4R NUTRIENT STEWARDSHIP FOR CROP PRODUCTION

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The Fertilizer Institute
2019
The Fertilizer Institute

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.
The U.S. fertilizer industry generates more than $139 billion in economic benefit and provides more than 80,000 direct jobs and 370,000 indirect jobs for a total of more than 450,000 U.S. jobs.

2017 Report 1,418 representing 21 member companies in the U.S.

https://www.tfi.org/our-industry/state-of-industry/fertilizer-on-the-farm
It’s A Priority

Better crop performance, improved soil health, and cleaner air and water.

- **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
Water Quality
Sustainability
Nutrient Use Efficiency
Green House Gas Goals
Soil Health
Water Pollution
Air Quality
Regulation
Nutrient Loss
Facebook/Twitter
Hypoxia Task Force Report

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

Figure 4. Annual total phosphorus loads in the Mississippi/Atchafalaya River basin transported to the Gulf of Mexico from 1980 to 2015. (USGS 2017)
Figure 2. Annual total nitrogen flux and streamflow for total Mississippi-Atchafalaya River Basin.

Figure 3. Annual total phosphorus flux and streamflow for total Mississippi-Atchafalaya River Basin.

https://toxics.usgs.gov/hypoxia/mississippi/flux_est/
Chesapeake Bay Report Card 2018

• Long-term trend is statistically, significantly improving over time.
• There are no regions in decline.
• Underwater grasses, dissolved oxygen, and total nutrients all showed positive trends
• However...
• Water clarity showed a negative trend, with several Bay regions making little or no progress
• Keep moving forward with 4R Nutrient Stewardship, Conservation, and Soil Health working together
GHG Emissions – Nitrous Oxide Loss

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%
<table>
<thead>
<tr>
<th>Company</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coca-Cola</td>
<td>Reduce GHG emissions across value chain by 25% by 2020</td>
</tr>
<tr>
<td>Unilever</td>
<td>Halve GHG impact of products across the lifecycle by 2020</td>
</tr>
<tr>
<td>Walmart</td>
<td>Fertilizer optimization on 14 M acres of U.S. farmland by 2020</td>
</tr>
<tr>
<td>Kellogg’s</td>
<td>Responsibly source top 10 ingredients &amp; materials by 2020</td>
</tr>
</tbody>
</table>
• Reduce GHG emissions across value chain by 28% by 2025, & **sustainably sourcing 100% of our 10 priority ingredients by 2020**
## Performance dashboard: Sustainable sourcing

**Commitment:** Sustainably source 100 percent of our 10 priority ingredients by 2020, representing 40 percent of our annual raw material purchases.

**Progress:** 76 percent of these raw materials were sustainably sourced in fiscal 2017.

<table>
<thead>
<tr>
<th>Raw material/ingredient</th>
<th>Progress* (% of volume sustainably sourced as of May of the year noted)</th>
<th>Primary focus**</th>
<th>Strategy</th>
<th>Sustainability definition</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>FY14</td>
<td>FY15</td>
<td>FY16</td>
<td>FY17</td>
</tr>
<tr>
<td>Cocoa</td>
<td>10%</td>
<td>28%</td>
<td>46%</td>
<td>50%</td>
</tr>
<tr>
<td>Vanilla</td>
<td>45%</td>
<td>45%</td>
<td>22%</td>
<td>22%</td>
</tr>
<tr>
<td>Oats</td>
<td>35%</td>
<td>40%</td>
<td>50%</td>
<td>61%</td>
</tr>
<tr>
<td>U.S. wheat</td>
<td>15%</td>
<td>24%</td>
<td>36%</td>
<td>61%</td>
</tr>
<tr>
<td>U.S sugar beets</td>
<td>34%</td>
<td>47%</td>
<td>68%</td>
<td>81%</td>
</tr>
<tr>
<td>U.S. corn (dry milled)</td>
<td>6%</td>
<td>26%</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>U.S. dairy (raw fluid milk)</td>
<td>20%</td>
<td>20%</td>
<td>38%</td>
<td>83%</td>
</tr>
<tr>
<td>Fiber packaging</td>
<td>99%</td>
<td>99%</td>
<td>99%</td>
<td>99%</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>42%</td>
<td>59%</td>
<td>67%</td>
<td>58%</td>
</tr>
<tr>
<td>Palm oil****</td>
<td>83%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

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The Fertilizer Institute

Nourish, Replenish, Grow
Industry Updates

• Walmart – Gigaton Challenge
  • “The adoption of best-in-class agricultural practices, including precision agriculture and feed optimization, can help reduce farmer input costs, improve water quality and reduce greenhouse gas (GHG) emissions.”
  • Recommend 4R practices to reach goals

https://www.walmart可持续性hub.com/project-gigaton/agriculture
Assessing 4R Awareness

• Qualitative online survey
  • Crop advisers
  • Farmers
    • Over 200 ha
    • Growing alfalfa, barley, cotton, dry beans, field corn, grain sorghum, hay, oats, potatoes, rice, rye, soybeans, sugar beets, sugarcane, timothy, or wheat

• Phone survey
  • 203 Farmers
Advisers Awareness of 4R

- 96% Aware of 4R concepts
- 92% Farmers are receptive to new fertilizer science
- 71% Cost or return on investment important to conversations on “new practices”
Farmer 4R Awareness

38% - a lot or some about 4R
Approach to Practice Adoption Split

- 42% Wait & See Approach
- 58% Adopt New Practices Pretty Quickly

- 68% Farm <1,000 acres
- 68% <$500K gross income
- 65% over the age of 65
Farmer Information Sources

76%
Frequently speak to other farmers about fertilizer practices

76%
Agronomist & retailers top fertilizer information source
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

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
Cost, Cost, Cost

- Link specific practice & benefits info to a real world example

- Want to see how it works for others

- Cost, ROI, Savings
4R Message Can Affect Change

- 4R awareness, favorability, & likelihood to try new practices increased during survey

**Favorability**
- 67 to 76% for farm income <$500K
- 57 to 70% for those implementing few 4R practices

**Try New Practices**
- 65 to 76% for those implementing some 4R practices
- 35 to 61% for those implementing not much or no 4Rs
4Rs make sense, but farmers want info on costs, equipment needs, logistics, and impacts.

Farmers respond positively to communications linked to other farmers & content that provides specific detail for better decision making.

Favorability & likelihood to try new practices increased with increasing 4R awareness.

Crop advisors are an important information source.

It’s advantageous to reference the 4Rs collectively, farmers are favorable towards concept as a system.

For crop advisors, increased practice adoption has implications for offered services, products & technologies.
What Practices are **Right** Practices?

- Provide positive results as demonstrated through research and ongoing systematic assessment (adaptive management)
- Site specific to account for variability related to management, soil, climate, genetics, conservation practices on site etc.
- Every crop nutrient application involves all 4Rs
- Practice use and selection are interrelated, each is linked
- Selected using adaptive management to assess site specific needs for all nutrient applications
Retailers and Agronomists: Farmer’s Information Source

- Retailers ranked as most important information source by farmers
- Key role in 4R adoption

Sources of information Michigan farmers indicated that they use to determine N fertilizer application rates. Redrawn from Stuart et al. 2014. Land Use Policy 36:210-218.
Who is implementing 4R practices?

- 4R Advocates
  - 10 Advocates – 160,000+ acres
  - 18 States
  - 3 from the Mid-Atlantic
2019 4R Advocates

- Brian Herbeck, Dewese, NE – Corn, Wheat, Soybean, Alfalfa
  Bill Nejezchleb, Fairfield Non Stock Coop, Fairfield, NE

- Danny Basham, Madisonville, KY - Corn
  Phillip Osborn, Nutrien Ag Solutions, KY

- Dustin Grooms, Plant City, FL - Strawberries
  Jerrod Parker, Chemical Dynamics, INC, FL

- Jonathan Quinn, Warwick, MD – Corn, Soybeans, Wheat, Barley, and Spinach
  Kenny Glenn, Southern States Cooperative, INC, DE

- Michael Ganschow, IL – Corn and soybean
  Malcolm Stambaugh, Growmark FS, IL
Beck Brothers Citrus, Inc.

- Use enhanced efficiency fertilizers – N
- Variable rate applications up to 6 times a season
- Some fertigation
- Leaf tissue analysis to adjust in-season applications
- Use GIS and mapping to examine where there are nutrient concerns in the fields
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
Corn

- 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
Manure use

- Applied to cover crops
- Spring application
- Beef and swine manure
- Credit for nutrient from manure
Other Conservation

- Dry Dams
- Conservation Reserve Programs
  - Pollinator Program
  - 80 acres CRP long-term
- Buffer strips around feed lots
- Grassed waterways
- Buffer Strips
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.”
Everyone Plays a Role

• Expand your 4R knowledge with available tools

• Educate stakeholder groups about 4R nutrient stewardship and encourage their engagement

• Utilize the 4Rs to share a common message

• Participate in relevant meetings and committees

• Inform the public when the opportunity arises
Economics of 4R Nutrient Stewardship

- **Basic**: spring pre-plant AA w/ inhibitor, liquid starter w/ seed, early post-plant w/ herbicide, liquid N side-dress with Y-drop

- **Intermediate**: Liquid starter w/ seed, early post-plant w/ herbicide, side-dress AA with inhibitor

- **Advanced**: Liquid starter w/ seed, early post-plant w/ herbicide, side-dress AA with inhibitor, liquid side-dress w/Y-drop (V10)
**U.S. BASED**

**4R RESEARCH FUND PROJECTS**

Meta-analysis
Research Projects
New Multi-State Project

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
Common N Findings

• Timing of N application was has a large impact on yield and N loss
  • 14 to 32 bu/ac increase when UAN is split between at planting and sidedress
  • Applying urea at sidedress increases yield compared to both pre-plant and fall application
  • Side-dressing nitrogen fertilizer reduced N$_2$O loss by 30 to 39%
• Nitrification and urease inhibitor use with UAN or anhydrous ammonia applications decreases N$_2$O and NO$_3$ losses
Common P Findings

- Placement of P fertilizer influences P loss
- P application based on crop need and soil test has potential to reduce P losses
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.
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. 1.8⁰F increase in average July temperate = increased emissions from additional application of 89.2 lb N/ac

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

With conservation practices, there is a 59% reduction through the combination of incorporation of P and conservation.

Qian and Harmel. 2016. JAWRA.
N Knowledge Gaps

- Lack of studies:
  - Measuring N loss from multiple pathways
  - Comparing suites of 4R practices
  - Measuring N losses outside the growing season
  - Conservation practices

- Need for more studies beyond Midwest cropping systems
P Knowledge Gaps

• Lack of studies:
  • Investigating P sources, timing, and placement
  • Addressing P form (particulate vs. dissolved)
  • Conservation Practices

• Need to incorporate P forms into water quality models

• Need for more studies beyond Midwest cropping systems
4R NUTRIENT STEWARDSHIP CERTIFICATION PROGRAM

Voluntary program in Western Lake Erie Basin (WLEB) and entire state of Ohio for agricultural retailers & nutrient service providers implementing the 4Rs

48 CERTIFIED BRANCH FACILITIES
38 FACILITIES IN WLEB
6,300 CLIENTS SERVICED
2.9M TOTAL ACRES
1.85M ACRES IN WLEB
1 43

GOALS
- Maximize crop nutrient uptake and minimize crop loss
- Positively impact local water bodies
- Provide up-to-date information on nutrient stewardship
- Help the agricultural sector adapt to new research and technology

REQUIREMENTS
- Initial training and on-going education
- Monitoring of 4R implementation
- Nutrient recommendation and application

THIRD-PARTY VERIFIED
- Audits review training and education, recommendations to growers and application records
- Third-party auditor verification occurs each year

RIGHT SOURCE - RIGHT RATE - RIGHT TIME - RIGHT PLACE

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Crops & Soils

Science for Stewardship

Providing the science needed to use fertilizers sustainably—remaining profitable while protecting the environment and benefiting society

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Matches fertilizer type to crop needs.

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Makes nutrients available when crops need them.

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2018 Farm Bill

- Research Title
  - Fertilizer Nutrient Research – High Priority

- Conservation Title
  - TSP and CCA
  - More EQIP $ for nutrient management
  - CEAP Reports

- Hopefully by December
Bringing it all Together - Challenges

• Challenges on water quality – state and national level
  • Good progress on N
  • What do we need to look at for P?
    • Rates are similar and yield have been increasing, but so is water concentration

• Challenges on emissions – Nitrous Oxide Loss
  • Example – General Mills – goal is 2020 – only 58% suitability on sugar cane
  • Walmart – BIG GOAL – 20+ years away – recommending 4R practices to meet goals and make plan

• CCAs are the trusted advisors
• Knowledge of 4R is high for CCAs and retail
• Farmers are very receptive to 4R message
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
- IPNI 4R website: www.ipni.net/4R
QUESTIONS?