Crop Sensors to Guide Nitrogen Fertilizer Application:
Reduce N Loss, Not Yield

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Why?
N gets into water

Mouth of Mississippi River

Huge algal bloom

Gulf of Mexico
Gulf Hypoxia: Water quality poster child

- Rates the General Session for this meeting
- Lots of popular press, very visual
- N is the issue (in textbooks 30 years ago)
- National Ag Water Conference: surely potential solutions will be presented?

- CSREES: Not working on solutions (hypoxia or other issues)
Crop sensors: What do they do?

Controller runs ball valve to change fertilizer rate

Computer in cab reads sensors, calculates N rate, directs controller

sensors
Crop N need is variable: within a field
Overapplication = leftover N in soil

N underapplied

N overapplied

Wasted $

Environmental risk
Putting the right fertilizer rate in the right place:

Spatially intensive diagnosis is needed to protect water quality

How?
## Diagnosing where to put more N

<table>
<thead>
<tr>
<th>Predictor</th>
<th>% of variability in N need explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>2 to 20</td>
</tr>
<tr>
<td>Soil nitrate</td>
<td>17 to 25</td>
</tr>
<tr>
<td>Soil N quick tests</td>
<td>0 to 18</td>
</tr>
<tr>
<td>Soil conductivity</td>
<td>8</td>
</tr>
<tr>
<td>Corn color</td>
<td>53 to 77</td>
</tr>
</tbody>
</table>
Locations of sensor demonstration fields 2004-2008

Total: 92
21 with USDA Spra-Coupe, 2004-2007
56 with producer-owned applicators, 2005-2008
16 with retailer-owned applicators, 2006-2008
Sensor outcomes

• 2004-2007: +$15/ac on corn (41-field ave)
  – Broke even on yield
  – Saved 24 lb N/acre
• 2008: +$29/ac (12-field average)
  – 9 bu yield increase (152 to 161)
  – Used 16 lb extra N
  – Adjusted for wet weather and N loss!
• 2009-2010: more sensor demos
  – Interested? Let me know
N timing in 2008—Columbia

Where did it go?

180 N at planting: LOST!!

110 N at knee high: DELIVERED!

+38 bushels
Missouri EQIP support available

- 2007: $20/acre x 3 years = $60/acre
- 2008: $19/acre x 2 years = $38/acre
- 2009: $36/acre x 2 years = $72/acre
Questions?
The Future

• N prices, environmental pressures will continue to push tighter N management
Nitrogen loss in 2008: What a mess!
Northwest Missouri, Missouri R. bottom, August 2
What kind of N applicator can you use sensors with?
Injecting anhydrous ammonia
injecting solution (tractor)
injecting solution (high-clearance)
Dribbling solution
Spinning on dry N
(easier to get a wide range of rates)
Spinning on dry N

- Kansas producer 2006-2008: 4000 acres of corn fertilized in seven days using high-clearance spinner, sensors, & our N recommendation equation
2006-07: Calibration research, looks great
2008 demo: Saved 45 lb N/acre, looks great!!
What have we learned?

• Power of visual reinforcement
  – The machine does what they would do
  – Dark crop = low N rate, light crop = high N
  – But automated to reduce operator fatigue

• Importance of preparation
  – Everything has to be slick
  – We calculate producer time at $11,000/day during spring & fall rush times
What have we learned?

• Sensors can maintain productivity while reducing N use
  – Cut back in smart places

• Sensors can identify places/years that need more N (than the normal producer rate)
What have we learned?

• Obstacles:
  – Good recommendation equations
  – Weed interference (control early)
  – Limited range of rates with liquid
    • New spring-loaded nozzle bodies will help
What have we learned?

• Obstacles:
  – High-N reference area
  • Hassle of installing
  • Use—Greenseeker uses best 3 seconds in a round, artificially inflates target appearance
  – Drift of sensor rates during the day
Crosswise high-N strips

High-N reference strips

With a plane, you could do a lot of these in a hurry

Can update value for high-N corn every time you drive across the strip
Corn yield is not as sensitive to late N application timing as you might think.

28 small-plot trials in producer fields, Missouri, 1997-1999

Vegetative stage of 200 lb/ac N application
Sensor Benefits:

• Make sure enough N is applied

• Avoid unneeded N application
N application to head-high corn

N rate map

June 20, 2007
Sensor Benefits:

- Make sure enough N is applied
- Avoid unneeded N application
Pounds of Nitrogen As Applied Via UAN on 6/13/07
Becker Farm - Laddonia, MO

As Applied
- 60-81
- 82 - 111
- 112 - 137
- 138 - 164
- 165 - 180
August 1 Aerial Photo after the June 13 UAN Application
Yield of Three Combine Passes Per 80 Ft Swath of the RoGator

Bu/A
- 156 - 192
- 192 - 204
- 204 - 213
- 213 - 222
- 222 - 247

Test Area

80' RoGator Swaths

Fixed
- 214.1
- 208.0
- 208.5
- 206.6
- 206.6
- 211.6
- 205.4

Variable
- 215.4
- 212.1
- 204.2
- 212.4
- 215.5
- 204.9
- 206.6

Avg Bu/A
- 208.6
- 210.2