Environmental & Economic Benefits of Precision Ag Linked to 4R Nutrient Stewardship

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4R Nutrient Stewardship

• Improve agricultural production while contributing to social well being and minimizing environmental impacts (benefits water and air quality)
4R on the Farm

- Spring soil sample, 2.5 acre grid
- Spring apply stabilized N, 70% side dressed in-season at V10
- VRT apply P & K per soil maps
- All equipment has GPS, yield monitors, VRT & auto shutoff
- Determine N rate using yield & soils data integrated with in-season assessment
- Of farm research trials to test new products & practices
- 80% of acres are no-till
- Buffer strips, dry dams and grassed waterways in place as needed
Figure 2. Dealer offerings of variable-rate technologies. 2023 are projections.

Source: CropLife-Purdue University Precision Agriculture Dealership Survey

CropLife-Purdue 2020 Precision Ag Survey
Case Study Data Collection

- 3 - 4 years of data at whole farm average level
  - OR 4 individual fields over 3 - 4 years

- Cost & equipment associated w/ fertilizer application

- Equipment cost, time & fuel use based on national databases

- Fertilizer price based on reported prices to USDA
## 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>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic</strong></td>
<td>• Guaranteed or book value for all sources applied</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>
</tr>
<tr>
<td></td>
<td>• Urea, UAN, Anhydrous Ammonia, Manure</td>
<td>• Properly accounting for legume &amp; Manure N</td>
<td>• Apply manure according to a manure management plan</td>
<td>• If broadcasted Urea accompanied by an inhibitor</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>• UAN w/herbicide no more than 40 Lbs</td>
</tr>
<tr>
<td><strong>Intermediate</strong></td>
<td>• Guaranteed or known analysis for all sources applied; <strong>with nitrification inhibitor or controlled release if preplant;</strong> 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></td>
<td>• Manure analysis required to determine rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Advanced</strong></td>
<td>• Guaranteed or known analysis; <strong>with nitrification inhibitor or controlled release if preplant;</strong> 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>
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<td></td>
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</tr>
</tbody>
</table>
Field to Market – GHG Assessment

• Quantification Components
  › Land Resource Region (Climate, Geography, Soil)
  › Surface Soil Texture
  › Nitrogen Application Rate
  › Level of 4R Management
    • Basic, Intermediate, or Advanced
Illinois 4R, no-till

**All Fields:** Fall variable rate application of MAP and potash based on grid soil sampling and yield data; Variable rate seeding based on zones and incorporating use of software for in-season decision; auto guidance in use

- **Basic:** spring pre-plant anhydrous ammonia 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 anhydrous ammonia with inhibitor
- **Advanced:** Liquid starter w/ seed, early post-plant w/ herbicide, side-dress anhydrous ammonia w/ inhibitor, liquid side-dress w/ Y-drop (V10)

Cost of 4R Practice Implementation for IL Corn – Yield Range 229 to 256 bu/ac

- **Basic** 2014: $220.00  2015: $230.00  2016: $240.00  2017: $250.00
- **Intermediate** 2014: $260.00  2015: $270.00  2016: $280.00  2017: $290.00

**Grid Based Variable Rate** 2016: $24.25  2017: $15.57

**Zone Based Variable Rate** 2016: $15.57  2017: $15.57

Decreased cost per acre
- Grid - $24.25
- Zone - $15.57
# Environmental Metrics – IL Corn

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>4R Practice Level</td>
<td>Basic</td>
<td>Basic</td>
<td>Intermediate</td>
<td>Advanced</td>
</tr>
<tr>
<td>Corn Grain Yield (bu/ac)</td>
<td>229</td>
<td>220</td>
<td>246</td>
<td>256</td>
</tr>
<tr>
<td>N Application Rate (lbs/ac)</td>
<td>253</td>
<td>208</td>
<td>253</td>
<td>204</td>
</tr>
<tr>
<td>Nitrogen Use Efficiency (lb N applied/bu corn grain)</td>
<td>1.11</td>
<td>0.95</td>
<td>1.03</td>
<td>0.80</td>
</tr>
<tr>
<td>N Balance (lb N applied – lb N harvested)</td>
<td>69.5</td>
<td>31.9</td>
<td>56.6</td>
<td>-1.14</td>
</tr>
<tr>
<td>CO2e Emissions per bu</td>
<td>9.4</td>
<td>8.43</td>
<td>8.17</td>
<td>6.14</td>
</tr>
<tr>
<td>Percent reduction</td>
<td>-</td>
<td>10.3</td>
<td>13.1</td>
<td>34.7</td>
</tr>
</tbody>
</table>
NUE (N removed / N applied)

Risk of mining soil N

Desirable range for NUE

Risk of inefficient N use

International Nitrogen Expert Panel Recommendations
No-Till Corn Ohio

• Practices Changed from Basic to Advanced:
  › Removed ammonia sulfate from fall strip-till application
  › Variable rate seeding and starter fertilizer application
  › Side dress N with inhibitors applied at a variable rate and knifed-in
    • Working with NRCS to test variable rate nitrogen applications
  › Phosphorus and potassium applications with strip-till and variable rate

NW Ohio Corn-Soybean No-till Rotation (170 to 193 bu/ac)

- Decreased cost $101.11 per acre
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<tr>
<td>4R Practice Level</td>
<td>Basic</td>
<td>Basic</td>
<td>Intermediate</td>
<td>Advanced</td>
</tr>
<tr>
<td>Corn Grain Yield (bu/ac)</td>
<td>178</td>
<td>193</td>
<td>170</td>
<td>175</td>
</tr>
<tr>
<td>N Application Rate (lbs/ac)</td>
<td>204</td>
<td>224</td>
<td>195</td>
<td>184</td>
</tr>
<tr>
<td>Nitrogen Use Efficiency (lb N applied/bu corn grain)</td>
<td>1.14</td>
<td>1.16</td>
<td>1.14</td>
<td>1.05</td>
</tr>
<tr>
<td>N Balance (lb N applied – lb N harvested)</td>
<td>61.3</td>
<td>68.6</td>
<td>58.4</td>
<td>43.4</td>
</tr>
<tr>
<td>CO2e Emissions per bu</td>
<td>10.3</td>
<td>10.2</td>
<td>9.67</td>
<td>8.34</td>
</tr>
<tr>
<td>Percent reduction</td>
<td>-</td>
<td>-</td>
<td>6.12</td>
<td>19.0</td>
</tr>
</tbody>
</table>
Greenhouse Gas Reductions with Advanced 4R Management in US Corn Grain Systems

Total Area: 13,580 acres
Yield Range - 164 to 256 bu/acre
CO2e Reduction Range - 10.7 to 34.7 %
4R Implementation Costs

Year 1 through Year 4 represent progress from basic to advanced level of 4R practice adoption.
4R Case Studies: 4RFarming.org

- Innovation and advanced 4R practices lead to success on Florida potato farm
- Source, time, and rate practice change leads to increased nutrient use efficiency for Florida tomato farm
- Illinois corn farm sees 34% emissions decreases while also lowering cost per acre
- Focus on sustainability and conservation lead Louisiana cotton farm to increased nutrient use efficiency
- Moving from basic to advanced 4R, Illinois corn farm sees large cost-saving and efficiencies
- Advanced Michigan potato farm’s move to fertigation means cost savings of nearly $30 per acre
### One Final Thought

**Nutrient Use Efficiency**

- **World**: 0.585
- **EU (central)**: 0.559
- **USA**: 0.740
- **4R Advocates**: 1.116

**Corn Yield**

- **World**: 90
- **EU (central)**: 152
- **USA**: 173
- **4R Advocates**: 203
Questions

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