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

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“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)
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
- **30%** Minimizing impact on environment & retaining nutrients in the field
- **39%** Reducing risks associated with good & bad weather, improving yield
- **45%** Action now may reduce the need for regulation later
- **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.

Rooting zone P dynamics also change with no-till.

Mehlich-3 (mg/kg) P

0          20          40          60          80         100

No-Till

Tillage

P Mehlich-3 (mg/kg)

kg P/ha

● 0

● 17.5

● 35

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$_2$O) emissions response to N rates

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

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


**Rate** – Strong positive relationship to yield, NO₃ leaching, and N₂O air loss.
2.9 to 11.9 % increase for each 10 kg N/ha increase

**Source** – N₂O losses are highest with Anhydrous Ammonia > Urea = Polymer Coated Urea = Urea Ammonium Nitrate (UAN) = UAN + Agrotain PLUS® > Super U

**Time** – Side dress fertilizer reduced N₂O emissions 30 to 39 %

**Place** – Broadcast placement of N fertilized decreased N₂O 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
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.

Total P ~30%
Cover crops increased Dissolved P runoff losses by 60%
How can we minimize nutrient loss through tile drainage?
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.

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>Solubility of P fertilizer applied will influence P loss to tile drainage; however, this will differ by soil type and rate.</th>
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</thead>
<tbody>
<tr>
<td>RATE</td>
<td>Rates and soil tests less than or at recommended levels are associated with lower P losses from tile drains.</td>
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<tr>
<td>TIME</td>
<td>Losses of dissolved reactive phosphorus are greater with late fall, winter and early spring applications than with applications made in August and September.</td>
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<tr>
<td>PLACE</td>
<td>Subsurface P placement decreases loss of dissolved phosphorus to tile drainage.</td>
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</table>
Incorporating P significantly reduced tile dissolved reactive P concentrations

Before P application & tillage
(April 28th)

TD1

TD2

Discharge (mm)

After P application & tillage
(May 12th)

P incorporated

P not incorporated

Discharge

DRP (g/ha)

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
- Existing or Modified 4R Program
- Existing 4R Certification Program
## Non-irrigated Corn-Soybean – Eastern US

<table>
<thead>
<tr>
<th>Practice Level</th>
<th>Right Source</th>
<th>Right Rate</th>
<th>Right Time</th>
<th>Right Place</th>
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<tbody>
<tr>
<td><strong>Basic</strong> - adopted by approximately 50% of growers</td>
<td>• Guaranteed or book value for all sources applied Urea, UAN, Anhydrous Ammonia, Manure</td>
<td>• Rate based on evidence recognized by regional soil fertility extension</td>
<td>• Spring; not on frozen soil</td>
<td>• Broadcast and incorporated, injected or subsurface band</td>
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<td>• Properly accounting for legume &amp; Manure N</td>
<td>• Apply manure according to a manure management plan</td>
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<td>• If broadcasted Urea accompanied by an inhibitor</td>
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<td></td>
<td>• UAN w/herbicide no more than 40 Lbs</td>
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<td><strong>Intermediate</strong> - adopted by approximately 20% of growers</td>
<td>• 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</td>
<td>• Rate based on evidence recognized by regional soil fertility extension, including results of local adaptive management research.</td>
<td>• Some or all applied nitrogen in season or if pre-plant used with NI or polymer coated Urea</td>
<td>• Broadcast and incorporated, injected or subsurface band, surface application only for sidedress urea with UI or dribbled UAN</td>
</tr>
<tr>
<td></td>
<td>• Manure analysis required to determine rate</td>
<td>• Surface application only for sidedress urea with UI or dribbled UAN</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Advanced</strong> - adopted by approximately 5% of growers</td>
<td>• Guaranteed or known analysis; with nitrification inhibitor or controlled release if preplant; with urease inhibitor for urea/UAN sidedress</td>
<td>• 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</td>
<td>• Some or all N applied in-season</td>
<td>• Broadcast and incorporated, injected or subsurface band, surface application only for sidedress urea with UI or dribbled UAN</td>
</tr>
</tbody>
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For **Non-irrigated Corn-Soybean – Eastern US**, the table outlines the appropriate practices for different levels of adoption by growers: Basic, Intermediate, and Advanced. Each level specifies the right source of nutrients, the right rate of application, the right timing, and the right placement. The table includes detailed guidelines for each level, emphasizing the importance of proper accounting for various factors such as legume and manure nitrogen, regional soil fertility, local adaptive management research, and within-field variability. The practices range from simple book value or guaranteed analyses to more complex systems incorporating crop sensors, PSNT, and models that allow adjustment of in-season nitrogen rates.
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.
Thank you!

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For more information

nutrientstewardship.org

@4Rnutrients

4R Nutrient Stewardship

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