Nutrient Stewardship

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THE FERTILIZER INSTITUTE

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

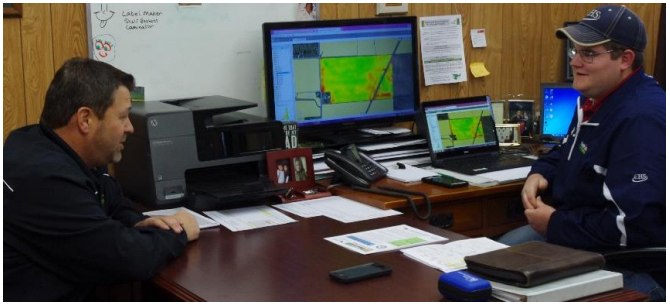
Makes nutrients available when crops need them.

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 source, right rate, right time, and right place nutrient management decisions**



Why 4R Nutrient Stewardship?

- **Rapidly approaching sustainability and nutrient reduction goals**

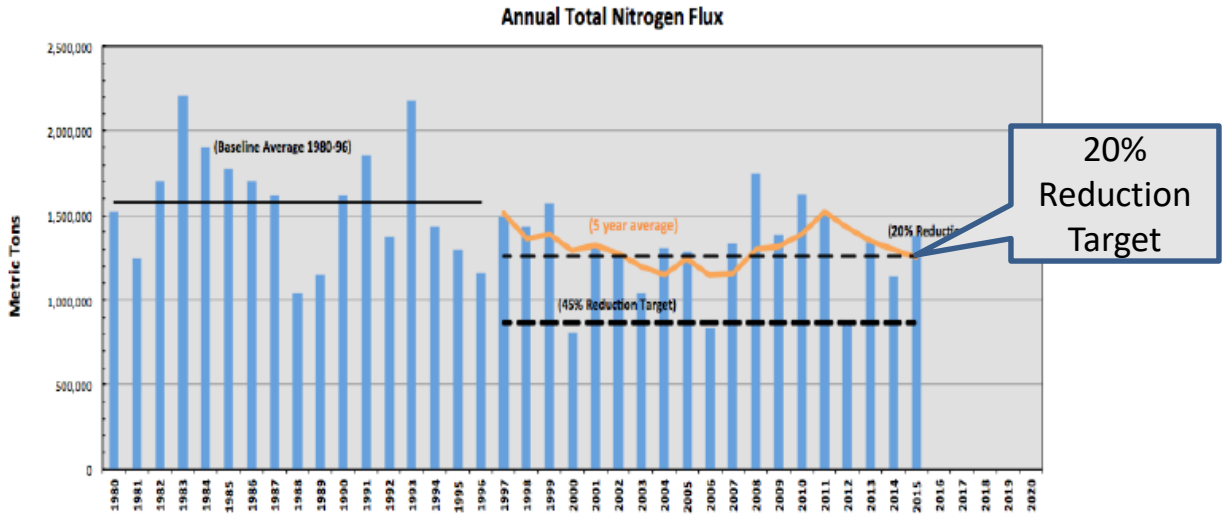


Figure 3. Annual total nitrogen loads in the Mississippi/Atchafalaya River basin transported to the Gulf of Mexico from 1980-2015. (USGS 2017)

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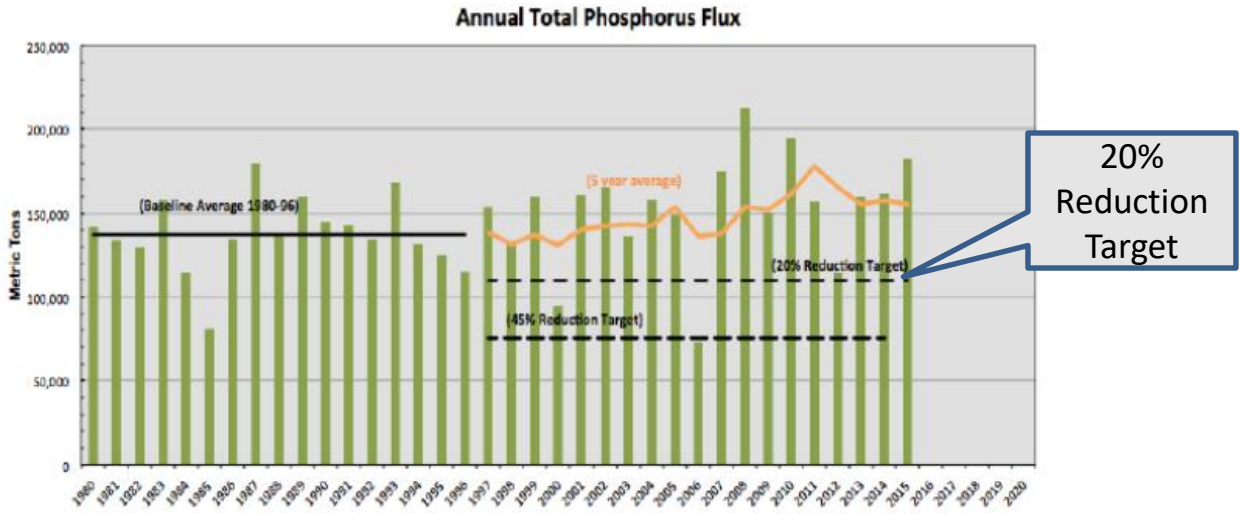


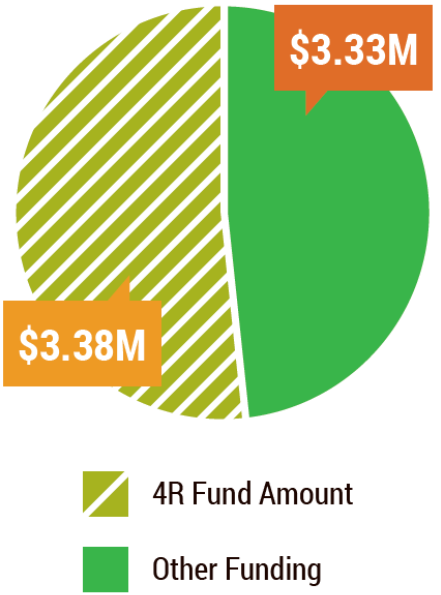
Figure 4. Annual total phosphorus loads in the Mississippi/Atchafalaya River basin transported to the Gulf of Mexico from 1980 to 2015. (USGS 2017)

Why 4R Nutrient Stewardship?

- **Rapidly approaching sustainability and nutrient reduction goals**
  - Consumer Packaged Goods Company Sustainability Goals
    - 2020 General Mills – 100% Sustainable Sourcing of 10 priority ingredients by 2020
      - 2016 – 33% of U.S. Corn sustainably sourced

4R Research Fund

- Established by fertilizer industry to help determine sustainability indicators and impact data on 4R
- Resources to support measuring and documenting economic, social and environmental impacts
- $5.5 million over 5 years
- 12 U.S. Projects and 10 Canadian Projects



Research Fund

Companies Contributed	Funded Projects	Dollars Contributed	Total Dollars Allocated
84	25	$5.7M	$13M

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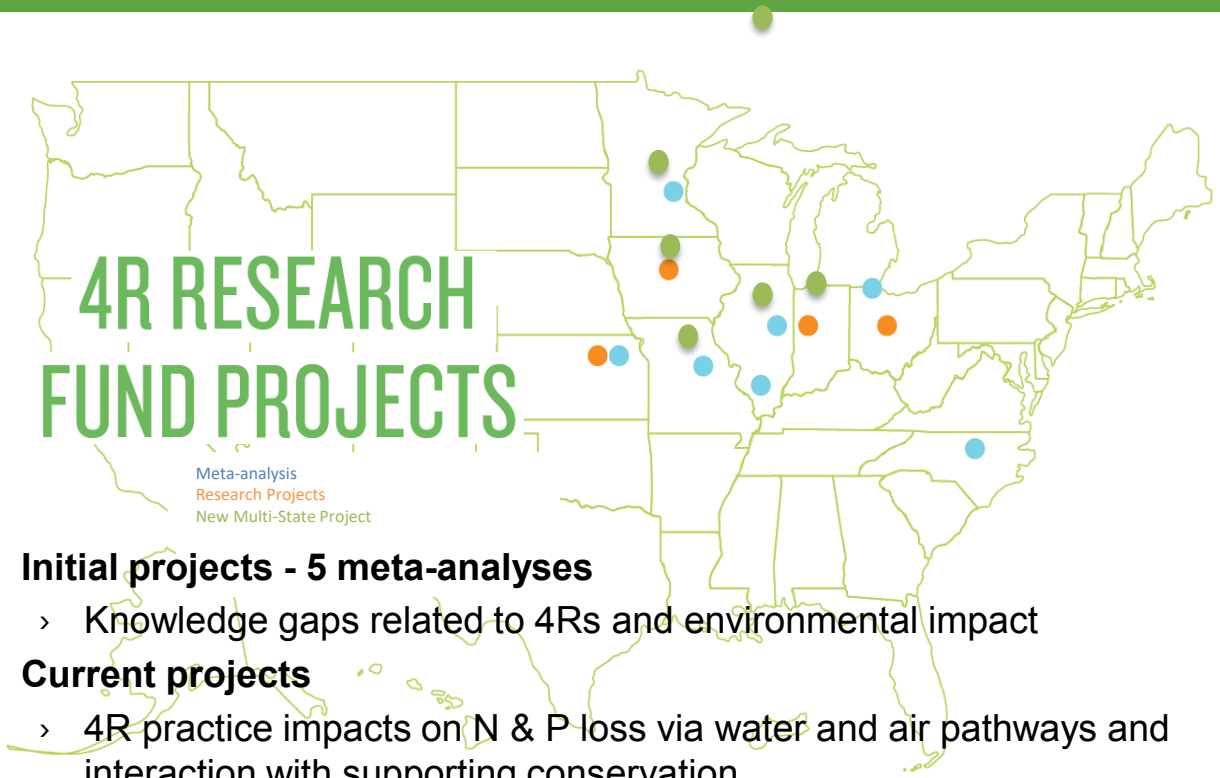
4R RESEARCH FUND PROJECTS

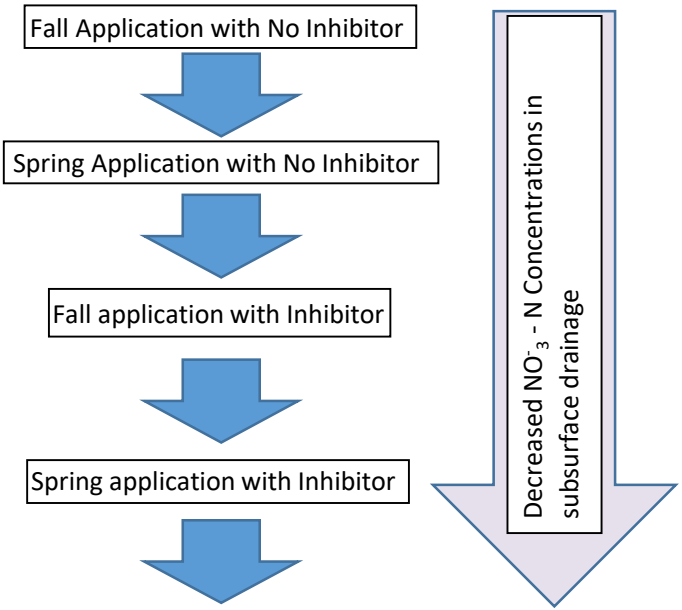


- **Initial projects - 5 meta-analyses**
  - Knowledge gaps related to 4Rs and environmental impact
- **Current projects**
  - 4R practice impacts on N & P loss via water and air pathways and interaction with supporting conservation

4R Nitrogen Research

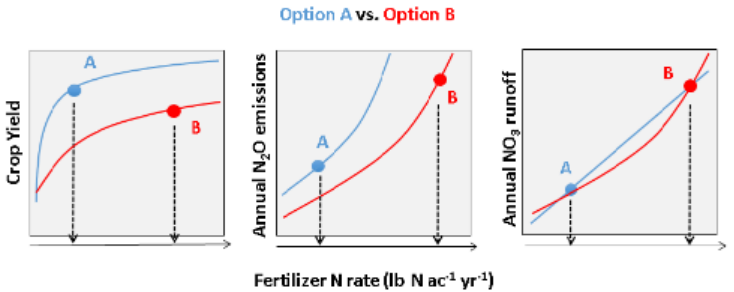
4R Research Fund Findings	4R				Outcomes		
	Right Source	Right Rate	Right Time	Right Place	Yield	N_2O Loss	NO_3 Loss
Timing of nitrogen application impacts corn yield and nitrogen loss			•		↑	↓	
Applying urea at side-dress increses yield compared to both pre-plant and fall application			•		↑		
Side-dressing nitrogen fertilizer reduced N_2O loss by 30 to 39%			•	•		↓	
Rate of nitrogen application impacts yield and nitrogen loss		•			↕	↕	↕
Yield and NO_3 loss to subsurface drainage increase with increased nitrogen application		•			↑		↑
As nitrogen application increases, N_2O loss increases exponentialy, while NO_3 losses increase linearly		•				↑	↑
Enhanced efficiancy nitrogen fertilizer use impacts N_2O and NO_3 losses	•					↓	↓
Nitrification and urease inhibitor use with UAN or anhydrous ammonia applications decreases N_2O and NO_3 losses	•					↓	↓
Weather has a larger impact on nitrogen loss than rate of applicaion	•	•	•	•	↕	↕	↕
N_2O loss from a 1.8°F increase in July average temperture is equal to N_2O losses of an additonal application of 89.2 lbs/ac	•	•	•	•		↑	
Increased drainage dischage volume increases nitrogen load	•	•	•	•			↑

Source and Timing Effect Nitrate loss for Anhydrous Ammonia



4R Nutrient Management in U.S. Corn-Based Systems

- Synthesize currently available research to examine N losses from U.S. Corn-Based Systems
- **Goals and Objectives**
  - **Source, Rate, Time, and Place** – Crop yield, nitrate (NO_3^-) leaching, and nitrous oxide (N_2O) emissions



4R Nutrient Management in U.S. Corn-Based Systems

- **Rate –** Strong positive relationship to 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 ranked from highest to lowest:
  - 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 –** N_2O emissions are higher with warmer temperatures.
  - 1.8ºF increase in average July temperate = increased emissions from additional application of 100 kg N/ha

4R Phosphorus Research

4R Research Fund Findings	4R				Outcomes		
	Right Source	Right Rate	Right Time	Right Place	Total P Loss	Soluble P Loss	Particulate P loss
The placement of phosphorus fertilizer influences phosphorus loss				•	↓	↓	
Incorporating phosphorus with tillage after fertilizer applicaton is a effective method to reduce surface phosphorus loss				•	↓		
Injecting or incorporating phosphorus fertilizer decreased soluble phosphorus loss by 66% and 75%, respectively, compared to surface application in a rainfall simulation study				•	↓		
A 97% decrease in souble P loss from the soil surface was achieved when MAP was banded versus surface applied in a rainfall simulation study				•	↓	↓	
Applying recommended rates, avoiding application during wet periods of the year and prior to large rain events, and placing fertilizer below the surface are practices associated with decreased phosphorus loss.				•	↓	↓	
Phosphorus application based on crop need and soil test has potential to reduce losses		•			↓		↓
Phosphorus losses to tile drainage are generally less than 5% of phosphorus fertilizer applied to the field		•			↓		
Annual edge-of-field total phosphorus loss represents 4% of the phosphorus applied to fields							
Edge-of-field soluble phosphorus loss is highest with no phosphorus fertilizer application on very high soil test phosphorus values		•			↓		
Conservation practices combined with phosphorus applicaton methods reduce loss				•	↓		
59% reduction in phosphorus loss is achieved when fertilizer is incorporated in combination with conservation practices				•	↓		

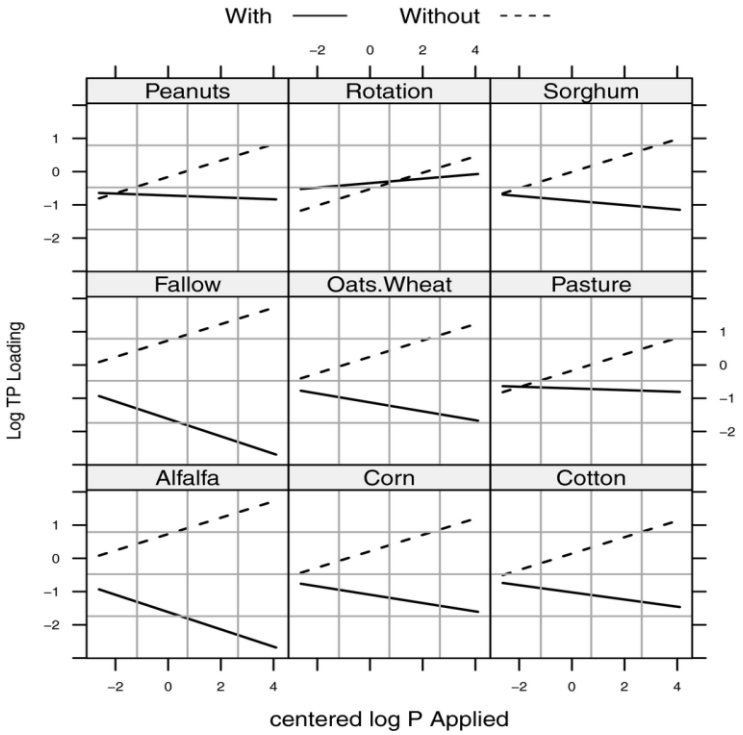
Phosphorus Fertilizer Placement and Tillage Interaction for Corn and Soybean in the U.S.

- **Rate –** When phosphorus applications are above 40 lbs/ac placement in the soil may increase yields.
- **Source –** Not enough information
- **Time –** Not enough information
- **Place –** Phosphorus placement did not change P losses when applications were below 40 lbs/ac.

4R Practices with Conservation Practices

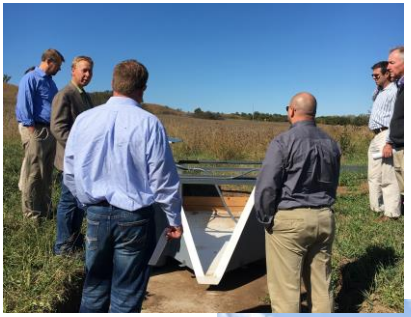
- **Rate –** Rate of phosphorus application and loss with and without conservation practices
- **Source –** Not addressed in this project
- **Time –** Not addressed in this project
- **Place –** Quantify the effects of fertilizer application methods on the loss of phosphorus from fields

Effects of P Applied on Loss is Reduced When Using One or More Conservation Practices



Gaps in the Research

- **Lack of complete data reporting**
  - All forms of N and P
  - Yield
  - All site conditions
    - Soil type, slope, weather
  - Form of nutrient applied
- **Lack of testing of rate changes with other 4R Practices**
- **Testing of conservation practices**
  - Number of studies per practice
  - Interactions with other practices



In Field Studies

Minimizing P Loss with 4R Stewardship and Cover Crops

- Different combinations of time and place of P fertilizer with and without cover crops
- Working with soil physics, cropping systems, agronomy, economics, and extension staff to collect results that cross disciplines
- Cover Crop use in Kansas decreases sediment loss, changes type of P loss

4R and Cover Crops

4R and No Cover Crops

Minimizing P Loss with 4R Stewardship and Cover Crops

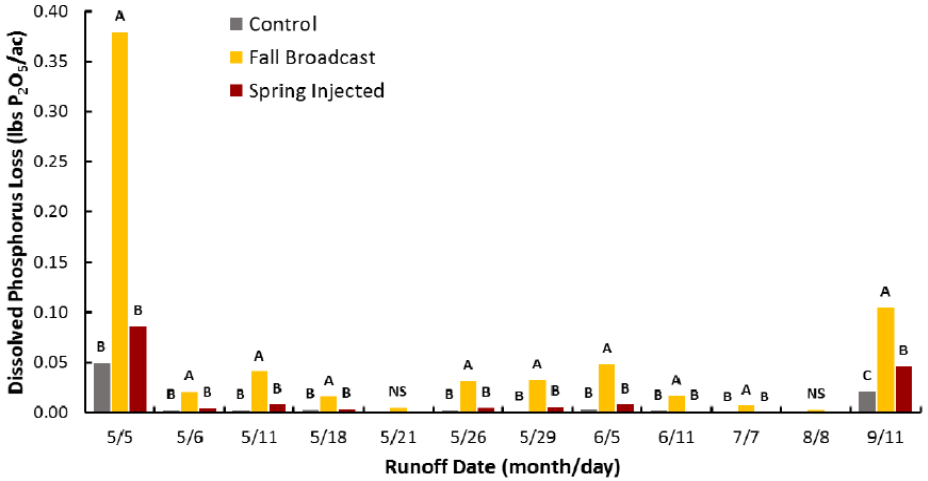
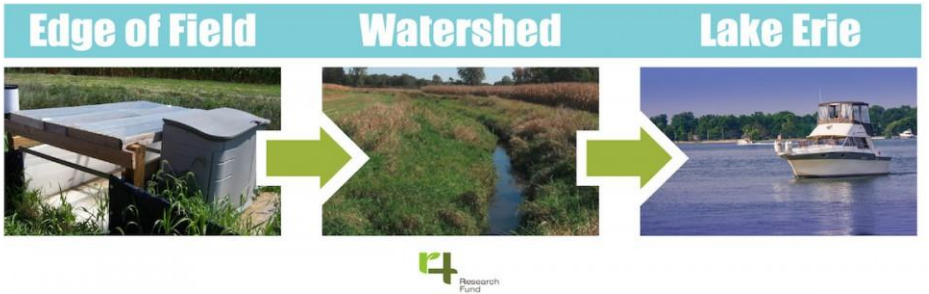


Figure 4. Fertilizer management effect on dissolved P loss. Cumulative dissolved P loss was 0.1, 0.7, and 0.2 lb P_2O_5/ac for control, fall broadcast, and spring injected treatments respectively.

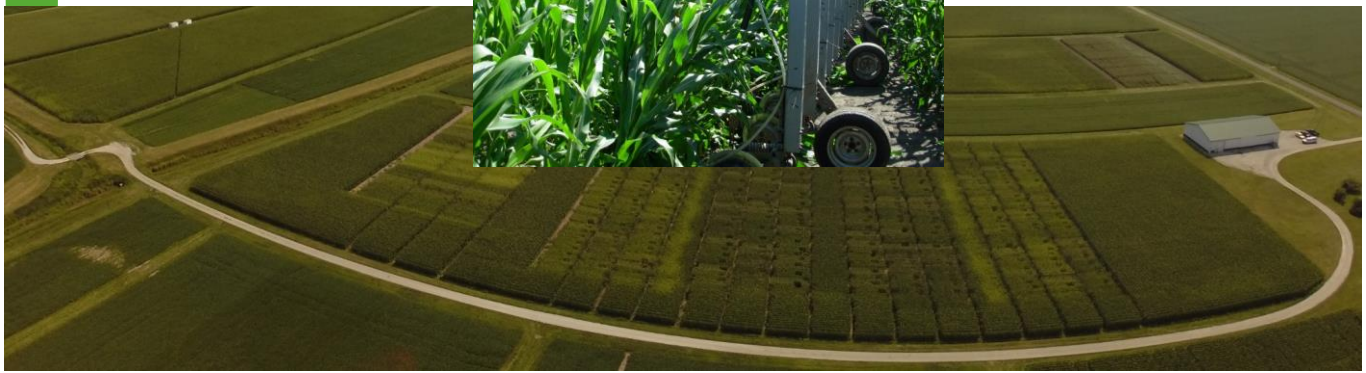
Evaluating the 4R Nutrient Stewardship Concept in the Western Lake Erie Basin

- Field level monitoring of implementation of 4R practices
- Analysis of the social and economic impacts
- USDA-ARS, Ohio State University, Heidelberg University, LimnoTech, IPNI, The Nature Conservancy, Private Farmers
- Placing P below the soil surface decrease P loss



Impacts of Late Season N for High Yield Corn: Indiana

- Evaluate impact of 4R recommendations for modern corn hybrids at assess agronomic, economic and environmental outcomes



Common Findings

- Timing of N application impacts yield and N loss
- Timing of N application when using an EFF can impact air and water losses
- The placement of P fertilizer influences P loss
- P application based on crop need and soil test has potential to reduce P losses

Continuing Research Needs

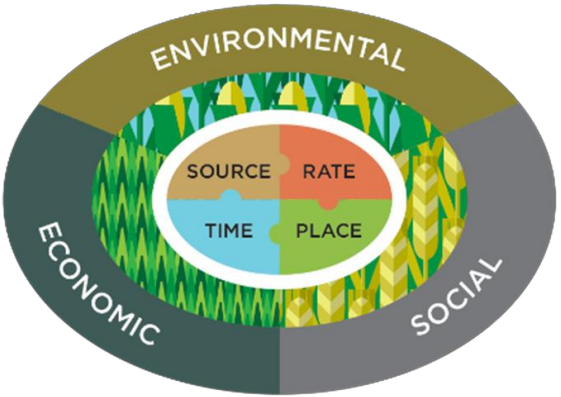
- **Assessing the impact of 4R practices with enhanced efficiency and other advancing technologies in nitrogen and phosphorus fertilizers on water quality and air quality, crop yield, crop nutrient content, and soil health from the same site during the same project.**

Continuing Research Needs

- **Assessing 4R nitrogen and phosphorus practices in more geographic locations, longer time periods, and more cropping systems relative to their effect on productivity and the environment using coordinated controls across multiple site years.**

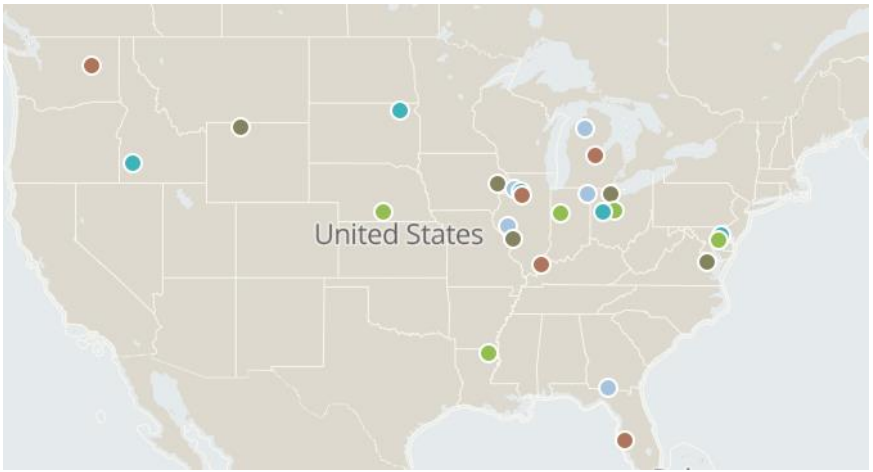
Continuing Research Needs

- **Social Sciences**
  - Why do farmers adopt practices?
  - How does the implementation of 4R impact social concerns



Who is implementing 4R practices?

- **4R Advocates**
  - 70 Advocates – 163,975 acres
  - 19 States
  - http://www.nutrientstewardship.com/advocates/



- **Glenn Beck, Windermere, FL**
  Rob Watson, Griffith Fertilizer Co. Frostproof, FL
- **Maria Cox, Whitehall, Il**
  Kyle Lake, CHS Carrollton, Il
- **Chuck & Darin Dunlop, Parker, KS**
  Jason Sutterby, AgChoice, Moran, KS
- **Jeff, CJ, & Greg Durand, St. Martinville, LA**
  Earl Garber, Sanders/Pinnacle Ag, Crowley, LA
- **Doug Weathers, Salem, OR**
  John Peters, Wilbur-Ellis, Woodburn, OR

Resources

- TFI 4R website: www.nutrientstewardship.org
-  1fertilizer
-  @4Rnutrients
-  4R Nutrient Stewardship
- 4R Quarterly Newsletter: sign-up at www.nutrientstewardship.org
- 4R Pocket Guide – request today from TFI
- 4R Educational Modules: http://www.nutrientstewardship.com/4r-training
- 4R Plant Nutrition Manual – purchase from IPNI Publications
- IPNI 4R website: www.ipni.net/4R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