4R NUTRIENT STEWARDSHIP & NITROGEN MANAGEMENT

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Director – Foundation for Agronomic Research
Today’s Discussion

• The Fertilizer Institute & The Foundation for Agronomic Research Updates
• 4R Research Fund Overview of Projects
• 4R Strategy Farmer Case Studies
• Challenge Areas
The Fertilizer Institute (TFI)

TFI is the voice of the fertilizer industry, representing the public policy, communication, stewardship and sustainability and market intelligence needs of fertilizer producers, wholesalers and retailers as well as the businesses that support them with goods and services.
Foundation for Agronomic Research (FAR)

*Enhance science-based nutrient stewardship efforts in private & public space.*

- Nutrient stewardship collaborations – Industry, Academic, NGO
- Public policy engagement
- The 4R Research Fund
Recent TFI Resources

• Publications [https://store.tfi.org/](https://store.tfi.org/)
Recent TFI Resources

• NuGIS  [http://nugis.ipni.net/map/](http://nugis.ipni.net/map/)
Recent TFI Resources

- North American Soil Test Summary
  http://soiltest.ipni.net/
Recent TFI Resources

- InfoAg Conference
- 2019 InfoAg Conference – 1,204 attendees
- July 28-30th, 2020 St Louis, Missouri
4R Nutrient Stewardship

Goal: Improve agricultural production while contributing to social well being and minimizing environmental impacts
4R Research Fund

Pre-2019

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

Spring 2019 Projects

- Proposals Submitted: 72
- Funded Projects: 5
- Dollars Contributed: $3.0M
- Total Dollars Requested: $36M
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
INTEGRATING STACKED NUTRIENT MANAGEMENT STRATEGIES

Farmer Case Studies
Central Illinois Example

• Can individual strategies of nutrient management be assessed as a system?
NW Ohio Example

Cost of 4R Practice Implementation for Ohio Strip-Till Corn
Yield Range 189 to 214 bu/ac
## NW Ohio Example

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield (bu/ac)</strong></td>
<td>177.5</td>
<td>193.3</td>
<td>170.0</td>
<td>174.9</td>
</tr>
<tr>
<td><strong>4R Level</strong></td>
<td>Basic</td>
<td>Basic</td>
<td>Intermediate</td>
<td>Advanced</td>
</tr>
<tr>
<td><strong>Base Cost per acre</strong></td>
<td>$286.68</td>
<td>$281.50</td>
<td>$224.70</td>
<td>$185.57</td>
</tr>
<tr>
<td><strong>Nitrogen (lb N/bu)</strong></td>
<td>1.18</td>
<td>1.19</td>
<td>0.94</td>
<td>0.99</td>
</tr>
<tr>
<td><strong>Phosphorus (lb P/bu)</strong></td>
<td>0.49</td>
<td>0.45</td>
<td>0.52</td>
<td>0.35</td>
</tr>
</tbody>
</table>
Economics of 4R Stewardship

- **Basic**: spring pre-plant anhydrous ammonia *with inhibitor*, liquid starter fertilizer with seed, early post-plant N with herbicide, liquid N side-dress with Y-drop placement

- **4R Oriented**: Liquid starter with seed, early post-plant N with herbicide, side-dress anhydrous ammonia *with inhibitor*
Diversifying 4R Strategies

- Transition to fertigated in-season N
- Grid sampled phosphorus and potassium
- Incorporated cover crops between growing seasons
Nutrient Management for Tomato Production

• 4-6 harvests per year
• Incorporation of starter into planting beds
• Implementation of soil-test recommendations
In Field Studies
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
- Learn how differences in climate and soil across North America affect these responses.

Eagle et al., 2017
A Meta-analysis of 4R Nutrient Management in U.S. Corn-Based Systems

Rate – Strong positive relationship to NO3 leaching and N2O air loss. 2.9 to 11.9 % increase for each 8.9 lb N/ac 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 are higher with warmer temperatures. 1.8°F increase in average July temperate = increased emissions from additional application of 89.2 lb N/ac

Eagle et al., 2017
4R and Conservation Practices

- Interactions between environmental conditions and management strategies
- Multi-scale assessments of 4R adoption + edge of field practices
Challenge Areas

- Measuring N loss from multiple pathways
- Comparing suites of 4R practices
- Measuring N losses outside the growing season
- Interaction with conservation practices
- Diversity of cropping systems
2019 4R Research Fund Projects

- Spatial and Temporal N Management for Irrigated Vegetable Production Systems
- An Integrated Approach for Nitrogen Management in Upland Cotton (*Gossypium hirsutum*) Across the U.S. Cotton Belt
- Determine Benefits of 4R Nutrient Management and Conservation Practices on Water Quality and Use Efficiency via the Arkansas Discovery Farm Program: A Collective Learning Experience
- Stacking and Intersecting Nutrient and Irrigation 4R’s
“(H) investigating the turfgrass phytobiome and developing biologic products to enhance soil, enrich plants, and mitigate pests.

“(13) FERTILIZER MANAGEMENT INITIATIVE.—

“(A) IN GENERAL.—Research and extension grants may be made under this section for the purpose of carrying out research to improve fertilizer use efficiency in crops—

“(i) to maximize crop yield; and

“(ii) to minimize nutrient losses to surface and groundwater and the atmosphere.

“(B) PRIORITY.—In awarding grants under subparagraph (A), the Secretary shall give priority to research examining the impact of the source, rate, timing, and placement of plant nutrients.
Missouri Corn Production and Nutrient Use on Corn

Since 1980, Missouri has produced 325% more total corn using 59% less nutrients per bushel.

Source: Computed from data reported by NASS, USDA.
<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>P2O5</th>
<th>K2O</th>
<th>NPK</th>
<th>% change from 1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>2.736</td>
<td>1.196</td>
<td>1.430</td>
<td>5.362</td>
<td></td>
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<tr>
<td>1985</td>
<td>1.189</td>
<td>0.392</td>
<td>0.508</td>
<td>2.090</td>
<td>-57% -67% -64% -61%</td>
</tr>
<tr>
<td>1990</td>
<td>1.289</td>
<td>0.473</td>
<td>0.653</td>
<td>2.416</td>
<td>-53% -60% -54% -55%</td>
</tr>
<tr>
<td>1995</td>
<td>1.553</td>
<td>0.426</td>
<td>0.561</td>
<td>2.540</td>
<td>-43% -64% -61% -53%</td>
</tr>
<tr>
<td>2000</td>
<td>1.065</td>
<td>0.342</td>
<td>0.425</td>
<td>1.832</td>
<td>-61% -71% -70% -66%</td>
</tr>
<tr>
<td>2005</td>
<td>1.489</td>
<td>0.453</td>
<td>0.550</td>
<td>2.493</td>
<td>-46% -62% -62% -54%</td>
</tr>
<tr>
<td>2010</td>
<td>1.065</td>
<td>0.479</td>
<td>0.297</td>
<td>1.840</td>
<td>-61% -60% -79% -66%</td>
</tr>
<tr>
<td>2014</td>
<td>0.960</td>
<td>0.307</td>
<td>0.365</td>
<td>1.632</td>
<td>-65% -74% -74% -70%</td>
</tr>
<tr>
<td>2016</td>
<td>1.030</td>
<td>0.305</td>
<td>0.374</td>
<td>1.709</td>
<td>-62% -75% -74% -68%</td>
</tr>
<tr>
<td>2018</td>
<td>1.243</td>
<td>0.442</td>
<td>0.486</td>
<td>2.172</td>
<td>-55% -63% -66% -59%</td>
</tr>
</tbody>
</table>

Source: Computed by The Fertilizer Institute from data reported by USDA.
<table>
<thead>
<tr>
<th>Practice Level</th>
<th>Right Source</th>
<th>Right Rate</th>
<th>Right Time</th>
<th>Right Place</th>
</tr>
</thead>
</table>
| **Basic** - adopted by approximately 50% of growers | • Guaranteed or book value for all sources applied  
• Urea, UAN, Anhydrous Ammonia, Manure | • Rate based on evidence recognized by regional soil fertility extension  
• Properly accounting for legume & Manure N | • Spring; not on frozen soil  
• Apply manure according to a manure management plan | • Broadcast and incorporated, injected or subsurface band  
• If broadcasted Urea accompanied by an inhibitor  
• 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.  
• 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 |
Questions?

nutrientstewardship.org
ipni.net/4R

@4Rnutrients
@PlantNutrition

4R Nutrient Stewardship

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