Adaptive N Management
Using *Adapt-N*
Incorporating the Weather Component

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Outline for Today

• Adaptive Management
  – What is it?
  – Why is it important for nitrogen in corn?
  – Why use a model for this?

• Overview of the Adapt-N online tool available to the public for N-management in corn
What is Adaptive Management?

“The process of refining a management strategy in response to evaluating its success”

- local conditions
- testing and measuring
- evaluation
- scientific principles
- experience
Why Adaptive Management?

- Site-specific characteristics (soils, farm, weather...)
- Management history (e.g., grain vs. livestock)
- Environmental Regulations
- Climate Change
- New tools provide a quantitative basis for adaptation.
  - Yield measurements (yield monitors)
  - Soil or tissue measurements
  - Models
  - Optical sensors...
Why Adaptive Nitrogen Management?
The Corn Nitrogen Problem

- ~ $5 billion/yr of N fertilizer applied to corn in U.S.
- Corn N use efficiency very low (30-50%)
- High groundwater nitrate levels
- Hypoxia/anoxia in estuaries not improving
- Greenhouse gases (N$_2$O and CO$_2$)
- High energy consumption (Haber-Bosch process, about 8,000 kcals per lb of urea)

From: Diaz and Rosenberg, 2008
Agricultural soil management, in 2008, accounted for:

- 92% of Agricultural N$_2$O
- Greater global warming potential than all of U.S. Aviation!
- 1.5 x greater global warming potential than Enteric Fermentation

Source: EPA, 2010
Win-Win Opportunities with more Precise Estimation of Corn N Fertilizer Needs

From: Snyder et al., 2009, based on data by Bouwman et al., 2002

**Large losses occur once crop demand is satisfied**

van Es et al., 2002
Variability in Agronomic Optimum N Rates

Maximum and Check Yields, and Agronomic Optimum N Rate (corn after soybean, Ohio)

From: Mullen, LaBarge and Diedrick, 2010, Better Crops, Vol. 94 (3).
Many sources of variation in N availability → generalized recommendations less applicable for corn N needs

Sources of Variability:

• Organic amendments (manure, compost, etc.)
• Crop rotations
• Soil type differences
• Soil organic matter contents (management-induced soil change)
• **Weather** (especially early season rains)

→ N needs CANNOT be predicted accurately at the beginning of the growing season
June Precipitation Variability in NY

2009

2010

Source: NOAA
Crop N uptake patterns .......

![Graph showing corn N uptake patterns over the seasons: Spring, Summer, and Fall.](image-url)
SOM mineralization occurs ahead of corn N uptake……

Critical Time Period – N builds up in soil before corn uptake

Soil or plant N

Spring  Summer  Fall

corn N uptake

… in normal year

Amount of Sidedress N Fertilizer Needed…

soil mineral N, normal year, no manure
Need for supplemental N fertilizer depends on early season weather …

Critical Time Period – N builds up in soil before corn uptake

soil or plant N

Amount of Sidedress N Fertilizer Needed…

… in normal year

… in year with wet spring

soil mineral N, normal year, no manure

soil mineral N, wet spring

Spring Summer Fall

corn N uptake
Manure Scenario: Soil N mineralizes from SOM and Manure

- Soil mineral N, normal year, with manure
- Soil mineral N, wet spring, with manure
- Corn N uptake

N excess ... in normal year
N deficiency ... in year with wet spring

- Soil or plant N

Spring Summer Fall
That is why N needs CANNOT be predicted accurately at the beginning of the growing season!

- Need to sidedress…
- How much?
Adapt-N web-based N management decision tool

1) User-friendly web interface available for on-farm application since 2008 for NE USA

2) Model incorporates weather effects & complex dynamics at individual field-scale

3) N sidedress recommendation and other info

4) Currently no cost!

http://adapt-n.cals.cornell.edu/

High Resolution Climate Data:
- Currently available for Northeast & Iowa
- Expanding to the Midwest
- Enables Field-Scale adaptation
Adapt-N Interface: User Inputs

Soil, Tillage

- User ID / Field ID
- Latitude / Longitude
- Soil textural group
- Approximate field slope
- Drainage
- Soil organic matter content
- Rooting depth
- Tillage information

Organic Inputs

- Manure applications:
  - Two previous years/current year
- Previous sod crop
- 1st year corn after soybean?

Fertilizer, Crop

- Starter fertilizer
  - type/rate/depth/application date
- Additional fertilizer
- Cultivar maturity class
- Planting date
- Expected harvest population
- Expected Yield

Running the Adapt-N model using a smart phone
1. E-mail Jeff Melkonian (jjm11@cornell.edu) for a username and password.

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Log In

Enter name and password, and then click the submit button. For assistance, contact Jeff Melkonian (jjm11@cornell.edu).

Name: [blank] Password: [blank]  

Log In

The Adapt-N tool works well on the Mozilla Firefox browser.
Entering Management Info for a Location
Tabbed interface. For example: Soil/Tillage Tab

Adapt-N A tool for calculating corn sidedress nitrogen rates

Soil Information
Please select a soil texture class (New York) or soil series (Iowa) that best describes the soil in the field.

Nicollet

Please select the estimated rooting depth. > 38 inches

Please select the approximate slope (%) of the field. less than 3%

Was there a soil test? There was a soil test in 2010

If you know the sample depth, please enter it in inches. Otherwise, please enter 6 inches. (inches) 6

soil organic matter: (%) 2

Tillage System Information
Please select the tillage system for this field. no tillage (no till, zone till, strip till, ridge till)

When you've entered all your information, please click the submit button Submit
Sidedress Nitrogen Recommendation: 65 lbs N/Acre

This recommendation is based on an "Expected Yield" entry that is assumed to be the economically optimum yield for your field. As such, it is relatively insensitive to profit within a range of +/- 15 lbs per acre around the recommended rate at current fertilizer and grain prices.

1. Calculation of Sidedress N Rate

Sidedress N rate estimated by AdaptN = CropN\textsubscript{Harvest} \times CropN\textsubscript{Current} \times SoilN\textsubscript{Current} \times SoilN\textsubscript{postsidedress} \times SoybeanN\textsubscript{Credit}

<table>
<thead>
<tr>
<th>Component</th>
<th>Rate (lbs N/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CropN\textsubscript{Harvest}</td>
<td>154</td>
</tr>
<tr>
<td>CropN\textsubscript{Current}</td>
<td>62</td>
</tr>
<tr>
<td>SoilN\textsubscript{Current}</td>
<td>17</td>
</tr>
<tr>
<td>SoilN\textsubscript{postsidedress}</td>
<td>18</td>
</tr>
<tr>
<td>SoybeanN\textsubscript{Credit}</td>
<td>30</td>
</tr>
</tbody>
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Root Zone Crop Available Water

Note that these estimates are for non-irrigated corn production.

Current root zone crop available water: 7 inches
Crop available water at field capacity: 7 inches

- Full Report and Graphs (pdf file)
- Sidedress N Definitions
Adapt-N Results Page

Example 2. Excess N in the system

Adapt-N: A tool for calculating corn sidedress nitrogen rates

Sidedress Nitrogen Recommendation: **No sidedress N recommended at this time**

This recommendation is based on an "Expected Yield" entry that is assumed to be the economically optimum yield for your field. As such, it is relatively insensitive to profit within a range of +/- 15 lbs per acre around the recommended rate at current fertilizer and grain prices.

1. Calculation of Sidedress N Rate

   Sidedress N rate estimated by \( \text{AdaptN} = \text{CropN}_{\text{Harvest}} \cdot \text{CropN}_{\text{Current}} \cdot \text{SoilN}_{\text{Current}} \cdot \text{SoilN}_{\text{postsidedress}} \cdot \text{SoybeanN}_{\text{Credit}} \)

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</tr>
<tr>
<td>( \text{CropN}_{\text{Current}} )</td>
<td>150</td>
</tr>
<tr>
<td>( \text{SoilN}_{\text{Current}} )</td>
<td>23</td>
</tr>
<tr>
<td>( \text{SoilN}_{\text{postsidedress}} )</td>
<td>-18</td>
</tr>
<tr>
<td>( \text{SoybeanN}_{\text{Credit}} )</td>
<td>30</td>
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2. Excess N

Adapt-N has estimated that the seasonal N supplied (all sources) will exceed total crop N demand (\( \text{CropN}_{\text{Harvest}} \)) by at least 10 lbs N/acre.

**Estimated Excess N:** 30 lbs N/acre

Root Zone Crop Available Water

*Note that these estimates are for non-irrigated corn production.*

<table>
<thead>
<tr>
<th>Current root zone crop available water: 5 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop available water at field capacity: 7 inches</td>
</tr>
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</table>

Click on link to download a full report, including graphs. This pdf can be saved electronically or printed.
Adapt-N Results
Sample Full Report (for Example 1.)

All user inputs are listed for easy record keeping.

Results from Results page on interface are provided in pdf.

Graphs are provided in following pages.
Adapt-N Report

Cumulative Nitrogen Losses From the Root Zone

N Losses lbs/acre

01JAN 01APR 01JUL 01OCT 01JAN

Crop Available N in the top 12 inches of the Root Zone

N lbs/acre

01JAN 01APR 01JUL 01OCT 01JAN

Adapt-N Graphs

- Cumulative N Mineralization
- Cumulative N uptake by Crop
- N Losses from Root Zone
- Crop Available N at 0-12"
- Season Daily Rainfall
- Cumulative Rainfall
- Post Planting Days
- Growing Degree Days
- Leaf Number
- Season Average Temperature
Retrospective Evaluation with Adapt-N SE New York 2009

- Rotate from sod 10/20/07
- 10,000 gal/ac manure on 4/18/09
- Starter N as MAP on 5/1/09

--- (blue line = time of sidedress)

Cumulative Rainfall (in)

(May-Sept)

2009 30 in
Normal 21 in

Cumulative N Losses (lb/acre)
Retrospective Evaluation with Adapt-N SE New York 2009

2009 (wet) vs. 2010 (average) with same practices

- Rotate from sod 10/20/07 vs. '08
- 10,000 gal/ac manure on 4/18/09 vs. '10
- Starter N as MAP on 5/1/09 vs. '09
Adapt-N Applications

Adapt-N can be used for a wide range of N management practices for corn:

- Split applications: Sidedress N rate recommendation
- Applications at planting: When are additional in-season N applications necessary?
- Manured fields – Interpretation of a low PSNT: Is additional N necessary, and how much?
- Retrospective evaluation of yields and yield response to N ... and What if...?.
- Learning tool
Conclusion

• N needs can’t be generalized
• N needs can’t be predicted at the beginning of the growing season, because of localized variability
• Adaptive management is based on local data and scientific/practical knowledge
• Adapt-N provides N recommendations and is also a Learning Tool

Questions as you try it out?
Email Bianca Moebius-Clune bnm5@cornell.edu

http://adapt-n.cals.cornell.edu/
Thank You!
Questions?