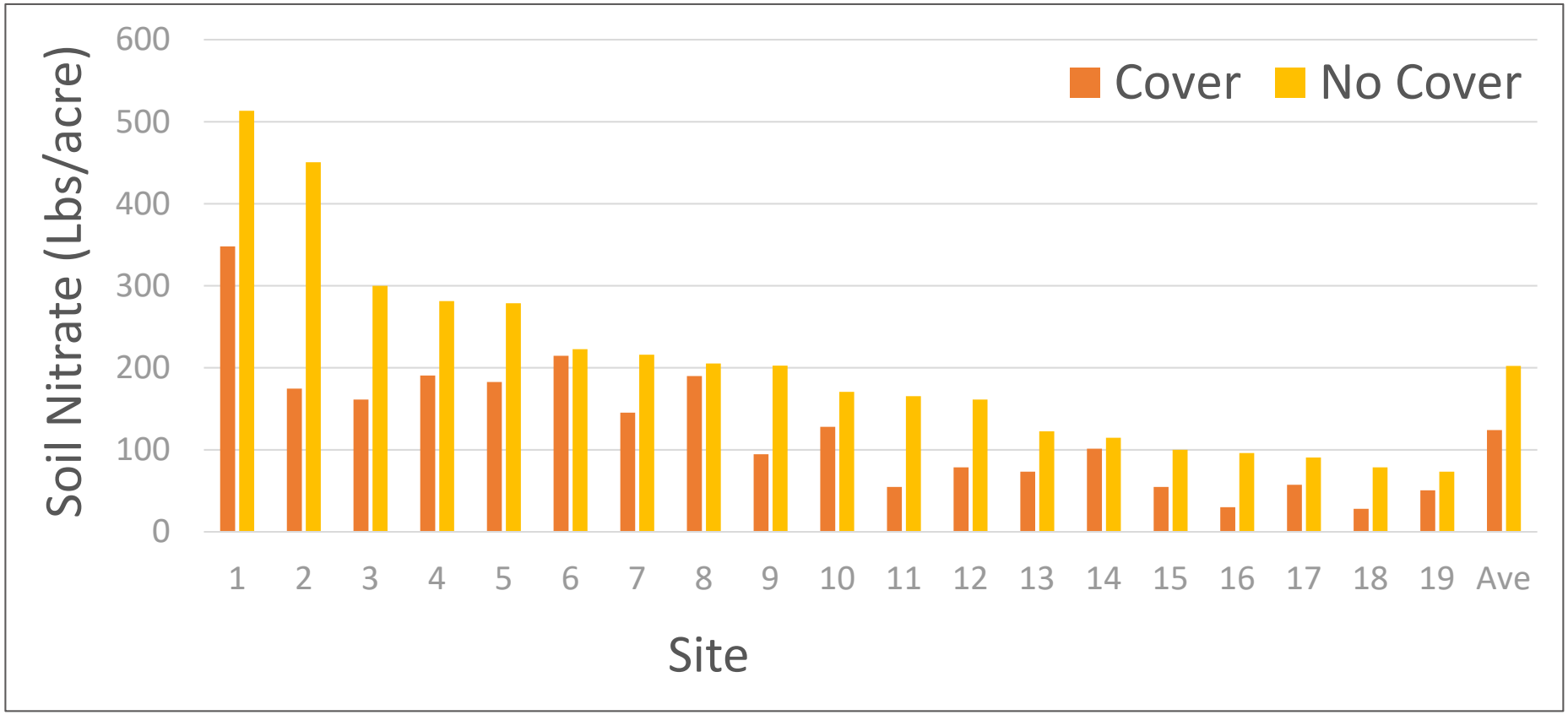


N TAKEN UP BY RYE – NORTH VS. SOUTH

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



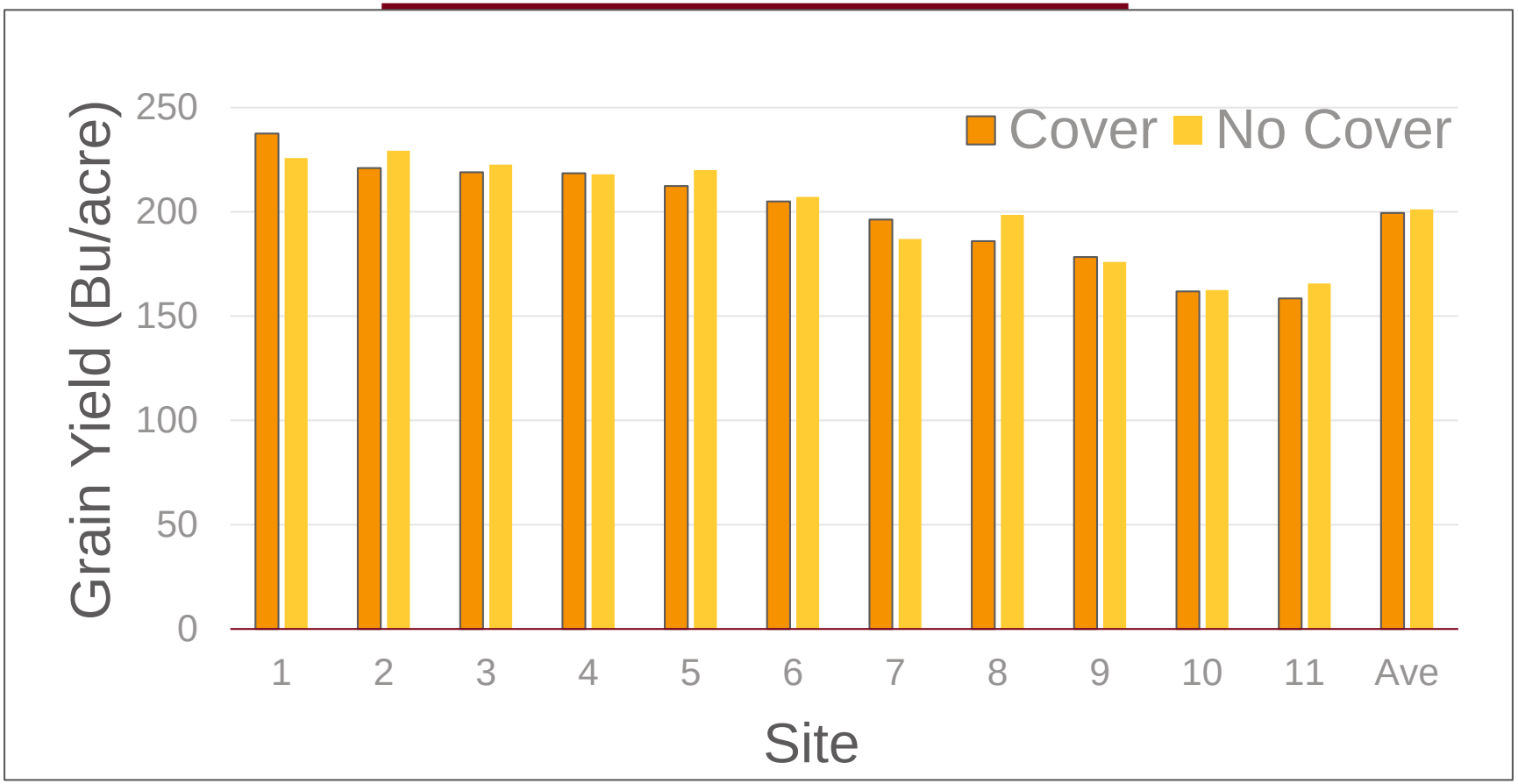
SPRING SOIL 24" NITRATE (NO_3)



Cover Crop: 124 lbs. NO_3/Acre
No Cover: 202 lbs. NO_3/Acre

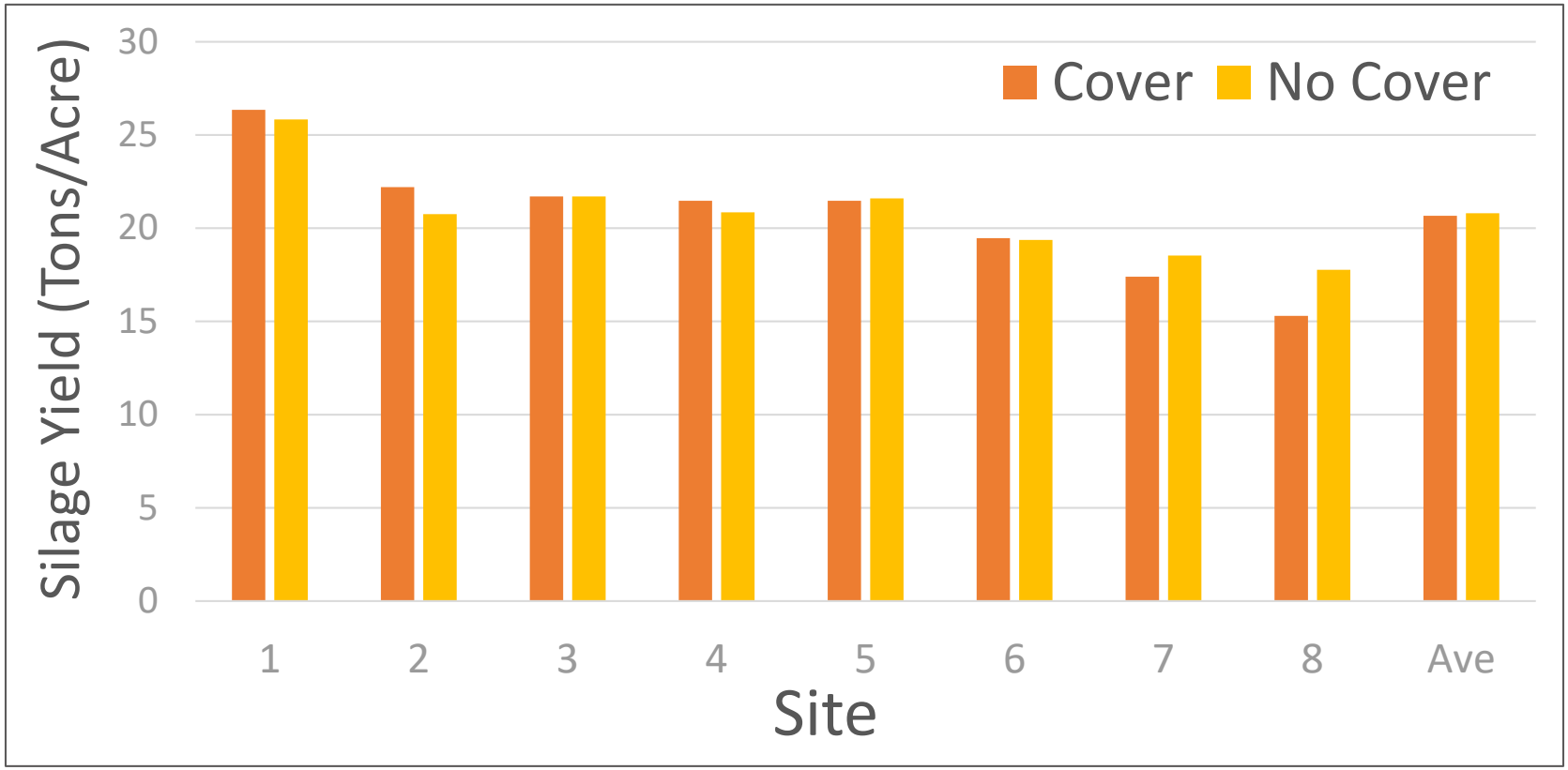
Difference: 78 lbs. NO_3/Acre

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?

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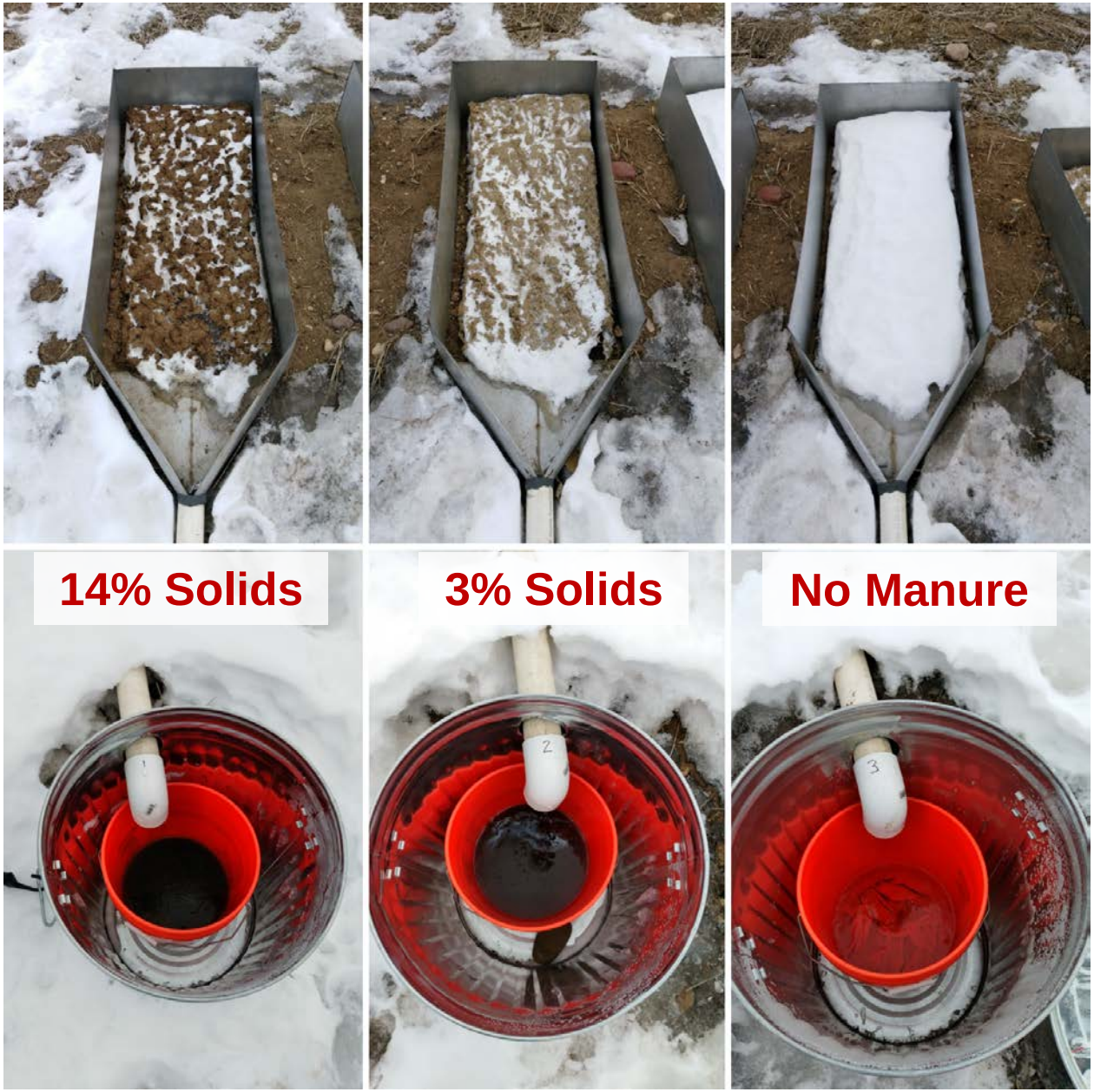
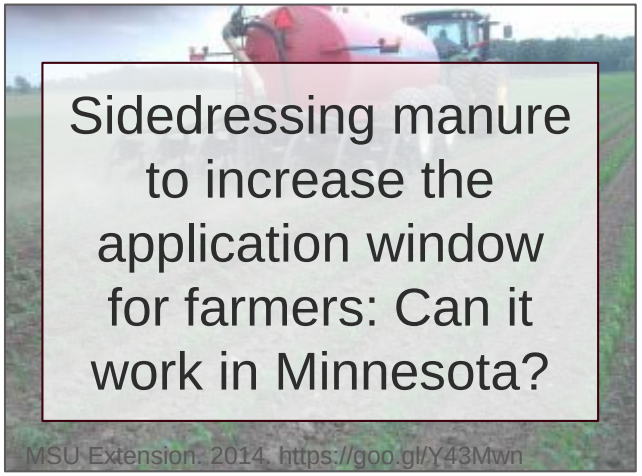


UPCOMING RESEARCH

- 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