Nitrogen decisions and tools to make them

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Managing Nitrogen in Crop Production
Peter Scharf

Published by the American Society of Agronomy in 2015
Available via Amazon or ASA
$30
Nitrogen decisions

- Timing
- Rate
- Source
- Placement

Biggest impact decision, past 10 years
Nitrogen timing

- Biology
- Equipment
- Weather
Nitrogen timing: know the biology

- Corn for grain
  - First application planting to chest-high
  - Last application by tassel
- Corn for silage
  - Last application by waist-high
- Wheat
  - Just before jointing
  - At greenup if tillers are needed
- Cotton
  - First application by first square
  - Last application by first flower
Yield response to N depends a lot on need, not much on timing

8 small-plot trials in producer fields, 1997

Field with high need for N

Field with low need for N

time of single-shot 200 lb N application
Nitrogen timing: equipment matters

1 acre in 3 minutes

3 acres in 1 minute

Make your equipment match your system & vice versa
Spring N

- I like dry with a cart on corn that’s 1-2 feet tall (also wheat, cotton, grass…)

- Fast
- Not very expensive
- You control it
- Unlikely to be lost
Nitrogen timing: weather is everything

- If you live where there’s less than 25 inches of rain, timing probably doesn’t matter
- Potential for loss is what makes managing N different than P & K
- Timing matters in wet years (or with over-irrigation)
Nitrogen timing in a wet year

Effect of N timing on corn yield (Urea + Agrotain)

- 140 pounds N applied in February 2013 Missouri
- 85 bushels applied in February
- 88 bushels applied in April
- 161 bushels applied in July

Do you ever make an N rate decision with a 70 bushel impact?
Nitrogen timing in a dry year

Doesn’t matter
Central Missouri 2008: in-season N kicks butt

180 N at planting

+ 44 bu/ac

110 N sidedress knee-high
What if N is lost after you apply?
Yellow corn can be rescued

0 bu

+30 bu
The worse it looks, the more it responds.

<table>
<thead>
<tr>
<th>Rescue N trial</th>
<th>Year</th>
<th>Stage</th>
<th>Yield response (bu/acre) to N when stress level was:</th>
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<tbody>
<tr>
<td></td>
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<td>2010</td>
<td>VT</td>
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<td>2010</td>
<td>VT</td>
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<td>6</td>
<td>2010</td>
<td>VT</td>
<td>8</td>
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<tr>
<td>Average</td>
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How do I know if it’s yellow?
Look from the air
I started a company to do this

20% commission/discount for consultants

Aerial photo, $2/acre: Any problem?
Yield loss map, $4/acre: How big is my problem?
N rate control file, $4/acre: Solve my problem optimally
March topdress makes a lot more wheat
(Just before jointing)

Columbia 2005, 2006
If you must topdress early, use ESN!

Anytime you topdress urea, use Agrotain!

Columbia 2005, 2006
Nitrogen rate

• Soil contribution varies
  – Year to year
  – Field to field
  – Place to place within a field

• Plant color can measure soil contribution, predict best rate

• Best N rate not predicted by yield, soil tests

• Computer models are the newest idea
Soil organic matter: the nitrogen sponge

Quite stable; release depends on weather, past N rates, tillage, drainage

40%
35%
25% lost

Lb N/acre
organic N  fertilizer N for corn
Soil N supply is spatially variable

Yield with no N: 13 to 145 bu/acre

Yield with unlimited N: 160 to 220 bu/acre

Wide yield variability

Adding N reduces variability
Optimal N rate is variable within a field
Crop color is the most accurate way I’ve found to predict how much N is needed.
Color measurements are more accurate than soil tests or yield data from 64 fields, 7 states.

- **9%** predictive ability for pre-plant soil nitrate.
- **4%** predictive ability for optimal N rate.
- **54%** predictive ability for corn 1 to 2 feet tall.

Optimal N Rate vs. yield at optimal N rate.
Diagnosing N rate from aerial photos

Research: dark corn needs low N rate, light corn needs high N rate

Field is half-fertilized

Eastern Kansas, June 2, 2016, corn is waist high

My company: conflict of interest
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
Sensor Demo Outcomes

- Corn 1 to 7 feet, 55 fields, all N sources
- Increased yield by 2 bushels/acre
- Saved 14 lb N/acre
- Decreased ‘surplus N’ by 25%
  - ‘Surplus N’ is the difference between N applied and N carried away in grain
- Cotton ‘mid-square’, 14 fields, urea or UAN
  - Increased lint yield by 19 lb/acre
  - Saved 6 lb N/acre
Computer simulation models

• Equations built to simulate the world
  – Water distribution/redistribution in soil
  – Nitrogen conversions
  – Crop growth
  – Updated daily on each of the above

• History
  – Powerful for scenario-building
  – Not very accurate
Computer simulation models

- Three introduced commercially in 2014 for N fertilizer management
- Adapt-N (Agronomic Technology)
- Encirca (DuPont Pioneer)
- Nitrogen Advisor (Climate Corp/Monsanto)
How do they compare?

- Performance
- Price
- Situation

Very little information is available
MFA 2016 trial

Adapt-N
Nitrogen Advisor
NVision Ag

Half-fertilized; tell us what to do
MFA 2016 trial, Yield by Program

Yield bu/ac

<table>
<thead>
<tr>
<th>Program</th>
<th>Yield (bu/ac)</th>
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<tbody>
<tr>
<td>Adapt-N</td>
<td>147.6</td>
</tr>
<tr>
<td>Climate</td>
<td>146.8</td>
</tr>
<tr>
<td>N Rich Strip</td>
<td>151.6</td>
</tr>
<tr>
<td>N-Vision</td>
<td>153.1</td>
</tr>
</tbody>
</table>
MFA 2016 trial, N Rate by Program

<table>
<thead>
<tr>
<th>Program</th>
<th>Total N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapt-N</td>
<td>116.5</td>
</tr>
<tr>
<td>Climate</td>
<td>121.4</td>
</tr>
<tr>
<td>N Rich Strip</td>
<td>246.0</td>
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<tr>
<td>N-Vision</td>
<td>123.5</td>
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## Photos, sensors, computer models: price (planned sidedress)

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<th>Product</th>
<th>Price</th>
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<tr>
<td>NVision Ag image + N rate control file</td>
<td>$6/acre</td>
</tr>
<tr>
<td>Ag Leader (OptRx) or Trimble (Greenseeker) sensors</td>
<td>~$15,000 to $20,000</td>
</tr>
<tr>
<td>Adapt-N model</td>
<td>$3/acre</td>
</tr>
<tr>
<td>Encirca model</td>
<td>$10/acre</td>
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<td>Nitrogen Advisor model</td>
<td>$1500/farm</td>
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## Photos, sensors, computer models: price (rescue N)

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<tr>
<td>NVision Ag image</td>
<td>$2/acre (Wet years only)</td>
</tr>
<tr>
<td>NVision Ag yield loss map &amp; summary</td>
<td>$4/acre</td>
</tr>
<tr>
<td>NVision Ag N rate control file</td>
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<td>Nitrogen Advisor model</td>
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## Photos, sensors, computer models: situational ads & disads

### Aerial photos

**Advantages:**
- Fast evaluation
- Simple
- Trust the plant
- Uniform (except UAV)

**Disadvantages:**
- Wait for plane (daily satellite will fix)
- Need high-N reference if half-fertilized
- Best after canopy

### Sensors

**Advantages:**
- Immediate
- Trust the plant
- Cheap if used a lot

**Disadvantages:**
- Learning curve
- Greenseeker ‘drift’
- OptRx interpretation
- Don’t help you decide where to go
- Capital cost upfront
- Need high-N ref

### Models

**Advantages:**
- Multiple times
- Any time (but likely more accurate later)

**Disadvantages:**
- Accuracy unknown
- Early commitment (pay even if unused)
- Data input needed

= important for rescue N
= important for planned sidedress
Thanks!

Questions?

06/08/2006
Is fall N needed?

Average of 8 Missouri experiments, ave 80 & 120 lb N rates
Is fall N needed?

• Sometimes but usually not
• Overall a slight yield advantage
  – Just enough to pay for the trip if wheat price is good
• I recommend fall N:
  – for sandy soils (20-30 lb)
  – when P is needed
  – after exceptional corn yields
Splitting spring N

• Who thought of this, anyway?
• Europeans
  – Cool moist summers
  – Long grainfill period
  – Potential for N loss
Splitting spring N

• In the US?
• East coast (Virginia, Carolinas)
  – Sandy soils
  – Don’t hold N well
  – **Potential for N loss**
  – Don’t provide N well (low organic matter)
  – About a 5 bushel advantage on average
Should I split my spring N?

- Do you have above-average potential for N loss?
- Maybe split on sandy soils, otherwise don’t bother
Should I split my spring N?

Average of 7 Missouri experiments
When should I apply my spring N?

- Answer: March!
- Exception: Thin stand in February
- When the stand is thin, tillering has probably been limited by N availability
- February N will stimulate new tillers
February N will stimulate new tillers

![Graph showing the relationship between N rate in February and tillers. The graph indicates a positive correlation between the N rate and the number of tillers. There are two data points: one at a high N rate showing a high number of tillers at greenup and one at a lower N rate showing a lower number of tillers at jointing.](image-url)
Wheat N timing:
Summary

• Fall N probably not profitable except:
  – On sandy soils
  – After exceptional corn yields
• Split spring N probably not profitable except:
  – On sandy soils
• Avoid January topdress
• If you must topdress in January, use ESN
Wheat N management: Summary

• Topdress in February for poorly-tillered fields
  – Stand looks thin

• Topdress in March if not sandy or thin

• If topdressing urea, USE AGROTAIN!
Locations of sensor demonstration fields 2004-2008

Total: 92
What kind of N applicator can you use sensors with?
Injecting anhydrous ammonia
injecting solution (tractor)
injecting solution (high-clearance)
Spinning on dry N
(easier to get a wide range of rates)