# 4R NUTRIENT STEWARDSHIP AND CONSERVATION, WORKING TOGETHER TO MEET LOCAL GOALS

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4 nutrient stewardship

SAND COUNTY FOUNDATION

THE FERTILIZER INSTITUTE

"Conservation can accomplish its objectives only when it springs from an impelling conviction on the part of private landowners."

*-Aldo Leopold*

*A Sand County Almanac*

*1949*

# 4R Nutrient Stewardship

## Goal: Improve agricultural production while contributing to social well being and minimizing environmental impacts



**RIGHT SOURCE**

Matches fertilizer type to crop needs.

**RIGHT RATE**

Matches amount of fertilizer to crop needs.

**RIGHT TIME**

Makes nutrients available when crops need them.

**RIGHT PLACE**

Keeps nutrients where crops can use them.

# What is 4R Nutrient Stewardship?

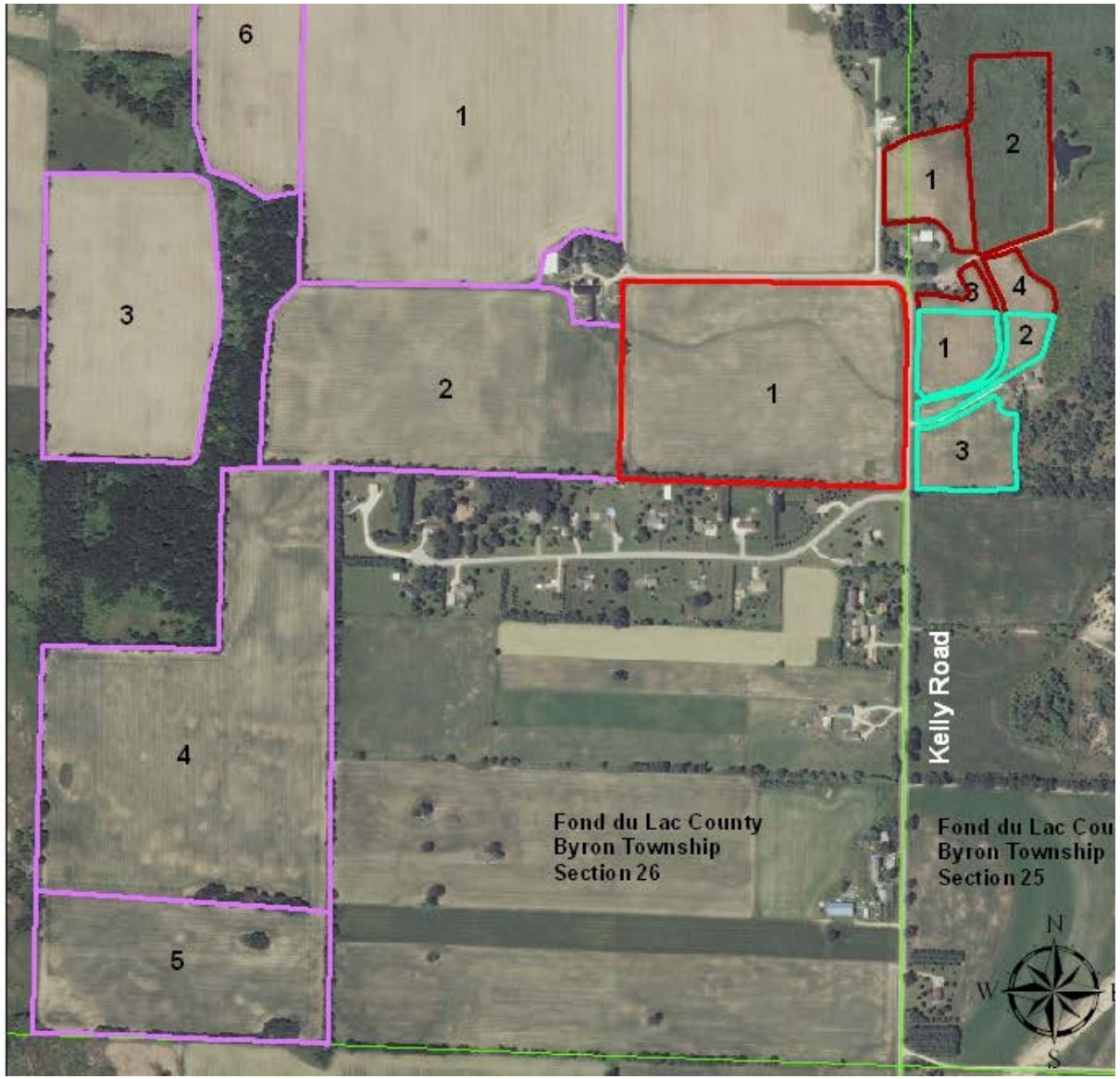
Actively considering **all management practices** and **site-specific characteristics** when making the *right* nutrient management decisions!

# Nutrient reductions for both nutrient management and conservation practices are field specific.

**<5% of the applied N and P tends to be lost in runoff**

(Daniels et al. 2018; Galloway and Nustad 2017, Smith et al. 1983, Tomer et al. 2016)

*NRCS/USDA Photo by L. Betts*




Nutrient Management Plan (227 acres) –
W. Branch Milwaukee River Watershed, Wisconsin

# A system approach to farm management just makes sense.

## Pay-for-Performance Approach:

Potential trade P 160 lbs/year **(227 acre farm)**

Reduced P losses by 73 lb/year by implementing:

Contouring

Switching Fall Chisel to No-Till

Reducing P Application

Income $1,832/year for trade value

**Total savings $6,156/year**

# Soil Health as a Driver of Change

## Getting the 4Rs right means:

**67%** Improving soil health, and that means improving crop performance

50% Minimizing impact on environment & retaining nutrients in the field

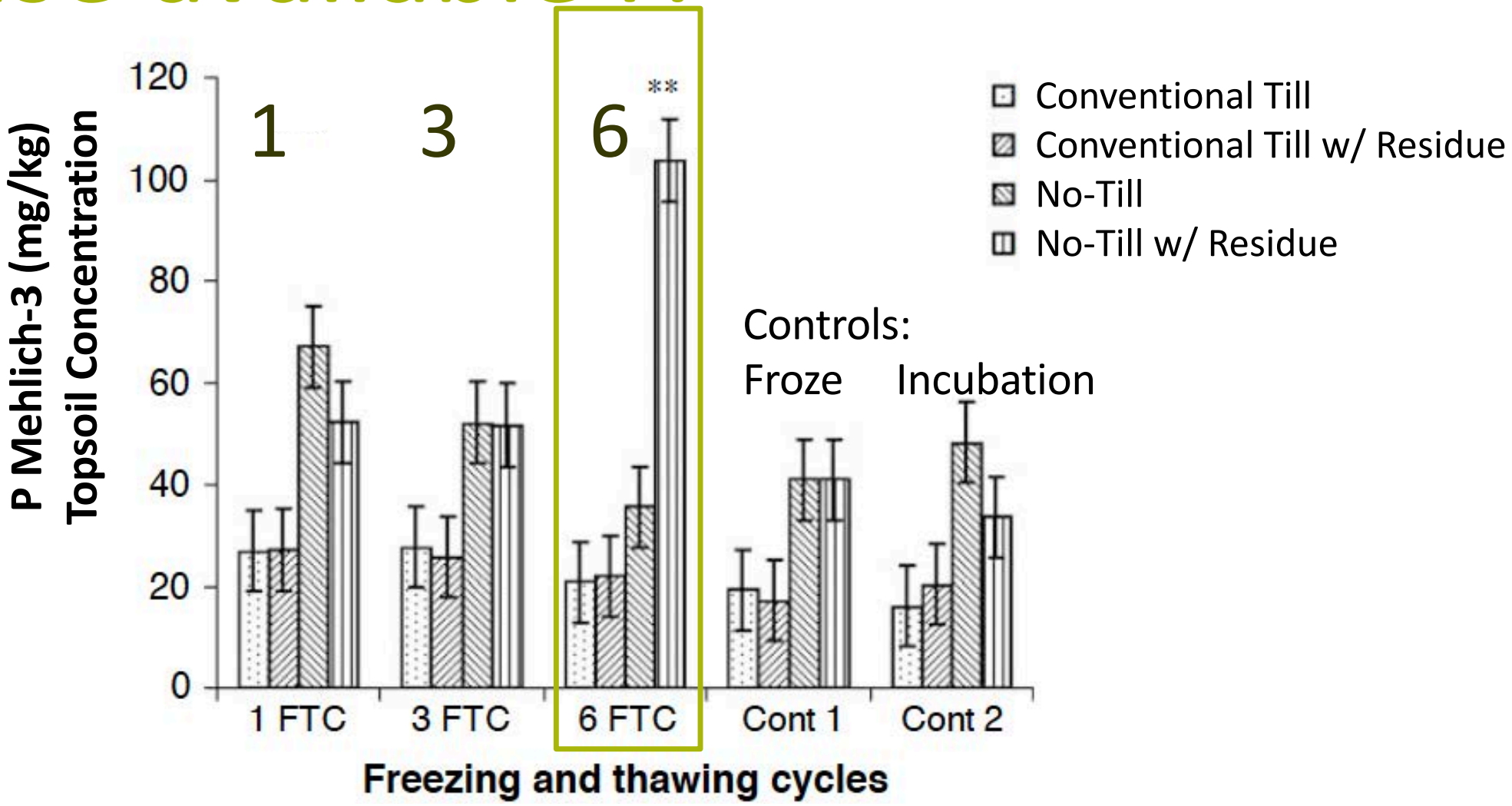
45% Action now may reduce the need for regulation later

39% Reducing risks associated with good & bad weather, improving yield

37% Doing more to improve our crop yields and profit

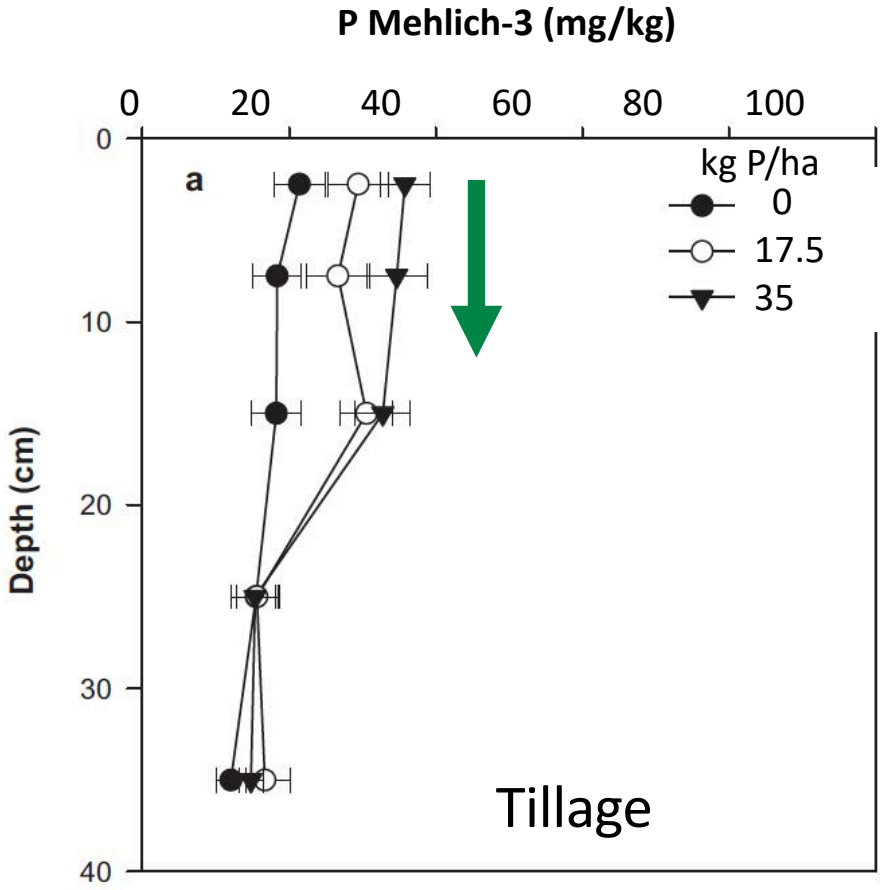
# How do soil health practices influence nutrient availability?

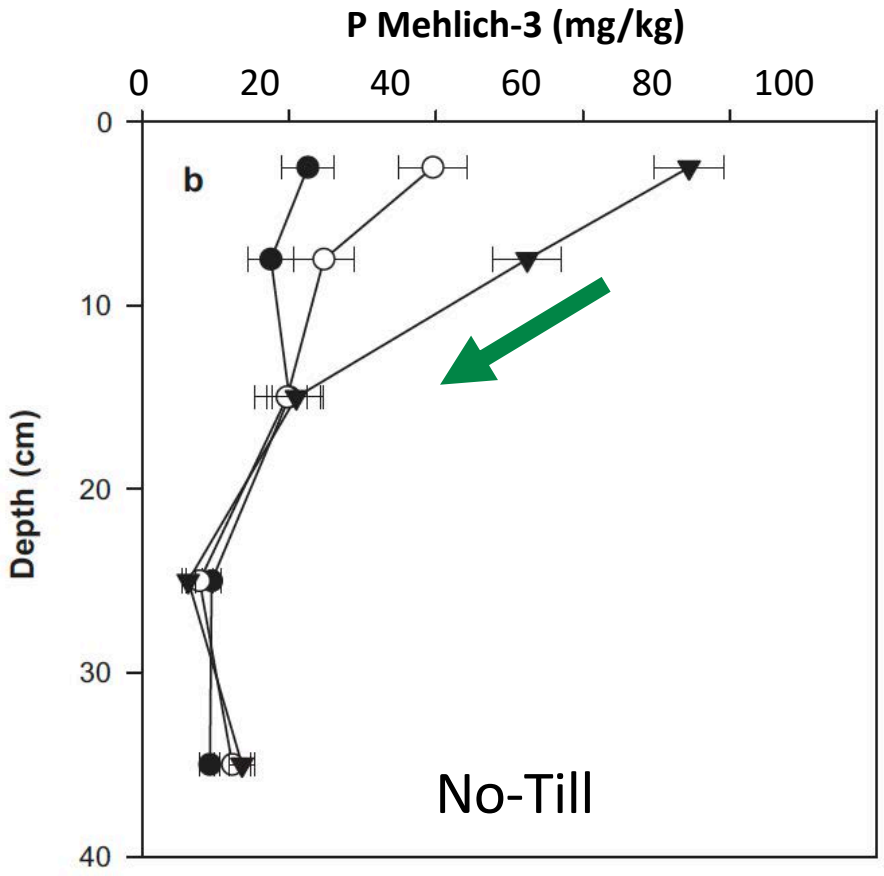
# Freeze-thaw cycles in no-till can increase available P.




*Messiga et al., 2010. Can.J.Soil.Science*

# Rooting zone P dynamics also change with no-till.




*Messiga et al., 2012. Field Crops Research*



**Initial projects: 5 meta-analyses**

Knowledge gaps related to 4Rs and environmental impact

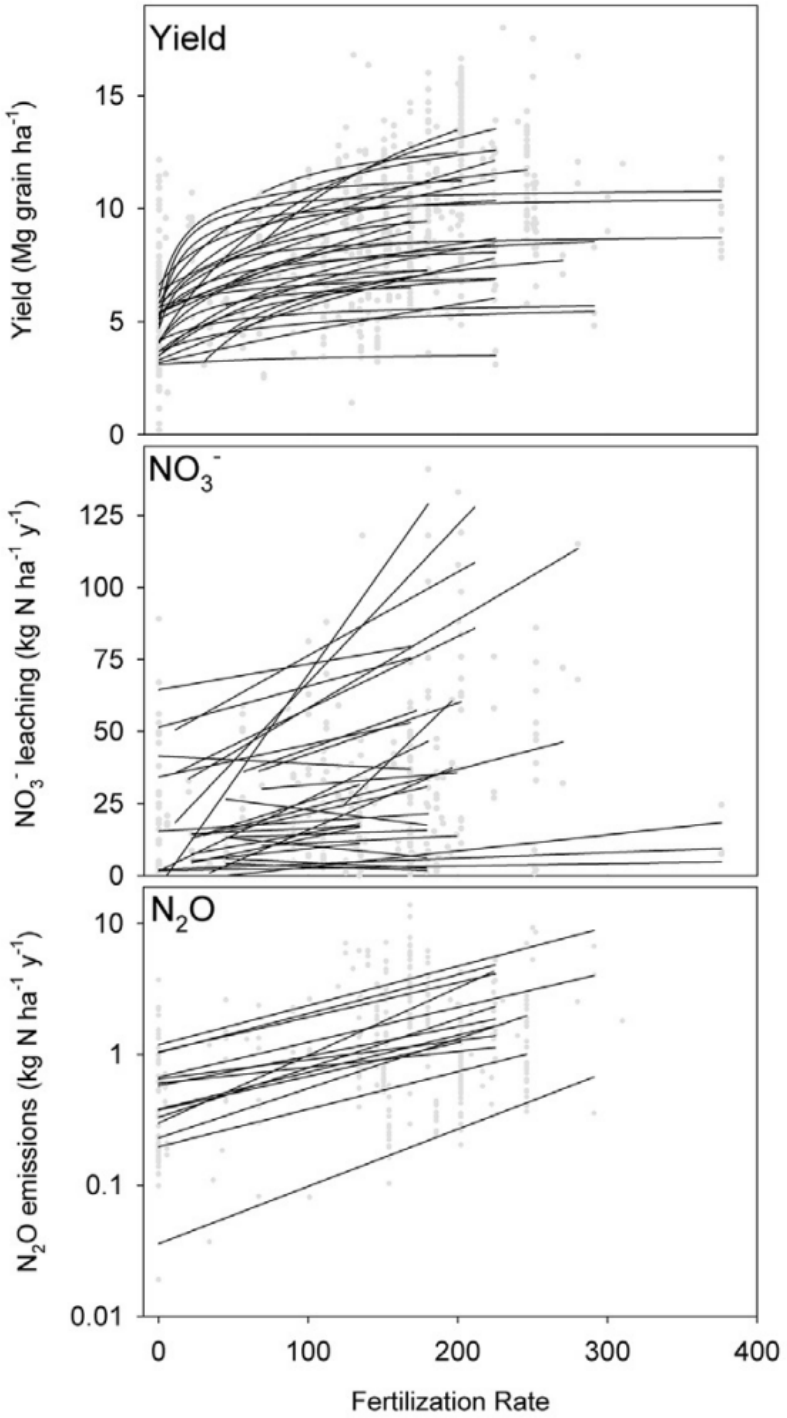
**Current research projects**

4R practice impacts on N & P loss via water and air pathways and interaction with supporting conservation

# A Meta-analysis of 4R Nutrient Management in U.S. Corn-Based Systems

**Rate, Source, Time, and Place** – Crop yield, nitrate ($NO_3^-$) leaching, and nitrous oxide ($N_2O$) emissions response to N rates

How do climate and soil differences across North America affect these responses?




Eagle, A.J. et al. 2017. Soil Sci. Soc. Am. J. 81:1191-1201.

**Rate – Strong positive relationship to yield, $NO_3$ leaching, and $N_2O$ air loss.**

2.9 to 11.9 % increase for each 10 kg N/ha increase

**Source – $N_2O$ losses are highest with Anhydrous Ammonia > Urea = Polymer Coated Urea = Urea Ammonium Nitrate (UAN) = UAN + Agrotain PLUS® > Super U**

**Time – Side dress fertilizer reduced $N_2O$ emissions 30 to 39 %**

**Place – Broadcast placement of N fertilized decreased $N_2O$ losses by 25 to 33% compared to injecting or banding**

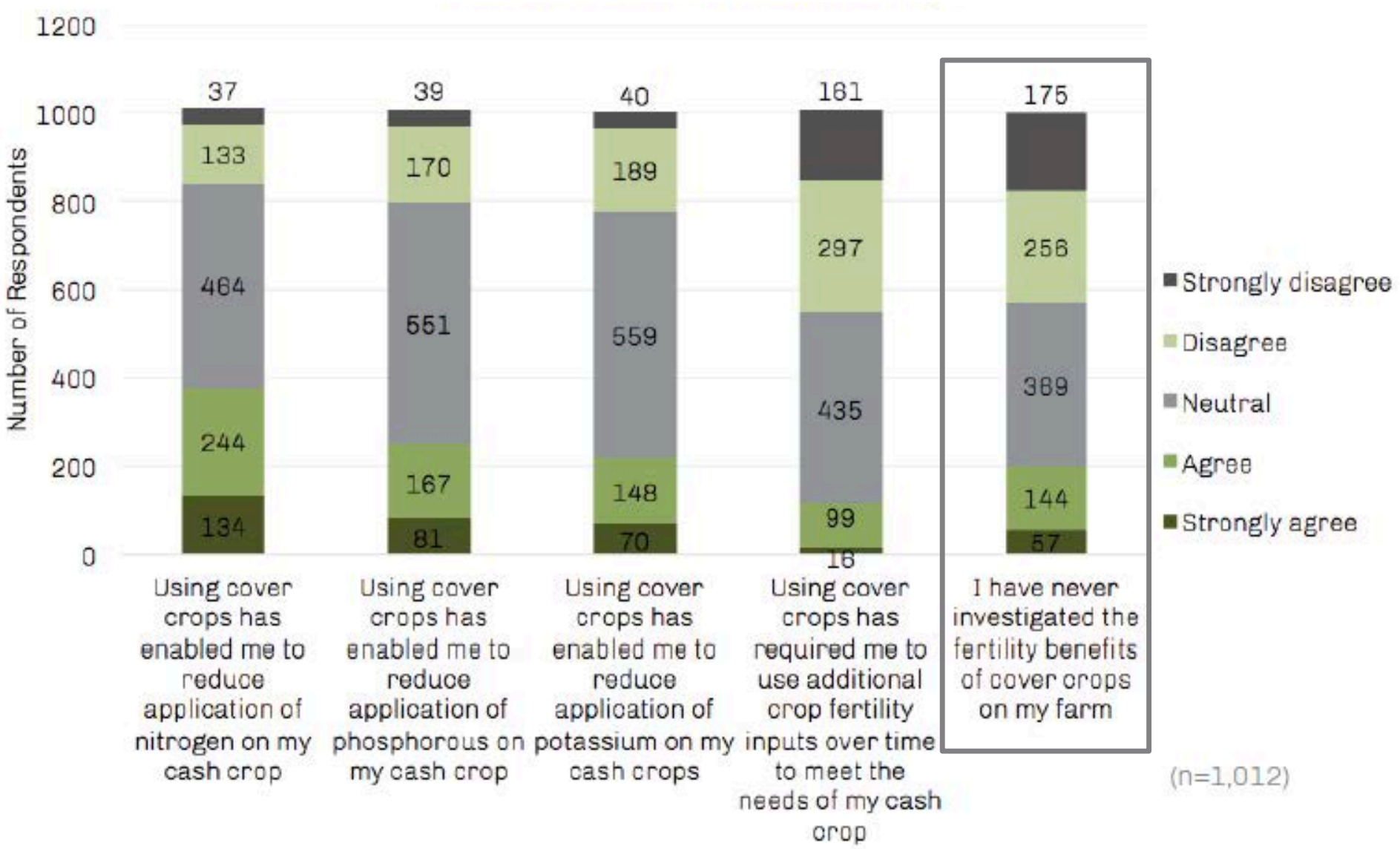
**Environmental – Nitrous oxide emissions dependent on temperature**

1°C increase in average July temperate = increased emissions from additional application of 100 kg N/ha

# A Meta-analysis of 4R Nutrient Management in U.S. Corn-Based Systems

Eagle, A.J., L.P. Olander, K.L. Licklier, J.B. Heffernan, and E.S. Bernhardt. 2017. Fertilizer management and environmental factors drive $N_2O$ and $NO_3$ losses in Corn: A Meta-Analysis. Soil Sci. Soc. Am. J. 81:1191-1201.

# Discussing cover crops and nutrient use




*SARE Cover Crop Survey 2017*

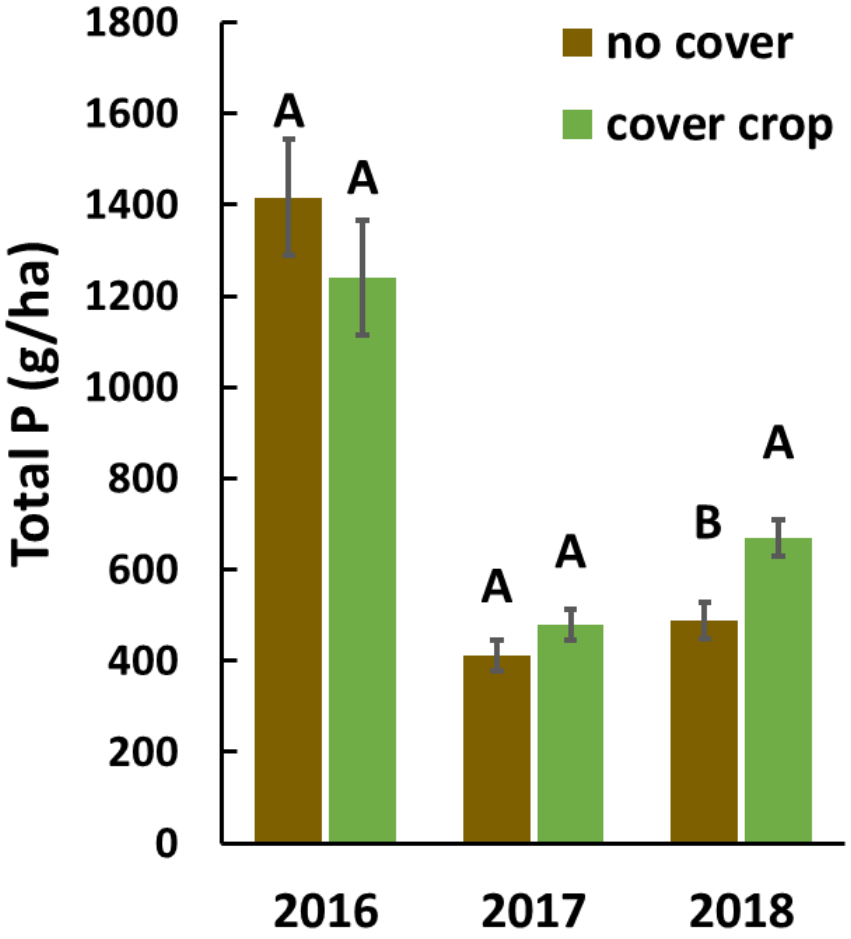
# Minimizing P Loss with 4Rs and Cover Crops

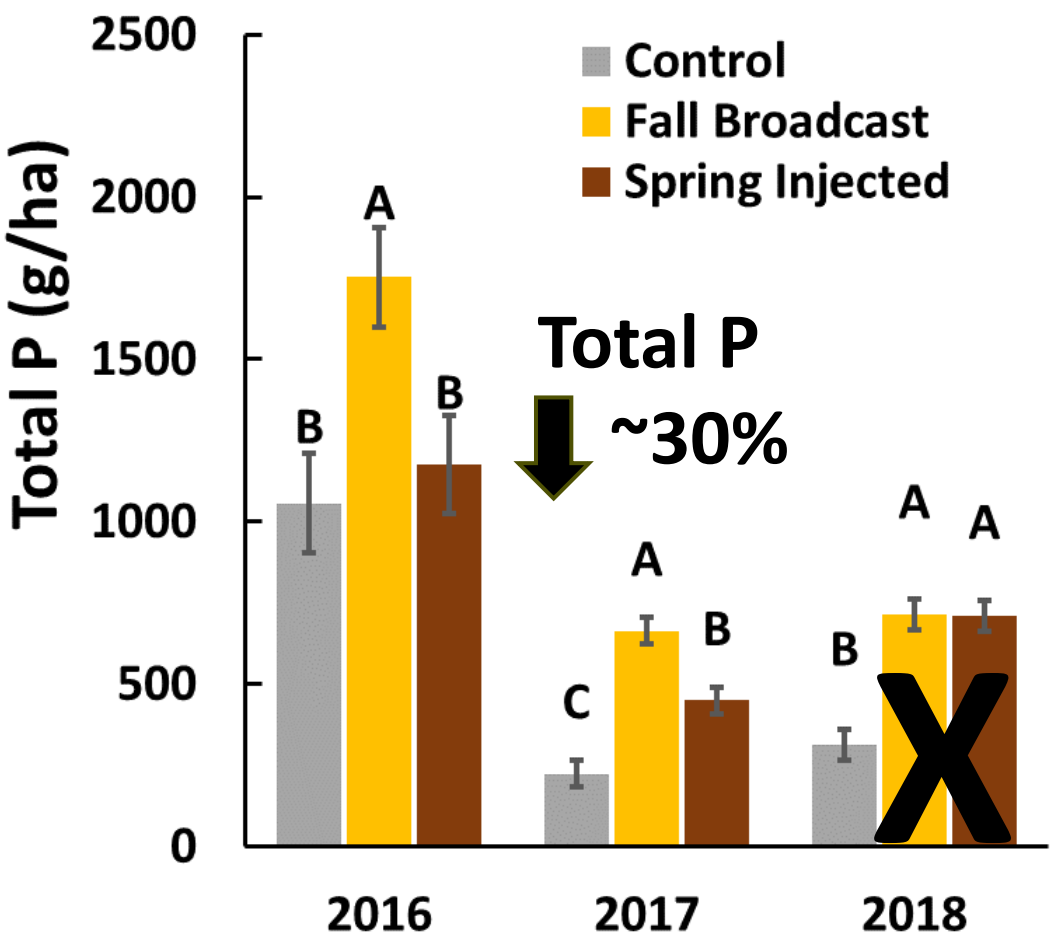
Dr. Nathan Nelson
Kansas State University

4R and Cover Crops

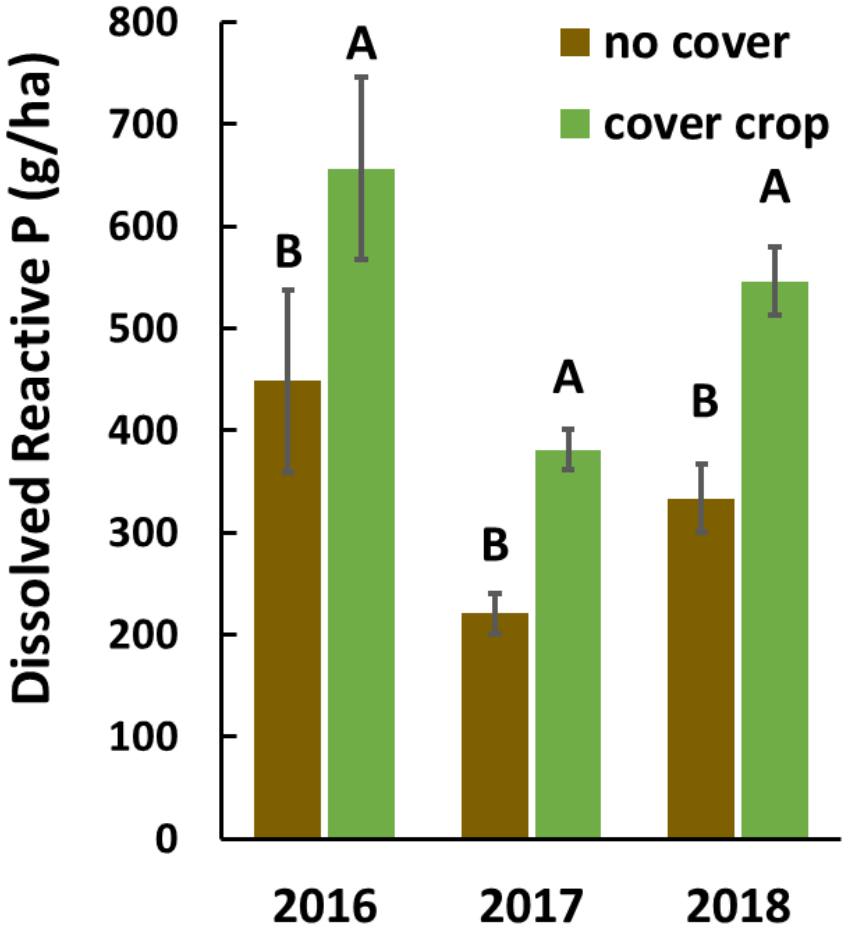
4R and No Cover Crops

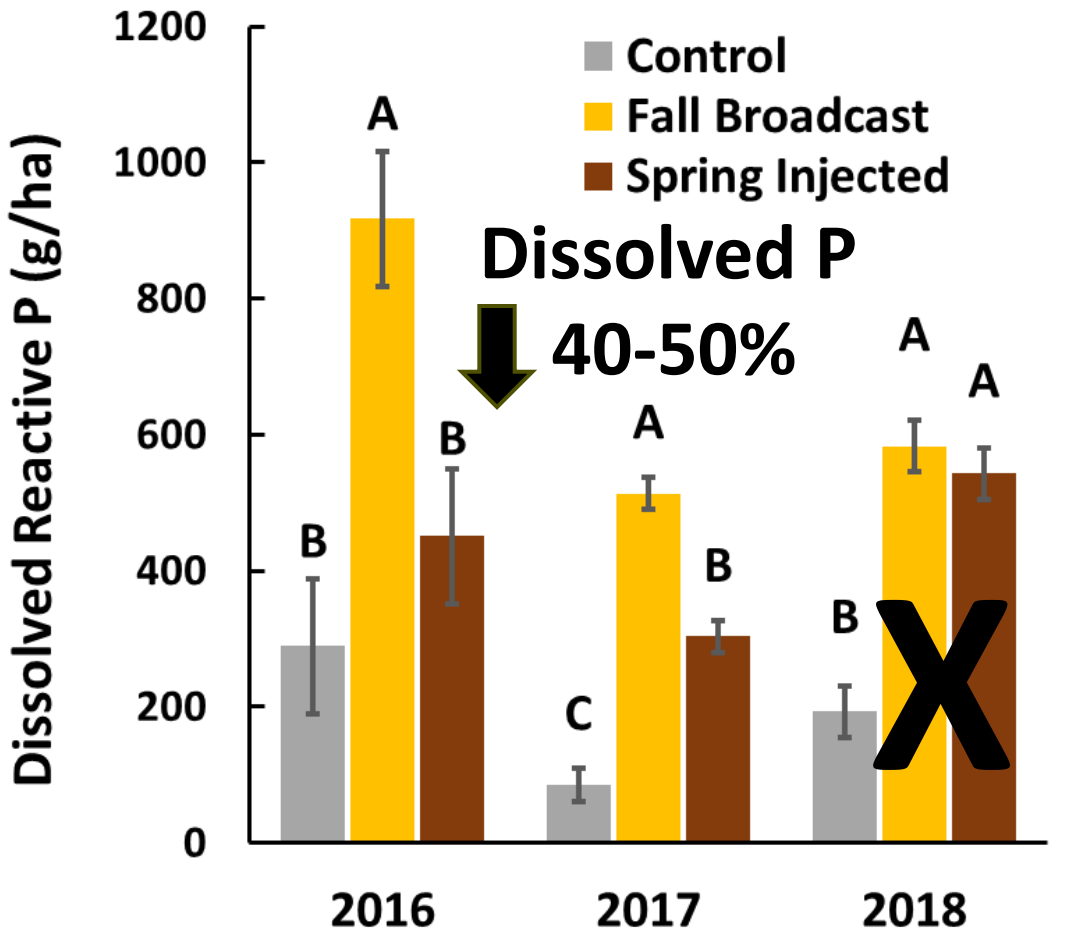
# Cover crops can have a varying effect on Total P



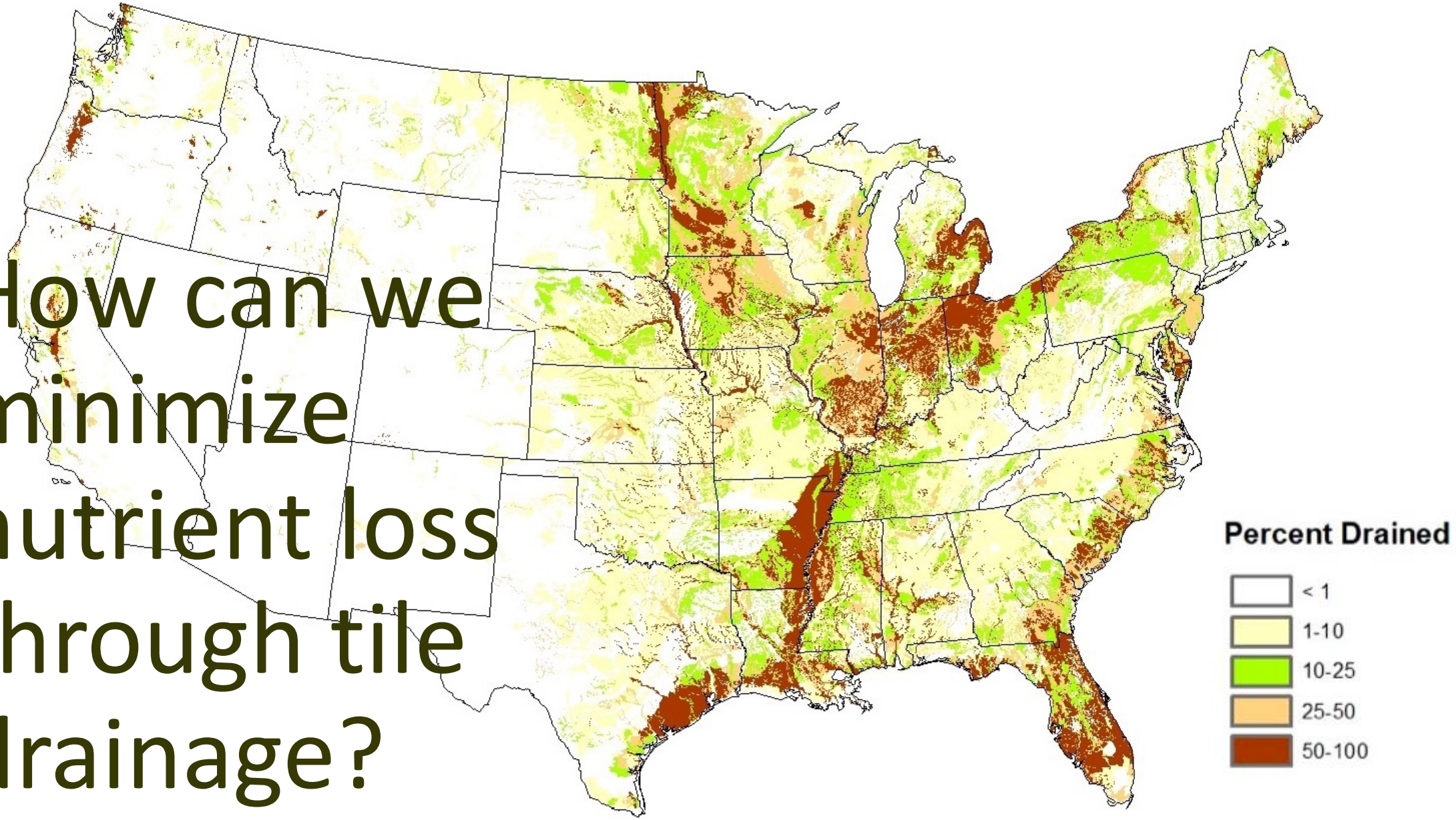



# Cover crops increased Dissolved P runoff losses by 60%



# How can we minimize nutrient loss through tile drainage?




Source: Jaynes and James 2007

# Evaluating the 4R Nutrient Stewardship Concept in the Western Lake Erie Basin

Field level monitoring 4R practice implementation

Social and economic impact analysis

Dr. Kevin King
USDA-ARS

Photo Credit: USDA

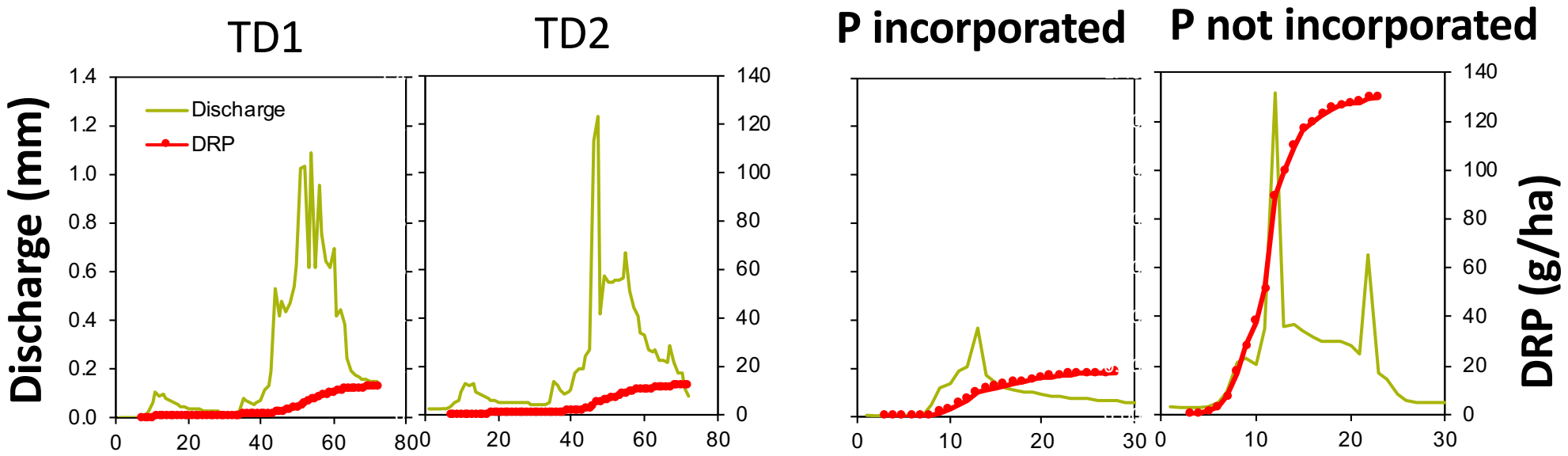
# Western Lake Erie Basin: There is not a time when tile discharge is without N or P.

| | |
|---|---|
| **SOURCE** | Solubility of P fertilizer applied will influence P loss to tile drainage; however, this will differ by soil type and rate. |
| **RATE** | Rates and soil tests less than or at recommended levels are associated with lower P losses from tile drains. |
| **TIME** | Losses of dissolved reactive phosphorus are greater with late fall, winter and early spring applications than with applications made in August and September. |
| **PLACE** | Subsurface P placement decreases loss of dissolved phosphorus to tile drainage. |

# Incorporating P significantly reduced tile dissolved reactive P concentrations

**Before P application & tillage (April 28th)**

**After P application & tillage (May 12th)**

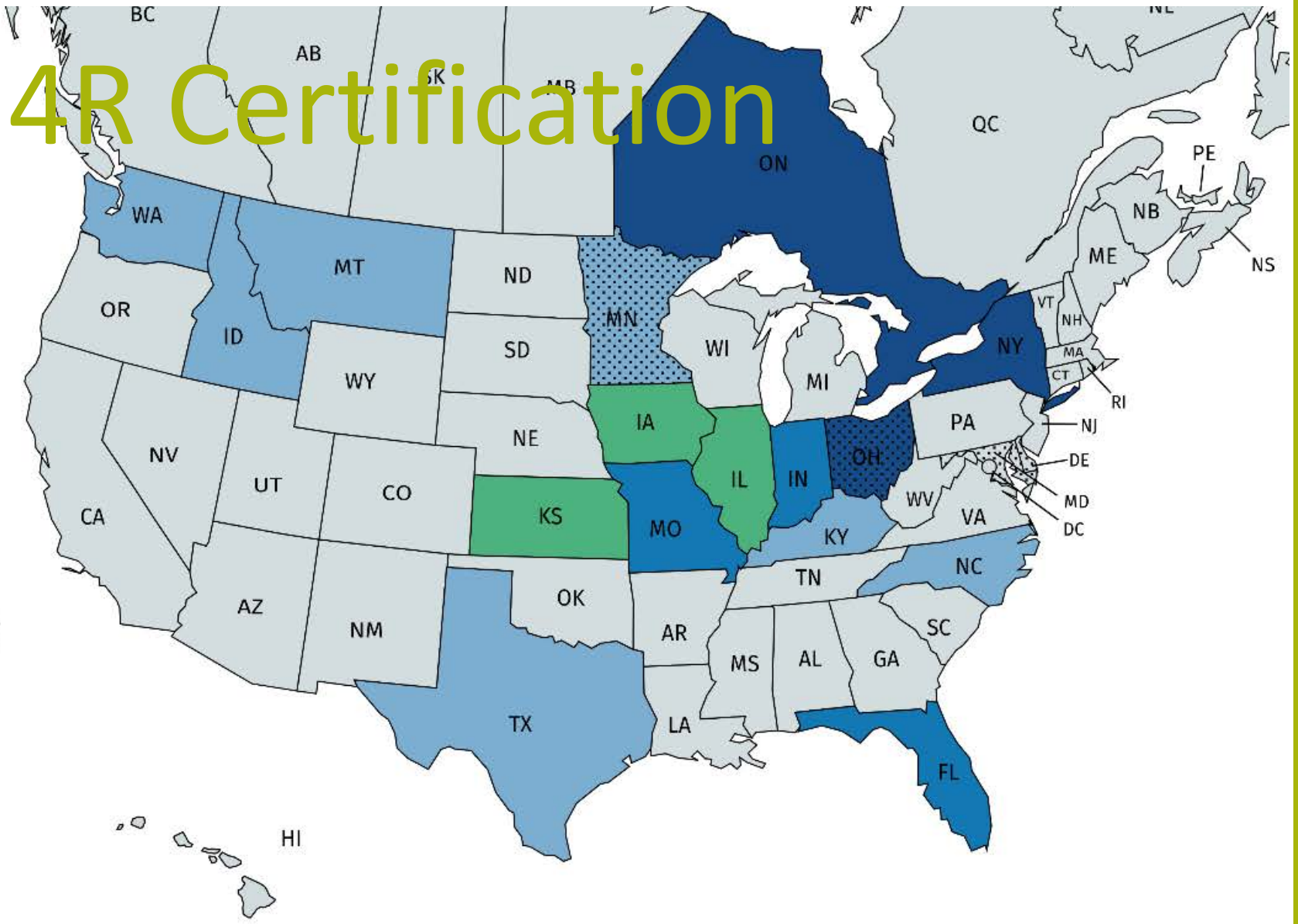



*Williams and King, USDA-ARS, Columbus, Ohio*

# Quantifying 4R adoption metrics can be difficult

It requires regional definitions of 4R practices

# Tracking 4R Certification




- Exploring/Interested
- State Mandated Nutrient Regulations
- Adopted/Launch Soon
- Exis ting or Modified 4R Program
- Existing 4R Certification Program

# Non-irrigated Corn-Soybean – Eastern US

| Practice Level | Right Source | Right Rate | Right Time | Right Place |
|---|---|---|---|---|
| **Basic -** adopted by approximately 50% of growers | • Guaranteed or book value for all sources applied<br>• Urea, UAN, Anhydrous Ammonia, Manure | • Rate based on evidence recognized by regional soil fertility extension<br>• Properly accounting for legume & Manure N | • Spring; not on frozen soil<br>• Apply manure according to a manure management plan | • Broadcast and incorporated, injected or subsurface band<br>• If broadcasted Urea accompanied by an inhibitor<br>• UAN w/herbicide no more than 40 Lbs |
| **Intermediate -** adopted by approximately 20% of growers | • Guaranteed or known analysis for all sources applied; with nitrification inhibitor or controlled release if preplant; with urease inhibitor for urea/UAN surface applied sidedress | • Rate based on evidence recognized by regional soil fertility extension, including results of local adaptive management research.<br>• Manure analysis required to determine rate | • Some or all applied nitrogen in season or if pre-plant used with NI or polymer coated Urea | • Broadcast and incorporated, injected or subsurface band, surface application only for sidedress urea with UI or dribbled UAN |
| **Advanced -** adopted by approximately 5% of growers | • Guaranteed or known analysis; with nitrification inhibitor or controlled release if preplant; with urease inhibitor for urea/UAN sidedress | • Rate based on evidence recognized by regional soil fertility extension, or results of local adaptive management research, AND, in addition, addressing within-field and weather-specific variability using tools such as crop sensors, PSNT, models that allow adjustment of in-season N rates | • Some or all N applied in-season | • Broadcast and incorporated, injected or subsurface band, surface application only for sidedress urea with UI or dribbled UAN |

# Final thoughts:

4R nutrient stewardship and conservation work in unison; coupling the two increases use efficiency and reduces environmental loss.

**There is no one-size-fits-all prescription for conservation.**

*Photo Credit: Guentzel*

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# Thank you!

# For more information

nutrientstewardship.org

@4Rnutrients

4R Nutrient Stewardship

https://www.youtube.com/user/1fertilizer/videos