Technologies for Opportunities for improved nitrogen use efficiency

crop consultants

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Nitrogen management is complex

- Spatial variability in soil N supply to crop
- Potential for loss between application and uptake
Complex + $$$ on the line

More management

Consultants
Nitrogen efficiency

- Landscape
- Nitrogen sensors
- Nitrogen loss and response
- Nitrogen additives etc.
Optimal N rates (lb acre⁻¹)

- 0 to 80
- 80 to 120
- 120 to 160
- 160 to 200
- 200 to 250

N_opt

Yield (bu acre⁻¹)

N rate (lb acre⁻¹)
Landscape affects N availability

• Soil N supply
  – Organic matter
  – Labile organic N
  – Weather effects on release of soil N

• Loss of soil and fertilizer N
  – Weather: excess water?
  – Where does the water go?
• Landscape controls water movement
• Water controls N loss
• Weather controls effect of landscape
N need: variability from year to year

Corn grown in Minnesota: the places that needed the most and least N were not the same in the two years.

Soil electrical conductivity to predict N need?

![Graph showing soil electrical conductivity vs. optimal N rate for Light and Heavy soil types. The graph includes data points and a trend line with an R² value of 0.08.]
Drainage class: Effect on best N rate?
Sensing crop N status

- Integrates landscape and weather influence and interaction
- How?
  - Chlorophyll meter
    - Can predict N rate needed
    - Can predict yield response to additional N
    - Niche: troubleshooting 1 field at a time
- Too limited—think bigger and faster
Variable-rate N sidedressing guided by color sensors

Controller runs ball valve to change fertilizer rate

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

sensors
Locations of sensor demonstration fields 2004-2008

Total: 92
Sensor outcomes

• 2004-2007: +$15/ac on corn
  – Broke even on yield
  – Saved 24 lb N/acre
• 2008: +$26/ac
  – 8 bu yield increase
  – Used 15 lb extra N
  – Adjusted for wet weather and N loss!
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)
Too slow?

- Kansas producer 2006-2008: 4000 acres of corn fertilized in seven days using high-clearance spinner, sensors, & our N recommendation equation
Opportunity?

• I believe that nitrogen sensors are the wave of the future
• Producers will need help with getting started and doing it right
Losing nitrogen = losing yield

My estimate: 460 million bushels of potential corn yield lost in 2008
The Cause

>16” precip April to June = trouble
Dollars lost in 2008 due to N deficiency:
My estimates by state

Total 9 states: $2.3B

- Some yields are very good anyway
- Many could have been better
Prevention: Later application

180 N at planting

110 N sidedress V7.
Diagnosis and decision: an example

Another opportunity for consultants!

June 24 aerial photo

Yield loss map predicted from June 24 aerial photo

Yield loss map based on yield monitor data (September 30)
The Cure
Rescue N example 2008: high clearance applicator, corn, early July, just before tasseling
Aerial photo August 3

+ 55 bushels
Plan B

- What will I do if we get enough rain to cause N loss?
  - Diagnosis & decision
  - Application
- Every producer should have a plan!
- Consultants are a natural fit
Nitrogen source technologies

- **Agrotain**
  - Volatilization inhibitor for urea
  - Cost $0.05/lb N

- **ESN**
  - Plastic-coated urea
  - Cost $0.10/lb N
Agrotain

• Average yield response in Missouri:
  – Corn 7 bushels (16 tests)
  – Wheat 4 bushels (9 tests)
    • Independent of topdress timing
  – Grass 330 lb/acre (6 tests)
ESN

• No advantage in at-planting applications to corn

• Advantage over urea in:
  – Early preplant N applications
  – Early wheat topdress
  – Low spots in the field
    • Dual-bin machine, urea & ESN?
    • Need zones: consultant opportunity
Wheat Response to N Application Timing

Yield (bu/acre)

January | February | March

- Urea
- Urea + Agrotain
- ESN

Increasing urea imports

Year

Urea imported (million tons)

1995 2000 2005 2010
Help producers avoid this:
Problems with dry N quality
Summary

- Nitrogen management is complex
  - Producers need help
  - Lots of money on the line

- Top opportunities:
  - Sensors to diagnose correct N rate
  - Aerial photos to detect N deficiency
  - Plan B to respond to N loss
  - Decisions about N source technology
Thanks!

Questions?

06/08/2006
## 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><strong>Corn color</strong></td>
<td><strong>53 to 77</strong></td>
</tr>
</tbody>
</table>
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

Can update value for high-N corn every time you drive across the strip

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