USING 4R NUTRIENT STEWARDSHIP TO OPTIMIZE SOIL AND PLANT HEALTH

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4R Nutrient Stewardship

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

20% Reduction Target
Why 4R Nutrient Stewardship?

- Rapidly approaching sustainability and nutrient reduction goals
GHG Emissions

Global emissions from agriculture (crops & livestock) continued to increase in the last 50 years.

1961: 2.7 billion tonnes CO₂ eq

2011: more than 5.3 billion tonnes CO₂ eq

The largest emitters in agriculture are:

- Enteric fermentation: 40%
- Manure left on pasture: 16%
- Synthetic fertilizers: 13%
- Paddy rice: 10%
- Manure management: 7%
- Burning of savannas: 5%

www.fao.org
• Reduce GHG emissions across value chain by 25% by 2020

• Reduce GHG emissions across value chain by 28% by 2025, & sustainably sourcing 100% of our 10 priority ingredients by 2020

• Halve GHG impact of products across the lifecycle by 2020

• Fertilizer optimization on 14 M acres of U.S. farmland by 2020

• Responsibly source top 10 ingredients & materials by 2020
- Meta-analysis
- 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
<table>
<thead>
<tr>
<th>Research Finding</th>
<th>4R</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td><strong>Timing of N application impacts corn yield and Nitrogen loss</strong></td>
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<tr>
<td>- 17 bu/ac increase when anhydrous ammonia is applied at planting vs fall or pre-plant</td>
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<td>- 14 to 32 bu/ac increase when UAN is split between at planting and sidedress</td>
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<td>- Applying urea at sidedress increases yield compared to both pre-plant and fall application</td>
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<td>- Side-dressing nitrogen fertilizer reduced N2O loss by 30 to 39%</td>
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<td>- Fertilizer split between early and late side dressing did not reduce N2O emissions compared to same rate of fertilizer applied at early sidedress</td>
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<tr>
<td><strong>Rate of N Application impacts yield and N loss</strong></td>
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<tr>
<td>- Yield and NOx loss to subsurface drainage increase with increased N application</td>
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<td>- Yield and NOx loss to subsurface drainage decrease with decreased N application</td>
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<td>- Yield increases as application rate of N increases and then plateaus</td>
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<td>- As N application increases N2O loss increase exponentially, while NOx losses increase linearly</td>
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<td>- Fertilizer N rate only explained 43% of the variation in N2O emissions</td>
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<td><strong>Enhanced Efficiency N Fertilizer use impacts N2O and NOx losses</strong></td>
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<td>- Nitrification and urease inhibitor use with UAN or anhydrous ammonia applications decreases N2O and NOx losses</td>
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<td>- Nitrification inhibitors reduced N2O loss by 31%</td>
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<td>- Lowest N2O loss risk with SuperU</td>
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<td>- Urease inhibitors with and without nitrification inhibitors decreased N2O emissions by 19-48%</td>
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<td><strong>Weather has a larger impact on N loss than rate of application</strong></td>
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<td>- 1.8°F increase in July average temperature is equal to N2O losses of an additional application of 89.2 lbs/ac</td>
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<tr>
<td>- 1.8°F decrease in July average temperature decreases N2O loss equal to utilizing a nitrification inhibitor or side-dress timing</td>
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<td>- Increased drainage discharge volume increases N load</td>
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<td><strong>Negative relationship between N recovery efficiency and N2O</strong></td>
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<td>- N2O emissions decreased with greater N recovery efficiency</td>
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<td>- Relationship between N2O emissions and N recovery efficiency were observed under farmer practices, and zero or strip till</td>
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<td>- Overall, for every 1% increase in N recovery efficiency, in-season N2O losses decreased by 35 kg N/ha</td>
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<td><strong>Negative relationship between N surplus or partial N balance and N2O</strong></td>
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<td>- N2O emissions increased with partial N balances for N in grain and plant, and surplus N</td>
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<tr>
<td>Research Finding</td>
<td>4R</td>
<td>Outcomes</td>
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<tr>
<td>---------------------------------------------------------------------------------</td>
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<tr>
<td>The placement of P fertilizer influences P loss</td>
<td>Right Source: •</td>
<td>Total P loss: • Soluble P loss: • Particulate P loss: •</td>
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<tr>
<td>- Incorporated is an effective method to reduce surface P loss</td>
<td>Right Rate: •</td>
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<tr>
<td>- Injecting P fertilizer decreased Dissolved Reactive P loss by 66% and incorporation of P fertilizer though tillage loss by 75% compared to surface application of P fertilizer in a rainfall simulation study</td>
<td>Right Time: •</td>
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<td>- 97% decrease in soluble P surface loss when MAP was banded versus surface applied in a rainfall simulation study</td>
<td>Right Place: •</td>
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<td>- When pooled across 38 fields broadcasting fertilizer had slightly higher DRP losses than injecting or tillage P, variation in site-specific practices of source, rate, and time, in addition to soil type, slope and soil test P increased variation of the pooled means</td>
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<tr>
<td>P application based on crop need and soil test has potential to reduce P losses</td>
<td>•</td>
<td>Soluble P loss: • Particulate P loss: •</td>
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<td>- P losses to tile drainage generally are less than 5% of P fertilizer applied to the field</td>
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<td>- Edge-of-field Dissolved reactive P loss highest with no P fertilizer application and very high soil test P values</td>
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<td>Conservation practices with P</td>
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<td>- 59% reduction when incorporation and conservation practice are combined</td>
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Common Findings

• Timing and Rate of N application was has a large impact on yield and N loss
• Timing of N application when using an EEF can impact air and water losses
• Improved NUE can indicate decreased air losses of N
• The placement of P fertilizer influences P loss
• P application based on crop need and soil test has potential to reduce P losses
Soil Health as 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
- **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
## Value of 4R Practices - Farmer

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
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<tbody>
<tr>
<td><strong>4R Practice Level</strong></td>
<td>Basic</td>
<td>Basic</td>
<td>Intermediate</td>
<td>Advanced</td>
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<tr>
<td><strong>Crop</strong></td>
<td>Corn</td>
<td>Corn</td>
<td>Corn</td>
<td>Corn</td>
</tr>
<tr>
<td><strong>Yield</strong></td>
<td>229</td>
<td>220</td>
<td>245</td>
<td>256</td>
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<tr>
<td><strong>Cost Per Acre</strong></td>
<td></td>
<td></td>
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<tr>
<td>Scenario 1</td>
<td>$ 290.29</td>
<td>$ 263.45</td>
<td>$ 285.44</td>
<td>$ 266.04</td>
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<tr>
<td>Scenario 2</td>
<td>$ 270.81</td>
<td>$ 274.32</td>
<td>$ 248.65</td>
<td>$ 255.23</td>
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<table>
<thead>
<tr>
<th></th>
<th>Field 1</th>
<th>Field 2</th>
<th>Field 3</th>
<th>Field 4</th>
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</thead>
<tbody>
<tr>
<td><strong>Crop</strong></td>
<td>Intermediate</td>
<td>Advanced</td>
<td>Intermediate</td>
<td>Advanced</td>
</tr>
<tr>
<td><strong>Crop</strong></td>
<td>Corn</td>
<td>Corn</td>
<td>Corn</td>
<td>Corn</td>
</tr>
<tr>
<td><strong>Yield</strong></td>
<td>262</td>
<td>251.4</td>
<td>251.9</td>
<td>248.9</td>
</tr>
<tr>
<td><strong>Total Cost per Acre</strong></td>
<td>$ 205.52</td>
<td>$ 188.99</td>
<td>$ 243.43</td>
<td>$ 191.35</td>
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</tbody>
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Farmer Information Sources

76%
Frequently speak to other farmers about fertilizer practices

76%
Agronomist & retailers top fertilizer information source
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
Cox Land and Cattle Co.

- 3,000 ac
  - Corn grain
  - Soybeans
  - Corn silage
  - Hay and cover crops
  - 750 cattle – cow/calf

- No-till since 1988
- Strip-till in corn

Maria Cox, Farmer
Kyle Lake Crop Consultant
Soybeans

• **Cereal Rye Cover crop**
  • Plant soybeans into green standing rye

• **4R Practices**
  • 2.5 ac grid sampling
  • Variable rate nutrient prescriptions using grid samples and yield maps
  • All P and K spring applied
  • Test manure for crediting

• **Performance**
  • 2016 – 71 bu/ac
  • Plus cereal rye hay production
- Strip-Till planting into cereal rye terminated at 10”
- No-till 25%
- Strip-till 50%
- Tillage on 25% that has hog manure
- 4R Practices
  - Variable rate N, P, K
  - Use N-serve (nitrification inhibitor) on all anhydrous ammonia
  - Split application
- Performance
  - 2016 – 190 bu/ac
Maria says:

• “We use cover crops as a way to build organic matter, prevent erosion, lessen weed pressure, and potentially lower fertilizer application rates long-term.”

• “4Rs can be implemented in all tillage situations, but we feel a no-till system on fields keeps the fertilizer from eroding and washing away.”
Strom Farms

- 5,600 acres
- Corn
- Soybeans
- Wheat
- Pasture for a 20-head Angus cow/calf operation

Grant Strom, Farmer
Adam Dexter, Crop Consultant
Soybeans

- No-till
- **4R Practices**
  - 2.5 ac grids
  - Zone soil sampling
  - Variable rate P and K applications
- **Performance**
  - 65 bu/ac - 2017
Corn

• No-Till
• Variable Rate Planting
• 4R Practices
  • 2.5 ac grid sampling
  • Zone sampling
  • Variable rate P and K
  • Variable rate N using field management software
  • All in-season N application
  • Y-Drops for side-dress and late season N
• Performance
  • 200 – 285 bu/ac – 2017 (256 avg)
Strom Farms on Farm Trials

- No-Starter test strips
- Continuous improvement
Grant says:

• “Following the 4R practices lets us spend less money on applying fertilizer and more on technology to improve our fertilizer use and put it where it needs to be.”
Resources

nutrientstewardship.org
ipni.net/4R
@4Rnutrients
@PlantNutrition

4R Nutrient Stewardship

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

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