Adapt-N Training Manual

A tool for precision N management in corn

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Cornell University
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Department of Crop and Soil Sciences
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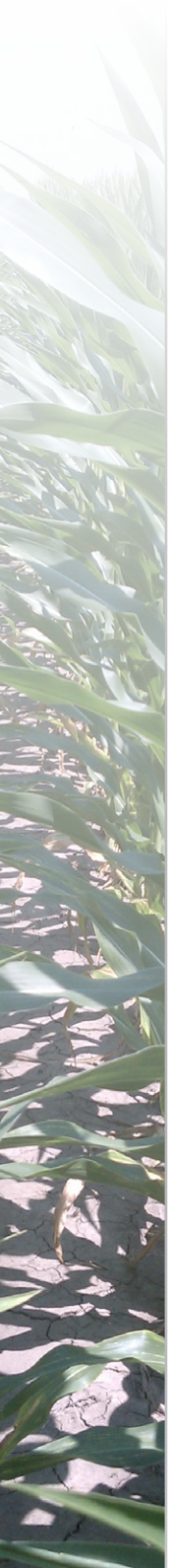

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Department of Earth and Atmospheric Sciences, Cornell University: Arthur T. DeGaetano and Laura Joseph

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Table of Contents

Adapt-N Basics and How to Use this Manual

Adapt-N is an online tool that helps precisely manage nitrogen (N) inputs for grain, silage, and sweet corn production. It can provide automatic daily updates of each field's N status and recommendations, based on real-time weather influences, and can be used with any device with internet access.

The tool uses a well-calibrated computer model, high resolution precipitation and temperature data, and soil, crop and management information to generate N recommendations for each management unit.

Contact the Adapt-N Team (adapt-n@cornell.edu) with your occupation and home state to register, and get your own Adapt-N account.

The economic optimum N rate that a corn crop needs is heavily influenced by weather, especially by early-season rainfall. The Adapt-N tool will help

- Determine corn N needs more precisely based on field-specific conditions
- Adjust in-season site-specific N applications based on weather events
- Reduce fertilizer rates, costs and losses in the long-term, while maintaining yield
- Alert you if additional or rescue N is needed to maintain yield after heavy spring rains
- Fine-tune sidedress N rates by field, or for variable rate application and save money
- Determine if manured fields need additional fertilizer N
- Assess whether excess N remains after the growing season
- Understand and evaluate alternative N management options by running "What if I had…?" scenarios using past years' weather data
- All while avoiding losses of N to the environment

This manual is intended as an introduction to help you get started using Adapt-N. You can either read it front to back, or pick the chapters with the information of highest priority to you.

We recommend reading Chapters 1 and 2 especially if you have not attended Adapt-N training events, as these introduce Adapt-N in greater detail. Here we explain the concept, importance, and benefits of managing N based

on weather and a simulation model. We describe the Adapt-N tool's infrastructure, and provide an overview of how the tool calculates a field-specific nitrogen rate. In Chapter 3 you find a step-by-step description of how to use the 2013 Adapt-N Interface. While the interface will change over time, basic concepts and needed inputs described here will still apply. Adapt-N troubleshooting tips and answers to some commonly asked questions are provided in Chapter 4.

Chapters 5 and 6 present data from two years (2011-2012) of beta-testing Adapt-N in New York and Iowa on-farm trials. In 84 trials conducted in average to dry seasons, Adapt-N helped growers decrease N inputs by over 50lb/acre, saving over $25/acre, on average.

With 2013's early wet months, many active users were alerted to major rain-induced N loss and were able to maintain yield and profit through precision N sidedress and rescue N applications. Some growers experienced more than $125/acre in added profit due to Adapt-N's recommendations. Field reports also directed us towards better soil drainage characterization for the 2014 version of Adapt-N.

A listing of further Resources and Publications is provided for those interested in more in-depth information, recorded webinars, or other training materials not provided in this edition of the manual. As further data, tool upgrades, and educational materials become available, they will be made accessible via our website at http://adapt-n.cals.cornell.edu/ and in future editions of this manual.

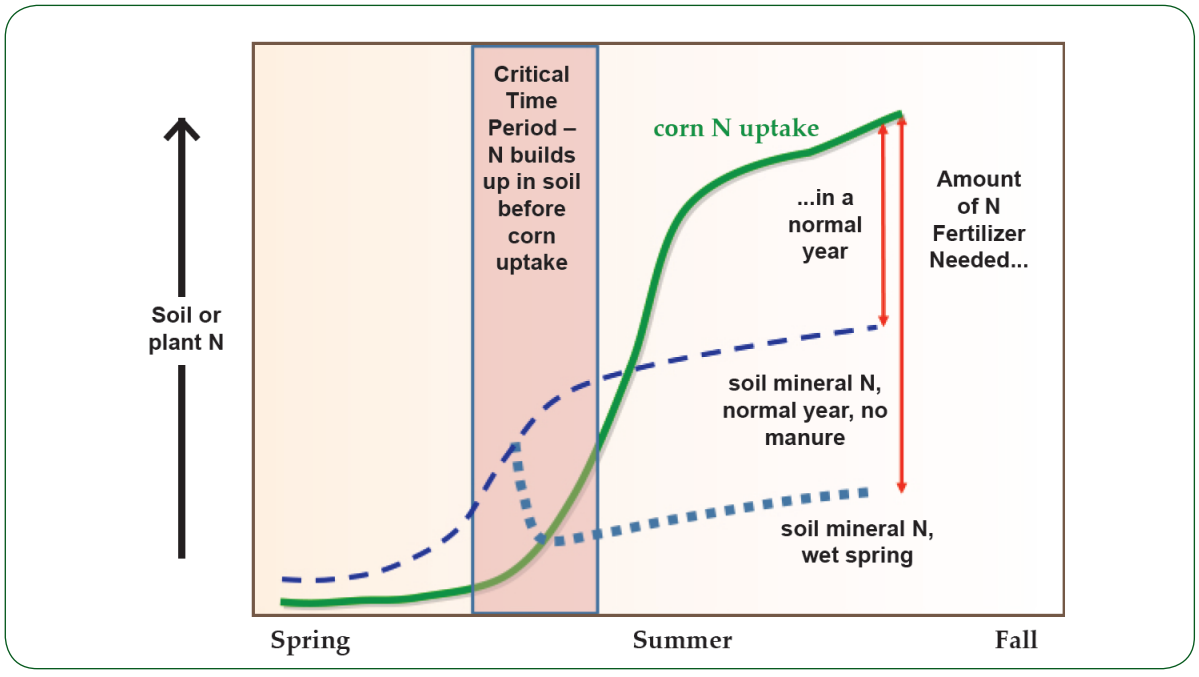
1. What is Adapt-N?

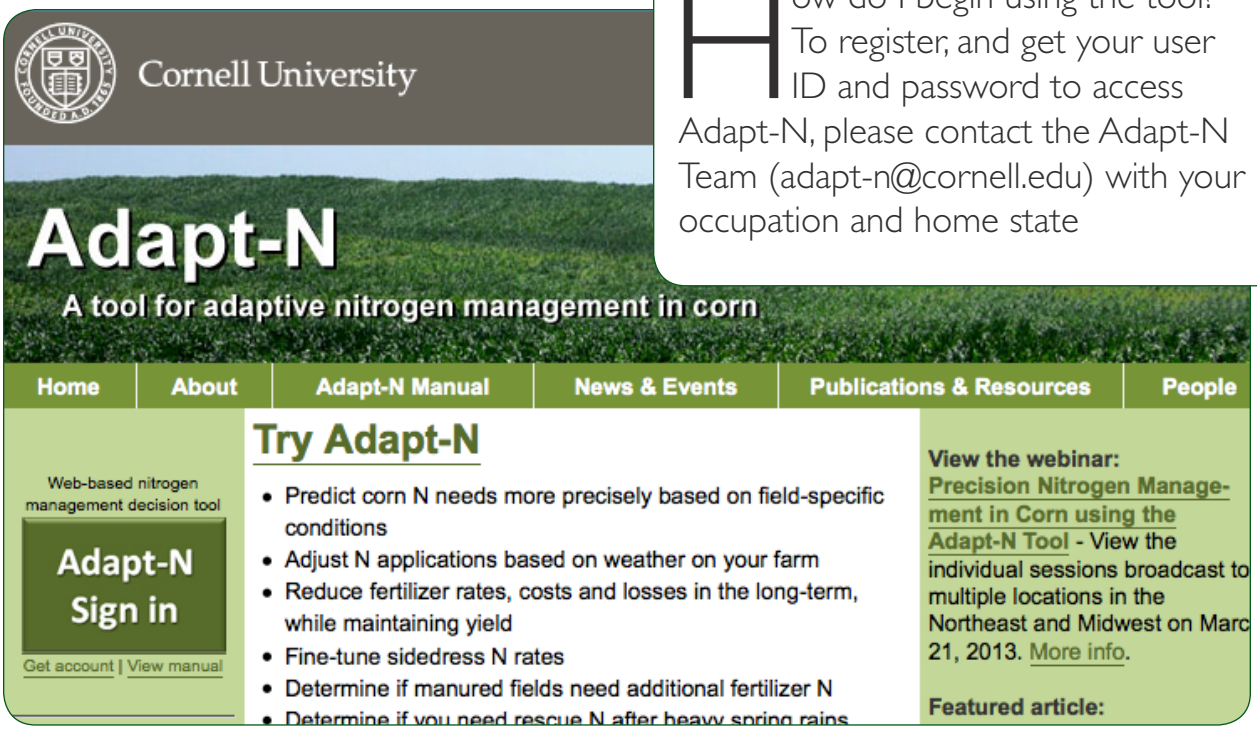
Introduction to Adapt-N

Nitrogen management is of key importance in corn production systems because of the high cost of N fertilization and public concerns over N pollution of the environment. Recent studies have shown that differences in early season weather conditions from year to year are a main source of the well-documented variability in economic optimum corn N rates.

In some years corn is clearly nitrogen deficient, and in others the same amount of fertilizer is adequate. This happens because nitrogen availability is extremely dynamic: In a fairly dry spring nitrogen mineralizes from organic sources in the soil, and remains in the root zone where the crop can take it up. However, in a wet spring (see the light blue dotted line in the graph below) nitrogen can be leached out of the crop's reach, because nitrates dissolve easily in soil water, and N can be lost to the atmosphere by denitrification. In warm weather nitrogen mineralizes faster from the organic matter in the soil to become available to the crop, while in colder weather mineralization is slower, and so less is available. This makes it hard to know how much nitrogen input is actually needed in any given year. Therefore, many growers pay for "insurance fertilizer" to avoid expensive yield losses. This risk management strategy in the face of uncertainty means that N is often inefficiently used in corn production. This reduces farm profits and causes potentially high environmental losses to both surface and ground water (nitrate leaching) and to the atmosphere (ammonia volatilization and denitrification).

The Adapt-N Tool is a new approach for managing N for corn based on site-specific conditions. The web-based decision support tool (url: http://adapt-n.cals.cornell.edu) provides field-specific, locally-adjusted sidedress N recommendations for corn production that incorporates the effects of local early-season weather, as well as basic soil, management and crop information to generate N recommendations. By basing recommendations on local conditions, the tool improves the accuracy and precision of N recommendations, thus improving farm profits, while reducing environmental N losses.





How do I begin using the tool? To register, and get your user ID and password to access Adapt-N, please contact the Adapt-N Team (adapt-n@cornell.edu) with your occupation and home state

Benefits of Using Adapt-N

Economic and Logistical Benefits

More accurately estimating N needs allows less money to be spent on fertilizer in average and dry years (about 3 out of 4 years) by adjusting sidedress fertilizer rates downward based on weather conditions in the spring, without losing yield. In wet years the value of the tool comes from predicting which fields may need greater N inputs at sidedress time to maintain yield. The tool provides instantaneous recommendations, and there is no need for in-season soil sampling or waiting for test results.

Environmental Benefits

1. *Less nitrate leaching*, because only the needed N is applied: Groundwater nitrate levels increase very little until corn N demand is satisfied. Residual soil nitrate levels, and therefore nitrate leaching, increase when more fertilizer is applied than is needed by the crop.

2. *Less denitrification*, which creates nitrous oxide (N2O), a potent greenhouse gas, because N needed later by the plant is applied at sidedress time. Adapt-N promotes precise N application when the crop needs it, thereby reducing early season denitrification, particularly on poorly drained soils during wet springs. Remember: N lost to the environment is N paid for that the crop cannot use.

2. How Adapt-N Determines a Recommendation

Sources of Nitrogen

Nitrogen comes to the crop from several sources:

1. Mineralized soil organic matter
2. Other organic sources like manure, and rotation or cover crops, especially legumes
3. A small amount from atmospheric deposition (minor contribution)
4. Applied fertilizer.

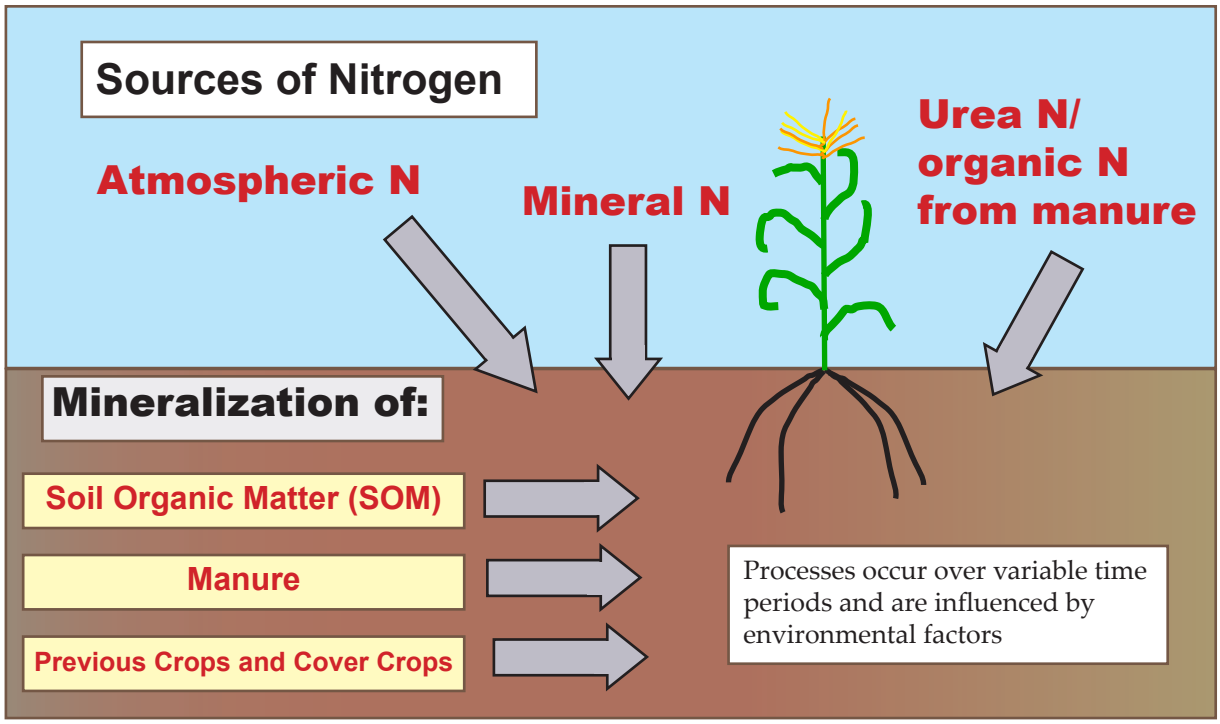
How much N the crop gets from sources 1 and 2 depends on several factors. For example, how much manure was applied, how much N was in each of its components and was it incorporated? Was there a sod, when was it plowed under or was it surface killed? What percentage of it was a legume? How much organic matter is in the soil?

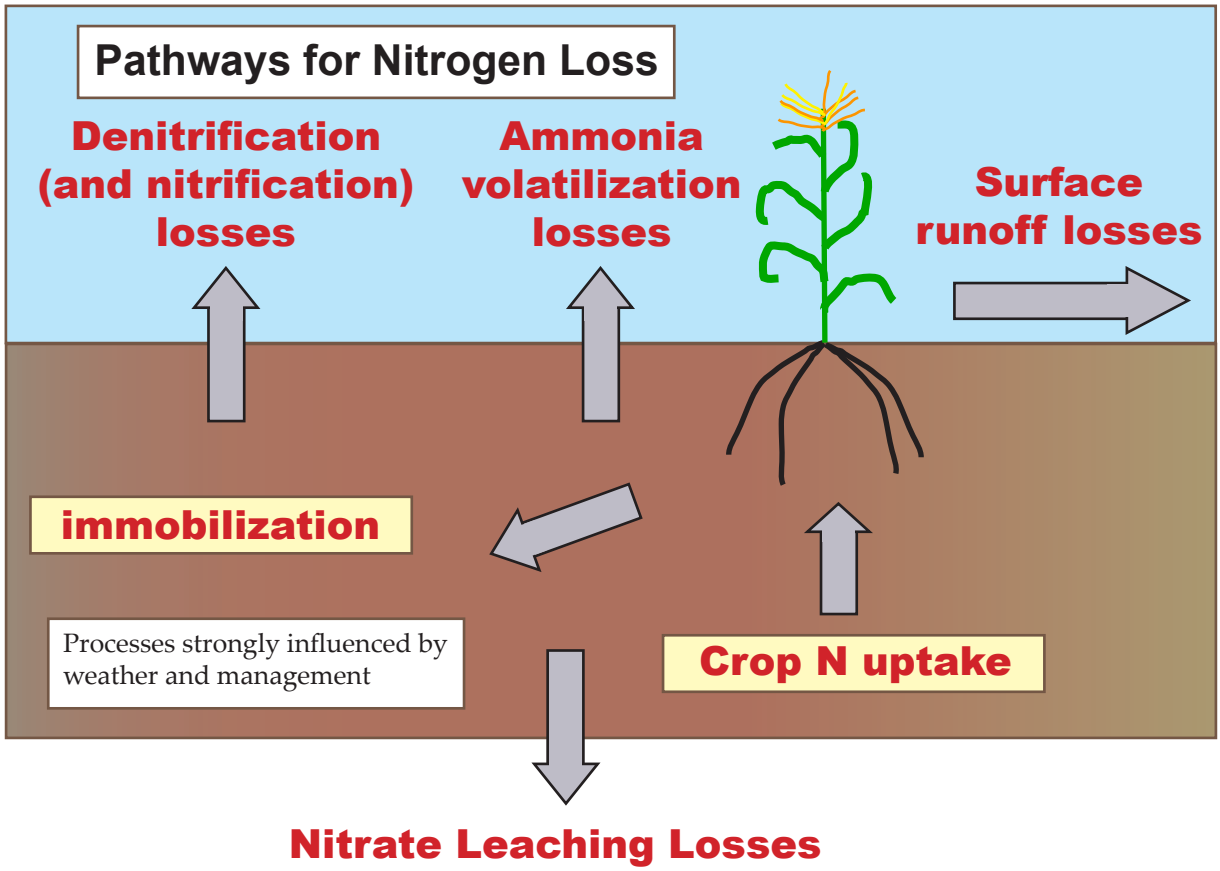
And then there's the important weather question! How warm and how wet has it been? Warmer weather will allow for more N to be mineralized than colder weather. But not all mineralized or added N will be available, because high rainfall may cause large losses during the 'Critical Time Period' (see graph on page 10). It depends on how much and when it occurs.

What info does Adapt-N use?

- **Latitude, longitude,** and **region** for the field location. This can be found by using the map tool in the interface.
- **Preplant, starter, and additional/sidedress N fertilizer.** Type, date of application, depth and rate of each application. Up to 6 applications can be entered for the current growing season. (Enhanced efficiency fertilizer additives will be included in a future version of the tool.)
- **Cultivar.** Silage, grain, or sweet corn, maturity class, planting date, expected harvest population, and expected yield in the field that year.
- **Soils.** Soil textural class or soil series, rooting depth (defaults available), approximate field slope. Organic matter content from recent soil test is highly recommended.
- **Tillage.** Fall plowing, spring plowing (date and depth), or conservation tillage (percent of residue remaining on surface: 25, 50, 75, or 100%).
- **Manure Applications**. For current season (and past 2 growing seasons depending on region), date, rate (in gallons/ acre or tons/acre), N content (in lbs ammonium-N and organic-N contents per 1000 gals or per ton), and method of application (surface applied or incorporated immediately, within 1, 2, or 5 days).
- **Sod in the rotation in the last 3 years.** Percent legume in the sod, method and timing of sod management (surface kill or incorporation).

Previous Crop. Corn grain, corn silage, soybean, or sod. Cover crops and additional previous crops will be included in a future version of the tool.)


Sources of Nitrogen
Atmospheric N
Mineral N
Urea N/
organic N
from manure
Mineralization of:
Soil Organic Matter (SOM)
Manure
Previous Crops and Cover Crops
Processes occur over variable time periods and are influenced by environmental factors


Pathways for Nitrogen Loss
Denitrification
(and nitrification)
losses
Ammonia
volatilization
losses
Surface
runoff losses
immobilization
Processes strongly influenced by weather and management
Crop N uptake
Nitrate Leaching Losses

Nitrogen Losses

You might call a corn field a "very leaky system" with respect to N. Corn will not be able to take up all the N that becomes available (from fertilizer or the other sources), because N can be lost by:

1. Nitrate leaching below the root zone
2. Surface runoff losses
3. Volatilization of ammonia
4. Denitrification to the atmosphere, primarily in the forms of N2 or N2O.

These losses are of environmental concern as they contribute to groundwater contamination, hypoxia in estuaries, and global warming. But how much is lost? That depends on the weather, soil type and management practices. N losses from leaching and denitrification can be especially large in a wet, warm spring (see page 2). In some cases these losses need to be compensated for through a higher sidedress N rate, while in other cases when losses are low and/or N mineralization is high, you may need little or no sidedress fertilizer.

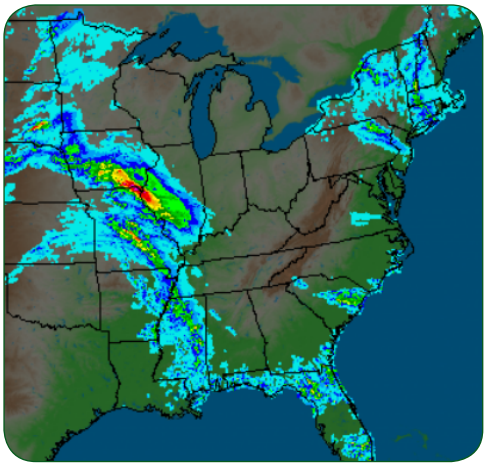
Nitrogen Needs Differ Every Year

Management may not change much, but the weather is different every year. Rainfall may even be different between fields that are a few miles down the road from each other, because it can be very spotty during the growing season. A warm, dry spring may provide so much soil N that you only need to sidedress half as much as in another year when losses are greater. On the other hand, one 2-inch rain storm might mean you lose 50 lb of N per acre, and so you may need to apply that much more at sidedress time. To be precise, many calculations of a complex system with many interacting factors need to be made. That's what the Adapt-N tool was designed to do. Adapt-N uses daily high-resolution climate data (on a 3 mile grid) and your expected economic yield, to calculate a sidedress N recommendation for your field. The recommended N rate becomes more accurate as the season progresses, because more of the season's weather is then accounted for.

Adapt-N Infrastructure

Adapt-N uses dynamic simulations of soil and crop processes. These feed into a mass balance equation that calculates the optimum N rate for a location based on field-specific early season weather that actually occurred, as well as post-sidedress estimates. The latter are based on probabilities calculated from long-term climate data. Adapt-N also provides a confidence range for recommended N rates, and incorporates economic considerations (crop-fertilizer price ratio and risk). It offers extensive additional diagnostic information on simulation results (N mineralized, leached and denitrified; soil N levels, etc.) and enables you to test alternative management scenarios as well. A feature allows for automatic daily updates of simulation results via email or text message, and provides opportunities for more precise variable rate nitrogen application.

Users of Adapt-N provide inputs via the web-interface from any internet enabled device (location, soils, crop, management, see Chapter 4 on how to use Adapt-N). These inputs are sent via the web to access the PNM model, which queries a database of high resolution weather data using the coordinates you entered. The weather data from the Northeast Regional Climate Center (NRCC) and your field management inputs are then used by the PNM model to dynamically simulate corn growth and N uptake, as well as soil processes affected by rainfall and temperature. The model calculates a field-specific sidedress N recommendation (see page 17, and also provides graphs that help you understand the fate of N during the simulated season.

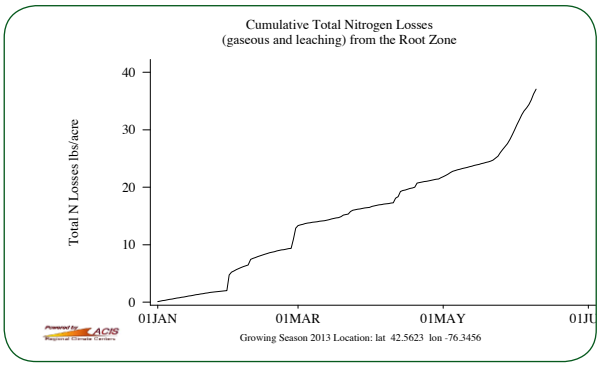


High Resolution Climate Data (5x5km grid)

Computer Model

simulates soil and crop processes on server using location-specific weather

Internet-connected devices



Adapt-N provides a N sidedress recommendation and a full pdf report with additional simulation results

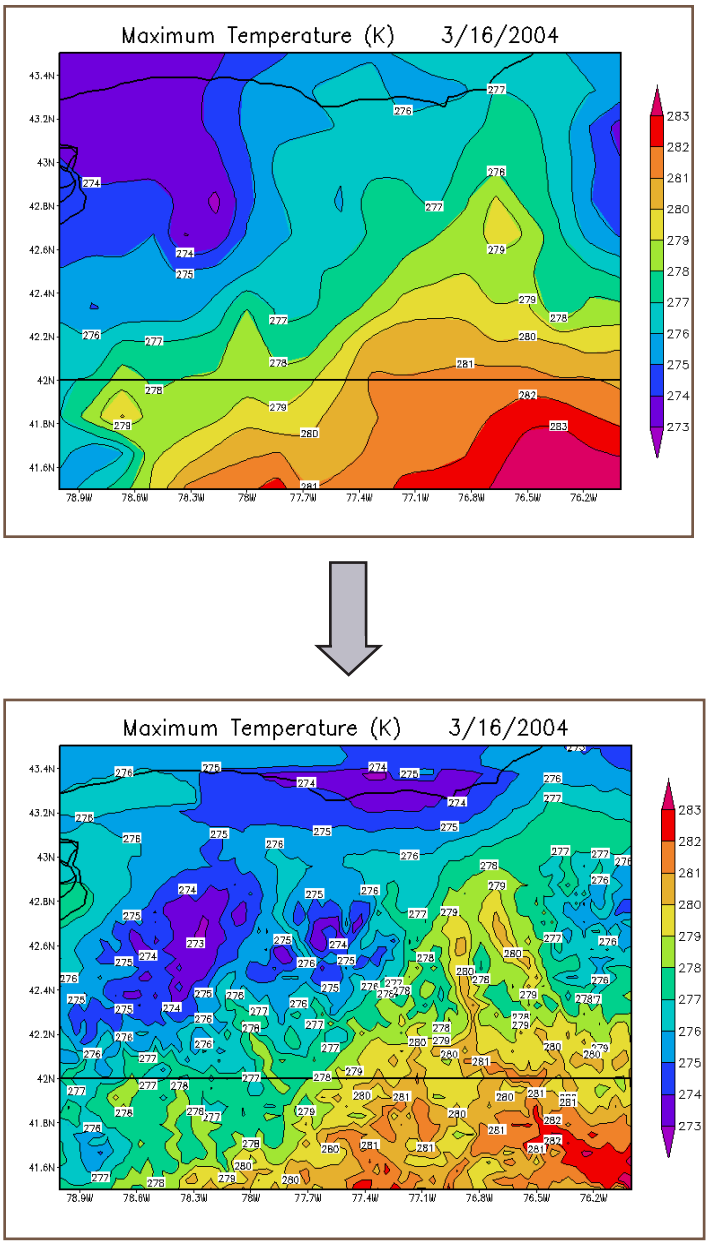
More about the Model & High Resolution Climate Data

The PMN (Precision Nitrogen Management) model that is at the core of Adapt-N (Melkonian et al, 2005) was developed from two re-coded and integrated models: a corn N uptake, growth and yield model (Sinclair and Muchow, 1995), and the LEACHN model which simulates soil, water, and N processes (Hutson, 2003). The crop model uses temperature, rainfall, and solar radiation data to simulate:

- Growth, development and yield of the crop
- Concurrent uptake of N and water

The soil model (LEACHN) uses information on soil properties and weather to simulate:

- Redistribution of water and N in the rootzone as affected by each rain event and soil characteristics ("tipping bucket" approach)
- Water storage in the rootzone
- Water drainage and evaporation out of the rootzone
- Biological and chemical N transformations in the rootzone
- N losses from the rootzone (leaching, ammonia volatilization, and denitrification)



High Resolution Weather Data.

Temperature data prior to adjustment (above). Temperature data after correcting for elevation on a 5x5 km grid (below). Temperature and precipitation data are further adjusted based on local weather station data. (Images from DeGaetano and Wilks, 2009).

Both models simulate these processes on a daily time step. The models have been extensively tested and validated in field trials. On-farm beta-testing of the Adapt-N tool has been ongoing in New York and Iowa in 2011-2012 (see page 63 for trial results), and more recently also in other Midwestern and Northeastern states (results will be available on our website, and in future versions of this manual).

Soils information used in Adapt-N is derived from NRCS SSURGO datasets. The model was developed through a collaborative effort among the Department of Crop and Soil Sciences, Department of Earth and Atmospheric Sciences, Northeast Regional Climate Center, and Center for Advanced Computing, with primary funding from a USDA Special Grant on Computational Agriculture.

The High Resolution Climate Data consist of daily maximum and minimum temperature and precipitation on a 4x4 km grid, and are a critically important feature of the Adapt-N tool. These data allow for field-specific and timely daily adjustments of N recommendations. The weather database is derived from routines using National Oceanic & Atmospheric Administration's (NOAA) Rapid Update Cycle weather model (temperature) and operational Doppler radars (precipitation). For both, observed weather station data are used to correct NOAA estimates and to generate spatially interpreted grids (DeGaetano and Wilks, 2009; Wilks, 2008). Adapt- N uses the most recent data, currently with a 1 day lag.

Calculation of Sidedress N Rate

The basic equation underlying the Adapt-N calculation of a sidedress N recommendation is as follows:

$$\mathbf{SidedressNrate = CropN_{Harvest} - CropN_{Current} - SoilN_{Current} - SoilN_{Postsidedress} - SoybeanN_{Credit} + Loss_{postapplication} - Correct_{profit}}$$

$CropN_{Harvest}$ is the amount of N estimated to be in the corn crop at harvest time. This is calculated from the "Expected Yield" input, and estimates of N contents of grain, stover and roots.

$CropN_{Current}$ is the amount of N in the crop on the day you run the model (or the season end date if you are running a retrospective analysis). This is determined by the model's corn growth and N uptake routines, using the high resolution weather data for a specific field location.

$SoilN_{Current}$ is the current amount of mineral N available to the crop from the soil. This is determined by the model based on input information on soil type, rooting depth, slope, organic matter content, tillage system, previous organic and inorganic N applications, rotations, and corn variety, maturity class, and population, where mineralization and losses are affected by the weather to date.

$SoilN_{Postsidedress}$ is the net mineral N that is estimated to become available (mineralized N – losses of N) from the soil between the day you run the model and crop harvest. This incorporates future weather effects that cannot be predicted at sidedress time, but can be estimated through long-term probabilities. The post-sidedress N contribution is based on a 35 year average of simulated weather effects on N-availability in the post-sidedress-to-harvest time period, for the texture, organic matter content, and management practices of the field.

$SoybeanN_{Credit}$ is the partial credit given to the additional N availability from a previous soybean crop. This is supplemental to the simulated effects of N immobilization from incorporation of previous-crop residues.

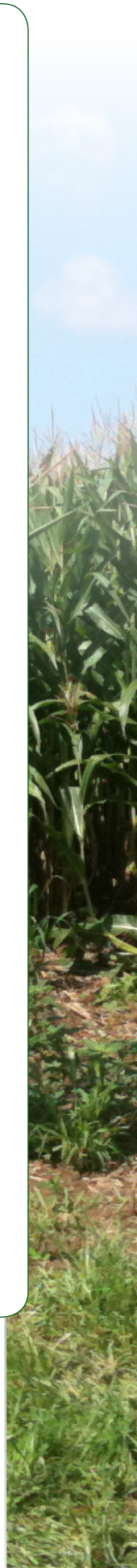
$Loss_{postapplication}$ is the estimated N loss (leaching, gaseous N losses) from the recommended sidedress N application itself. These losses were estimated by PNM model simulations over 35 climate years for locations in the Northeast and Midwest using different times/rates of N applications. Post-sidedress losses from other N sources, e.g. manure applications, pre-plant N applications, N mineralized from soil organic matter, are also accounted for in SoilNpostsidedress.

$Correct_{profit}$ is a correction factor to optimize profits to N application. It integrates the combined effects of the fertilizer-to-grain price ratio and the risk (which equals probability * cost) associated with Adapt-N predictions. The price ratio correction accounts for the cost of fertilizer relative to the returns from additional yield with higher N inputs. This results in lower recommended N rates with more expensive fertilizer or lower corn grain prices. The risk correction accounts for the fact that a nonlinear yield response to N inputs entails a greater profit penalty for under-prediction than over-prediction of the optimum N rate, and therefore the need for an upward adjustment of the recommended economic optimum N rate. Correctprofit is based on a price ratio of 0.1 for grain corn and silage, and 0.01 for sweet corn, and an uncertainty standard deviation of the N recommendations of 20 lbs N/ac for most scenarios.

The Sidedress N Rate is therefore the difference between net N availability (a function of N inputs, weather-affected mineral N gains and losses, and management) and the final expected N content of the crop. This difference can be made up by sidedressing the recommended rate to achieve full yield with limited environmental or profit losses.

In a Nutshell: How to Make Best Use of Adapt-N

- Plan to apply the majority of N fertilizer at sidedress time
- Use Adapt-N for a N recommendation at or after V6 (ideally V6-V12; Adapt-N is not designed to provide starter/preplant N rates, as weather impacts are not yet known at that time)
- Make sure your model inputs are accurate and representative of the management unit for which you are calculating a recommendation (see more on this in the section on Prioritizing Inputs, p 43)
- Take penetrometer measurements to account for compaction and rootzone limitations
- Consider weather influences that may impact rooting depth (e.g., very high rainfall tends to reduce rooting depth)
- Base expected yields on farm data for past years (we recommend the fourth highest yield from the last five years)
- Re-evaluate your crop's expected yield and population density before sidedress based on that season's conditions to date
- Use Adapt-N for variable rates based on changes across a field in texture, organic matter, and expected yield
- Enter sidedress applications into Adapt-N once completed to monitor mid and late-season N status
- Run end-of season evaluations to understand field N dynamics, and assess whether N management practices can be improved



3. How to Use the Adapt-N Interface

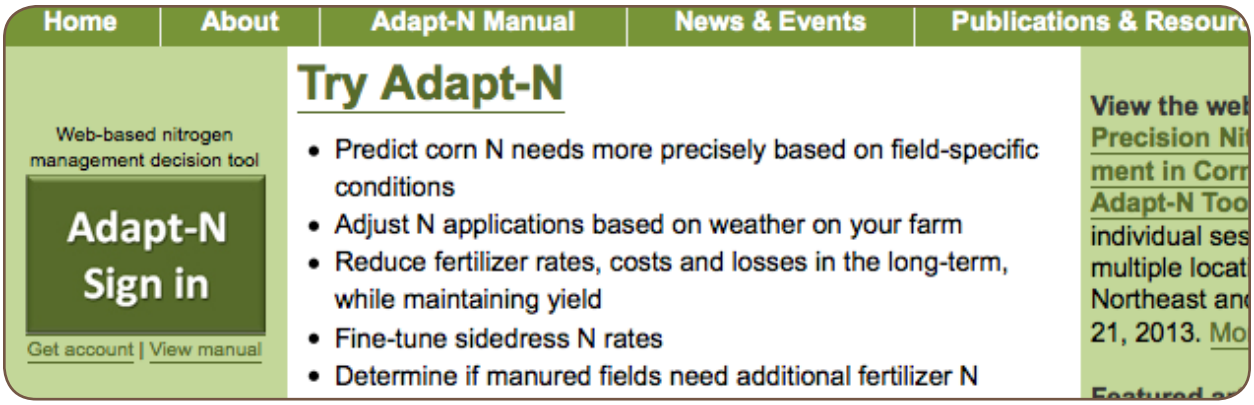
The goal of this chapter is to describe step-by-step how to use the Adapt-N interface to:

1. Set up new locations
2. Select locations
3. Enter management information
4. Run a simulation to generate a N recommendation
5. Interpret the output
6. Set up alerts and view updated recommendations
7. Modify locations
8. Use batch upload to enter location information
9. Assess what input information is most important

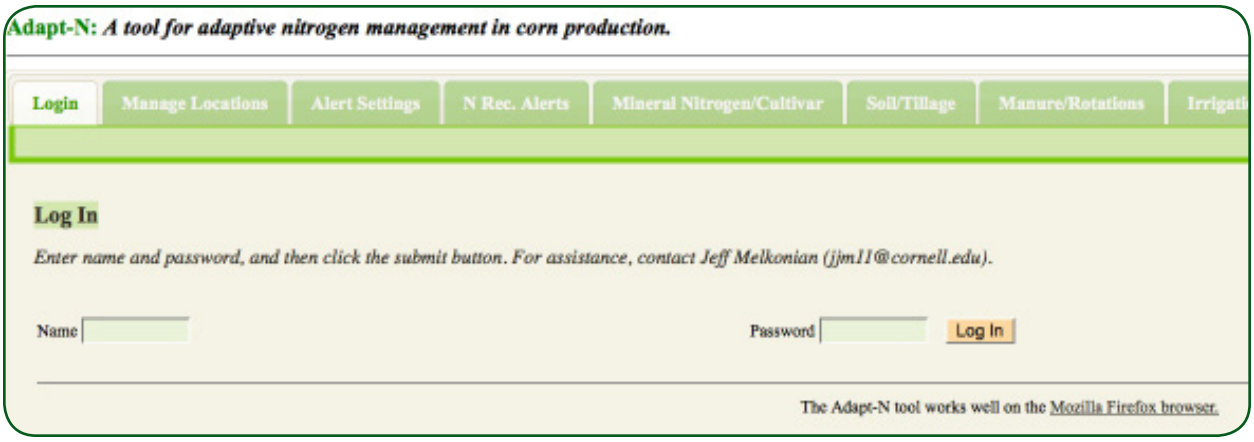
Interface Overview

The interface is tabbed. Some tabs are available for managing information for the whole account: **Login, Manage Locations, Alert Settings**, and **N Rec. Alerts**. The remaining tabs allow the user to manage information individually by location: **Mineral Nitrogen/Cultivar, Soil/Tillage, Manure/Rotation,** and **Irrigation**. The **Add Application** tab becomes active as needed. The **Results** tab becomes active when a location simulation has just been run.

After logging in via the login screen, the user will be directed to the **Manage Locations** tab. From there, users can navigate the interface and/or use the batch upload feature.



1. E-mail the Adapt-N team (adapt-n@cornell.edu) for a username and password.
2. Click the Sign in button from the main website (adapt-n.cals.cornell.edu)



3. Enter username and password and click Log In button

GENERAL NOTE: The tab in use is highlighted in white when in use. Click on the active dark green tabs to navigate the interface. Location information appears at the base of the window for management info tabs.

Using the Manage Locations Tab

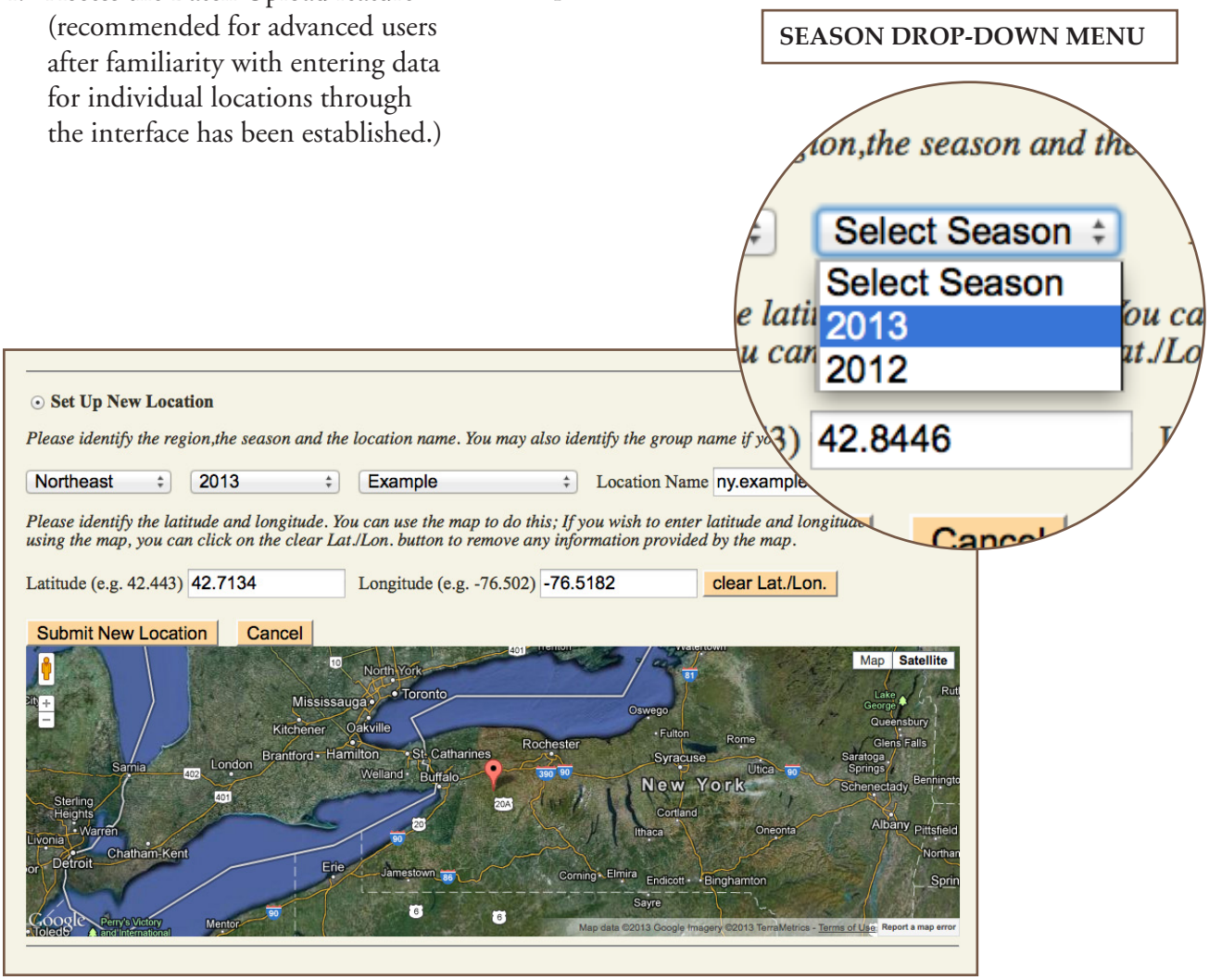
A 'location' in Adapt-N can either represent a field, or a subunit within a field, for which the user wants to receive a N recommendation. Subunits (management units) within fields can be defined for variable rate N application. The **Manage Locations** tab can be used to:

1. Set up new locations
2. Select a location to a) enter management and soil data, b) change management and soil data, and c) run a simulation
3. Modify (edit, copy, or delete) existing locations
4. Access the Batch Upload feature (recommended for advanced users after familiarity with entering data for individual locations through the interface has been established.)

1. Setting Up New Locations

New locations can be set up by clicking on **Set Up New Location** and providing the needed information, or via the batch upload feature (see page 41). After providing **Region, Season**, and a **Location Name**, the user can provide coordinates by navigating to the desired location by using the map feature (coordinates will fill in automatically), or by typing in latitude and longitude information.

1. In the **Manage Locations** tab, click on 'Set Up New Location'
2. Select ***Region, Season***, Group (optional) and assign a unique location name
3. Enter the latitude and longitude of your location to the 4th decimal place (.0001) **OR** find your field using the map

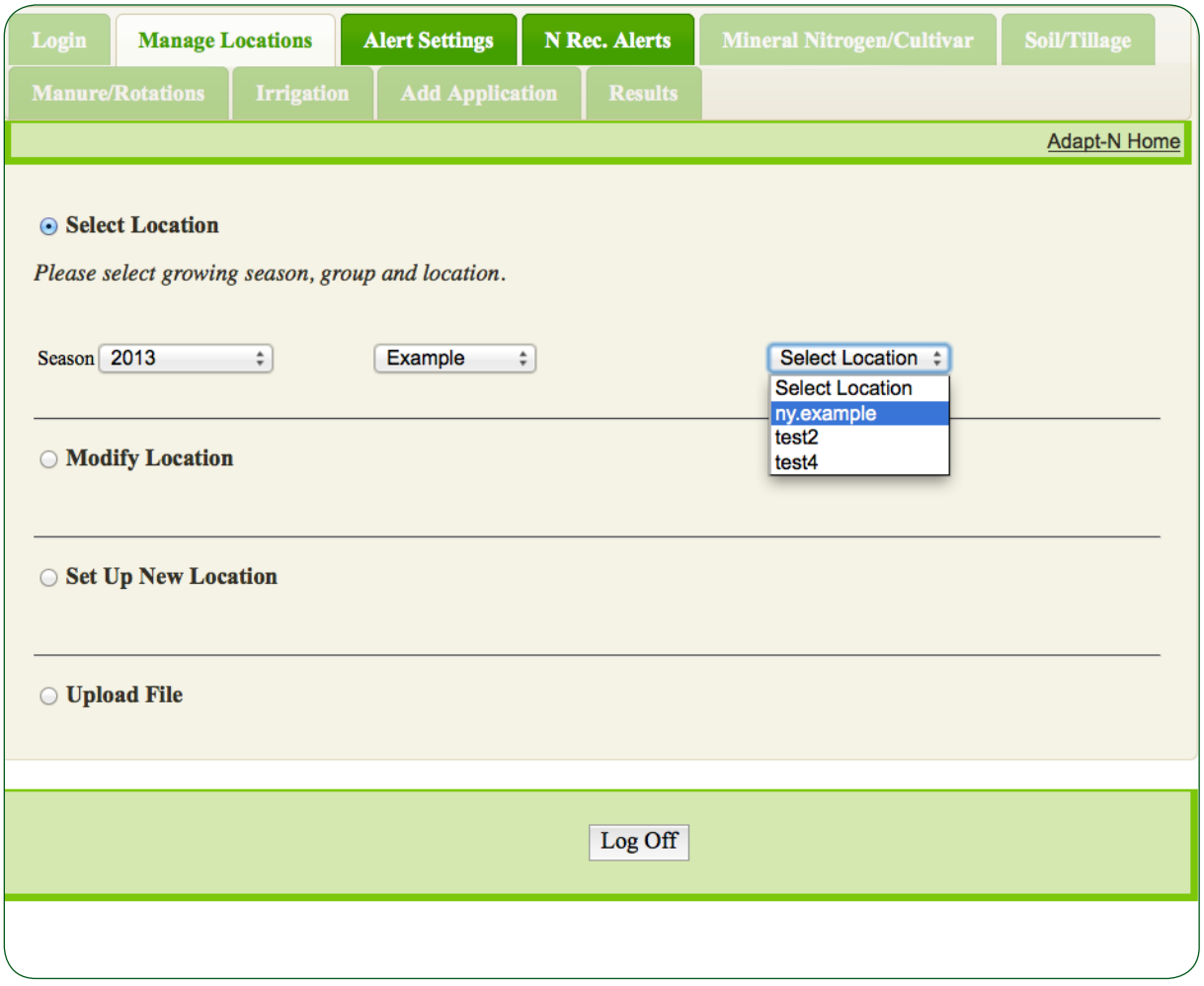


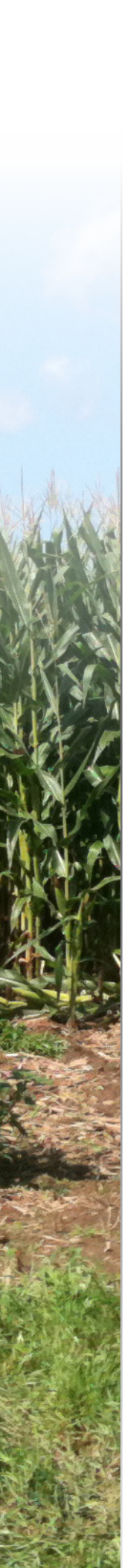
2. Selecting Locations

To select a location to input information, click on the **Select Location** tab. Use the drop down menus to select the **Season, Group** (default: "ungrouped"), and **Location** name.

All inputs for that location are loaded once selected. A tabbed menu for each location allows you to enter the appropriate management information in each category. Information can be provided or edited in the **Mineral Nitrogen/Cultivar, Soil/Tillage, Manure/Rotations,** and **Irrigation** tabs.

1. In the **Manage Locations** tab, click on 'Select Location'
2. Select 'Season' year from the drop-down menu.
3. Select the location 'Group' or 'Ungrouped'
4. Select location from drop-down menu.





3. Entering Management Information

Entering Management Information - Mineral Nitrogen/Cultivar Tab

The **Mineral Nitrogen/Cultivar** tab can be used to enter fertilizer information and cultivar information. In the Mineral Nitrogen/Cultivar tab you can enter:

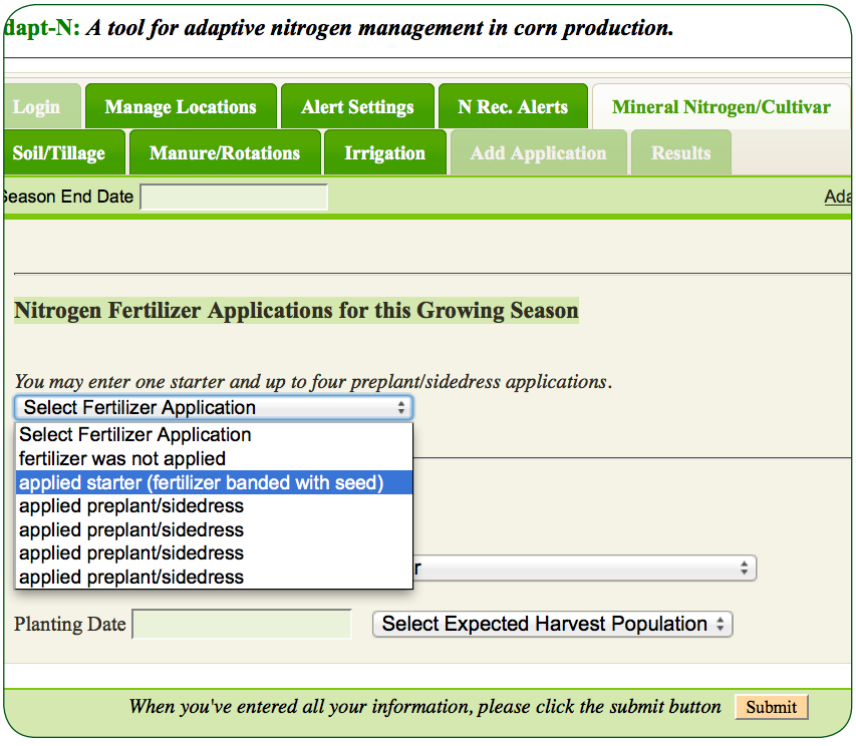
- ***Starter, preplant, and sidedress fertilizer applications***. There are 11 fertilizer type options and various depth of application options ranging from surface applied to 10 inches.
- ***Field corn cultivar***. Depending on region, the options include corn cultivars of varying day corn relative maturity (CRM) ranging from 95 d crm to 116 d crm OR corn cultivar options for field corn ranging from early maturity (70-90 d crm) to medium/late maturity (100-120 d crm).
- ***Silage corn cultivar*** (available for the Northeast and Wisconsin regions). Silage cultivars options range from early maturity (80-85 d crm) to late maturity (111-115 d crm), and the option to select "Shorter growing season region" or "Longer growing season region."
- ***Sweet corn cultivar*** (available for the Northeast and Wisconsin regions). Sweet corn cultivar options range from 70-75 days to 96-100 days to harvest.
- ***Planting date.*** Use the drop-down calendar to select the planting date.
- ***Expected harvest population***. Options range from 15,000 plants/acre to 40,000 plants/acre.

Fertilizer Applications

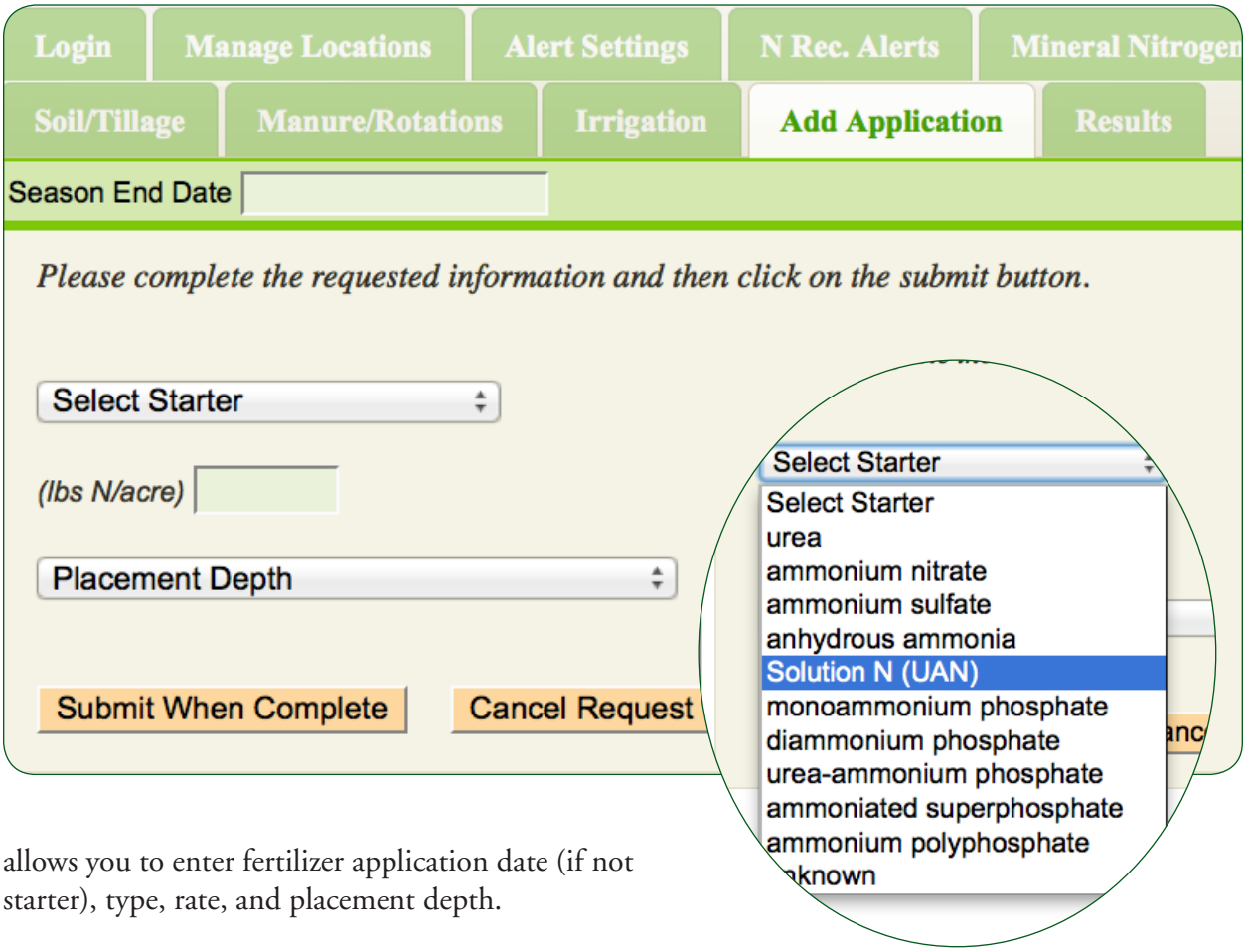
1. In the Mineral Nitrogen/Cultivar tab, select *applied starter, applied preplant/sidedress,* for each N application the location received, or *fertilizer was not applied.*

GENERAL NOTE: The tab in use (here: the Mineral Nitrogen/Cultivar tab) is highlighted in white when in use.

GENERAL NOTE: Click on the active dark green tabs to navigate the interface.

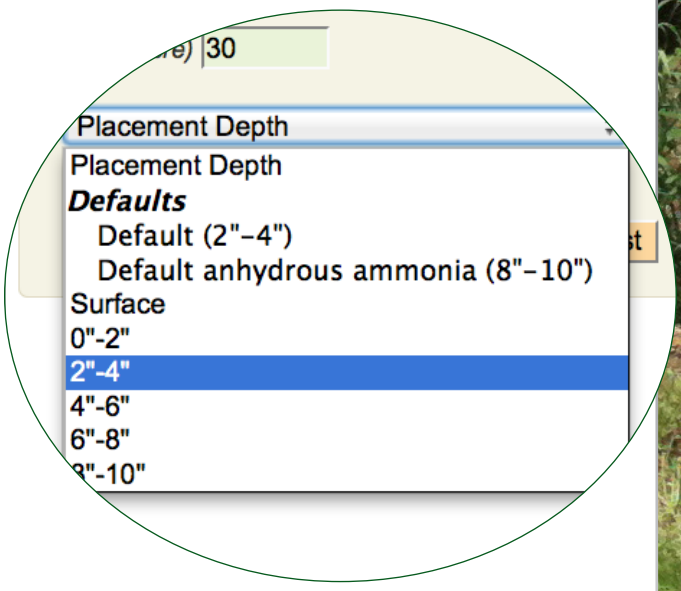


The **Add Application** tab is opened after selecting a fertilizer application. The **Add Application** tab



allows you to enter fertilizer application date (if not starter), type, rate, and placement depth.

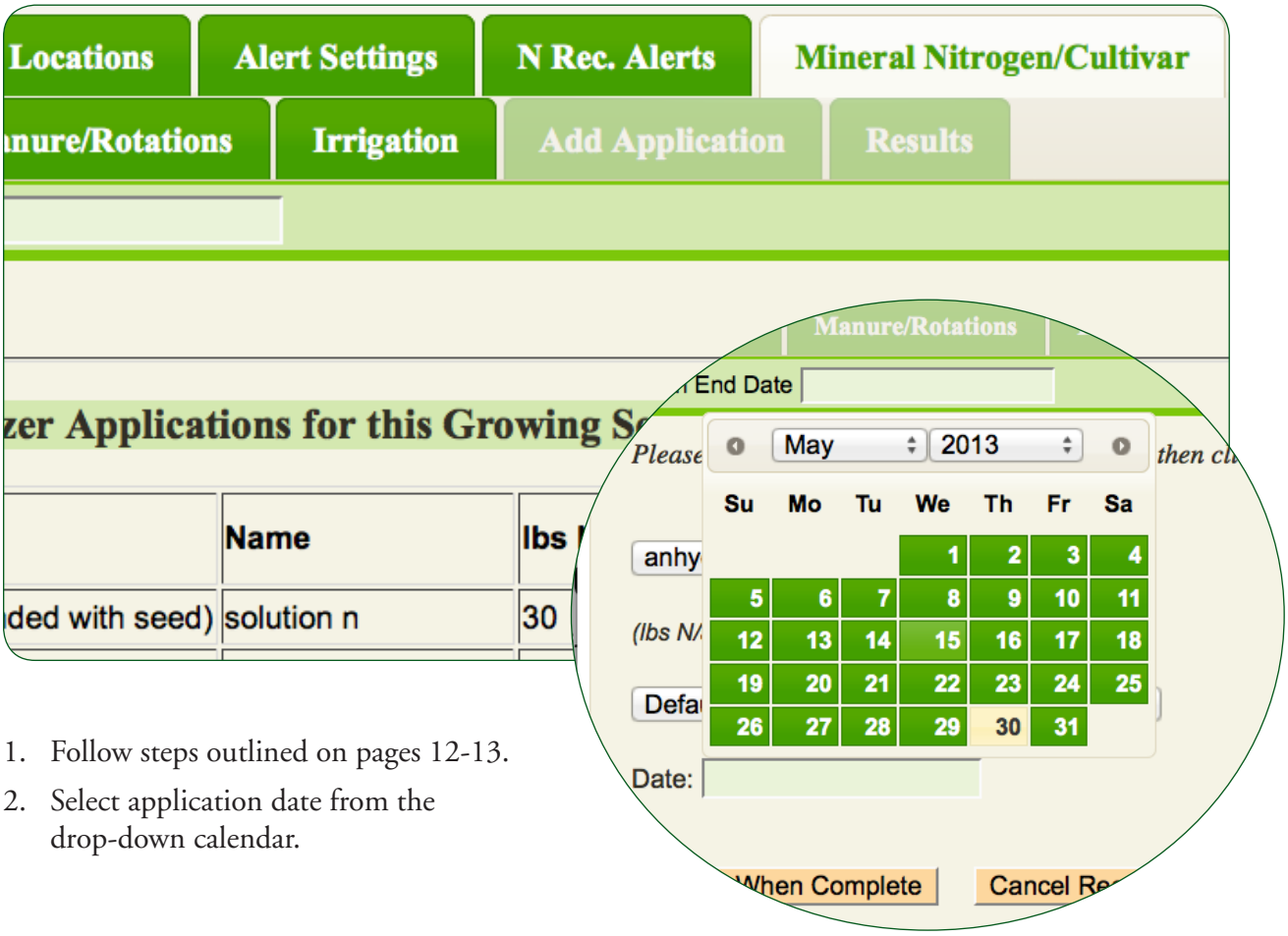
2. Select type of fertilizer from the "Select Starter" drop-down menu.
3. Enter fertilizer application rate in lbs N/ acre.
4. Select fertilizer placement depth from the "Placement Depth" drop-down menu.
5. Click "Submit" When Complete



NOTE: For starter applications, date of application is not entered, as it is the same as planting date.

Additional Preplant and Sidedress Applications

Entered fertilizer applications appear on the Mineral Nitrogen/Cultivar tab. Additional fertilizer applications can be chosen from the drop-down menu.

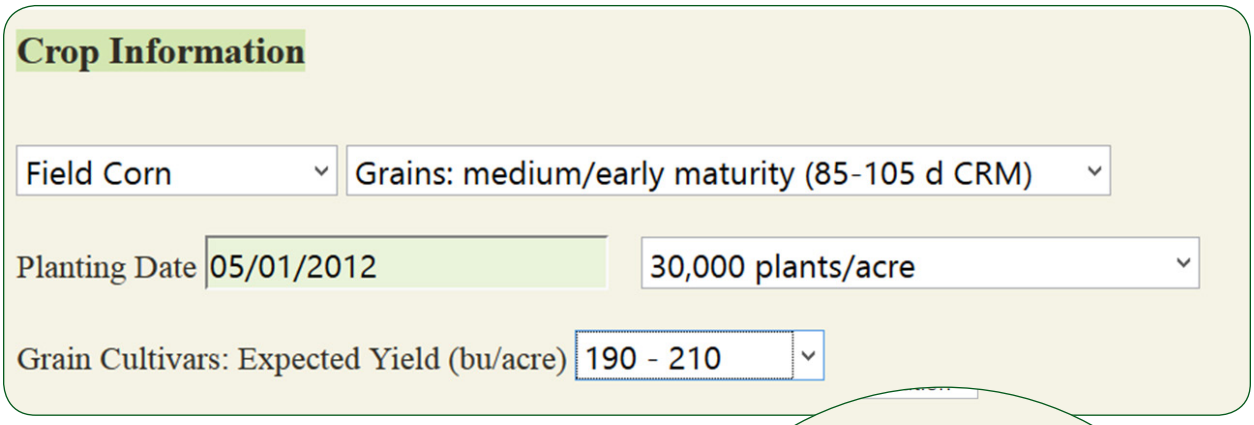


1. Follow steps outlined on pages 12-13.
2. Select application date from the drop-down calendar.

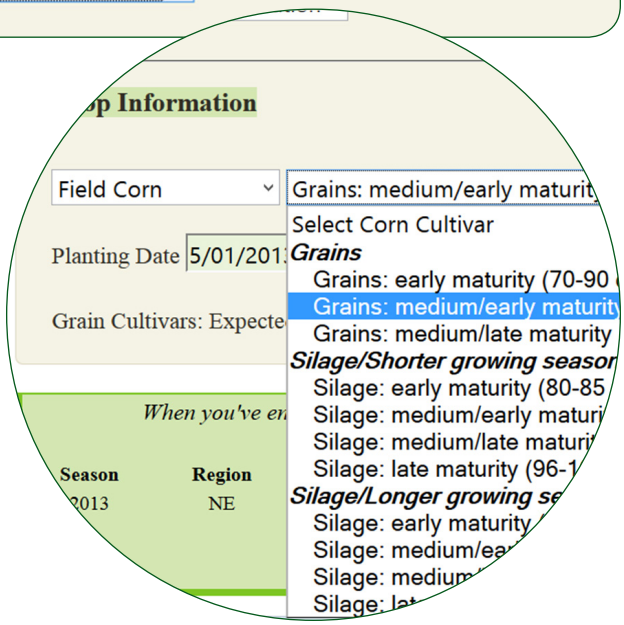
High Clearance Sidedressing.

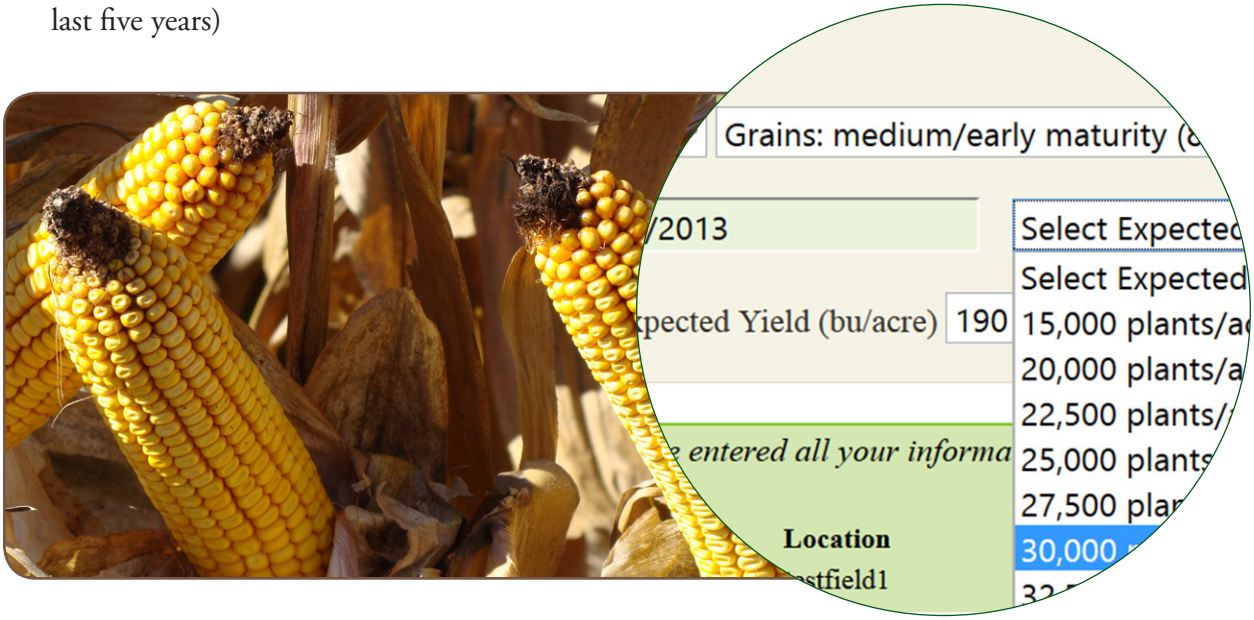
The ability to use high clearance equipment reduces risks associated with the short conventional sidedressing window. Later sidedressing (recommended up to V12) also allows Adapt-N to provide even more accurate N recommendations, to maximize N uptake and minimize N losses.

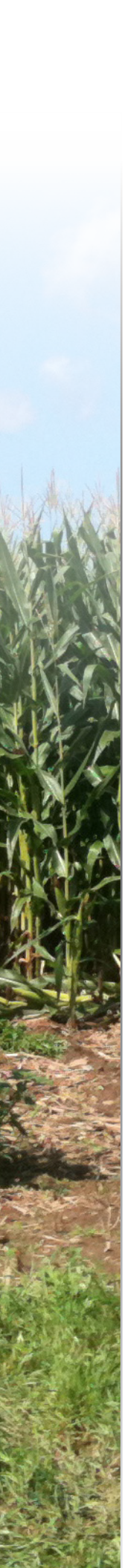
Corn Variety & Cultivar



1. Select type of corn from the "Corn Variety" drop-down menu (for Wisconsin and the Northeast).
2. Select corn cultivar from the "Select Corn Cultivar" drop-down menu.
3. Select planting date from the drop-down calendar.
4. Select plant population from the "Select Expected Harvest Population" drop-down menu.
5. Select expected yield in bu/ac from the "select bu/acre" drop-down menu. We recommend the fourth highest yield from the last five years)







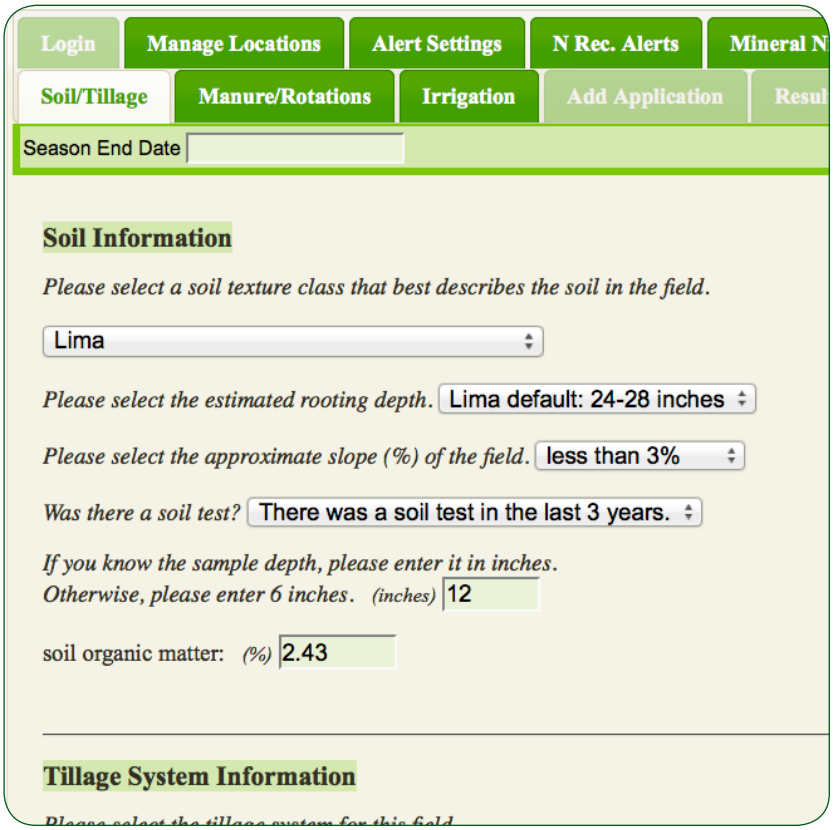
Entering Management Information - Soil/Tillage Tab

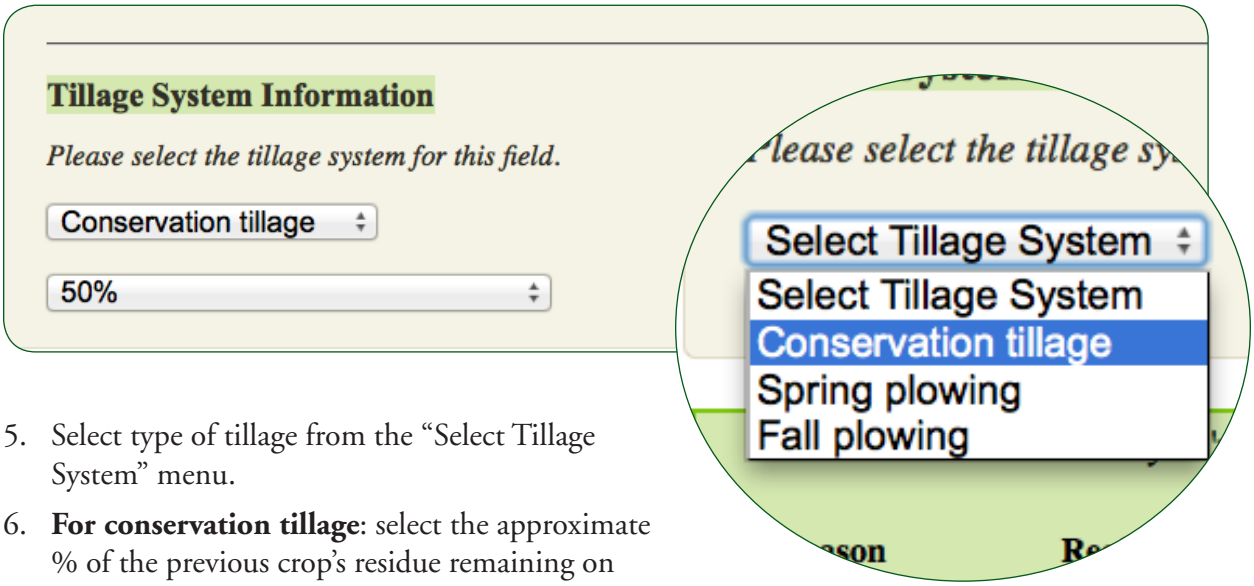
The **Soil/Tillage** tab is used to enter soil information and tillage information. In the Soil/Tillage tab you can enter:

- ***Soil Texture or Soil Series.*** Soil textural classes are modeled based on representative soils specific to the region in which a field is located. Where available, we recommend selecting the Soil Series of your field location for the most accurate results. Soil Series options are specific to region.
- ***Rooting Depth***. You can select rooting depth from a menu that ranges from 10 inches to >38 inches. The drop-down menu also includes a default option specific to the soil textural class or soil series.
- ***Slope***. There are 3 slope options: less than 3%, 3-8%, and greater than 8%.
- ***Soil test information***. Select whether or not there was a soil test (for soil organic matter content at your location in the last 3 years. If you select, "There was a soil test in the last 3 years" additional entry boxes will appear - Enter sampling depth and organic matter content in the entry boxes.
- ***Tillage Information***. There are 3 tillage options: Conservation Tillage, Spring Plowing, and Fall Plowing. For conservation tillage enter the approximate % of the previous year's crop residue remaining on the soil surface. For spring plowing, also enter the date and depth of tillage using the drop-down calendar. No additional entries are required for fall plowing.

Soil Information

1. In the **Soil/Tillage** tab, select Soil Texture (Ex. silt loam) OR Soil Series (Ex. Lima) from the "Select Soil Texture or Series" drop-down menu
2. Choose Rooting Depth (in inches) and Slope
3. Select whether or not there was a soil test (for organic matter content) in the last 3 years.
4. If there was a Soil Test in the last 3 years, enter Sample Depth (in inches) and Soil Organic Matter (%).





5. Select type of tillage from the "Select Tillage System" menu.
6. **For conservation tillage**: select the approximate % of the previous crop's residue remaining on the surface. An estimate is sufficient for this input as Adapt-N only provides four options: 25, 50, 75, 100%.

For spring plowing: enter the approximate date of tillage and the approximate depth of tillage.
For fall plowing: no additional information is needed.

Spring Plowing leaving almost none of the previous crop's residue on the soil surface (right pass).
Conservation tillage leaving 50% of the previous crop's residue on the soil surface (left pass).

Entering Management Information - Manure/Rotations Tab

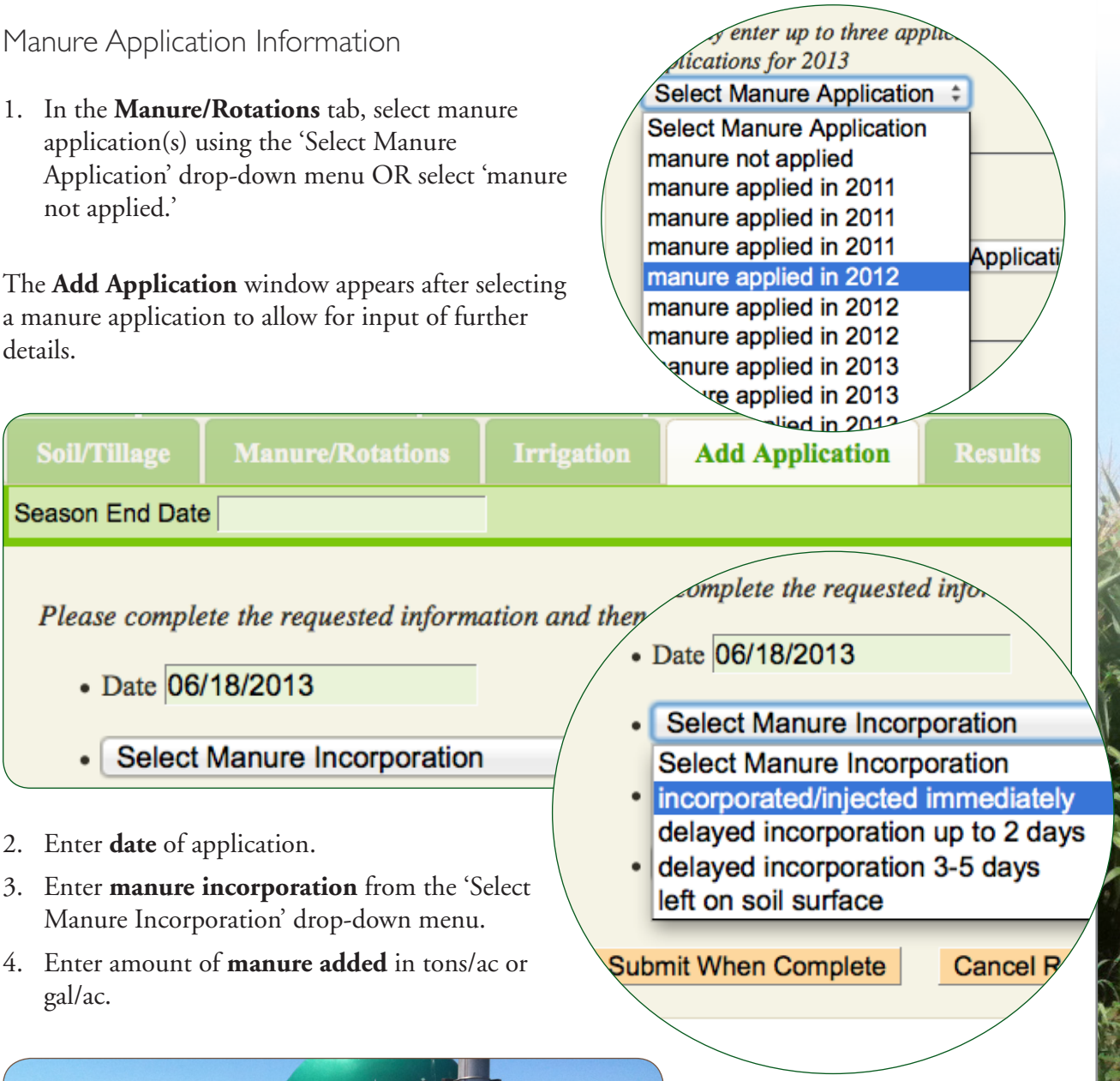
The **Manure/Rotations tab** is used to enter manure application information and previous crop information, including sod applications. In the **Manure/Rotations** tab you can enter:

- ***Manure N Applications***. Select manure applications using the 'Select Manure Application' drop-down menu OR select 'manure not applied' from the same menu. For the **Northeast** and **Wisconsin**: up to 3 applications can be entered for the current year and 2 previous years. For all other regions: up to 3 applications can be entered from the current and previous season.
- ***Manure Application Info***. Enter manure application info in the Add Application window that appears when you select a manure application. Enter date, manure incorporation, manure applied (tons/acre or gal/acre), ammonium N analysis (lbs/ton or lbs/gal), organic N analysis (lbs/ton or lbs/gal), and percent solids.
- ***N from Sod Rotation.*** Select the year of sod application OR 'sod not applied'. Year of sod application refers to the year that sod was terminated. For the **Northeast** and **Wisconsin**: sod can be terminated in the current year and 2 previous years. For all other regions: sod can be terminated in the current year.
- ***Sod Rotation Info***. Additional inputs appear if a sod application is selected. Enter the date that sod was terminated, approximate percent legumes. and the termination method (plowdown or surface killed).
- ***Previous Crop***. Select previous crop from the 'Select Previous Crop' drop-down menu. If your previous crop is not available as an option, see page 48.

Manure Application Information

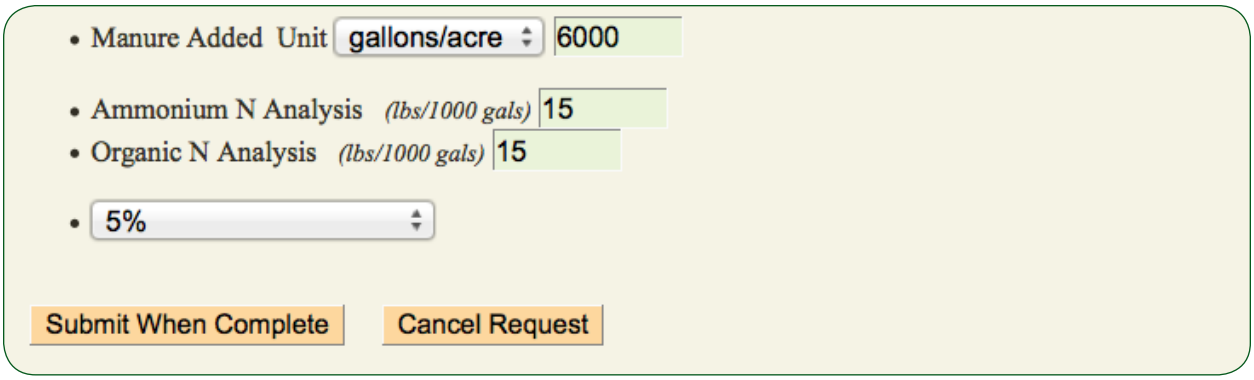
1. In the **Manure/Rotations** tab, select manure application(s) using the 'Select Manure Application' drop-down menu OR select 'manure not applied.'

The **Add Application** window appears after selecting a manure application to allow for input of further details.



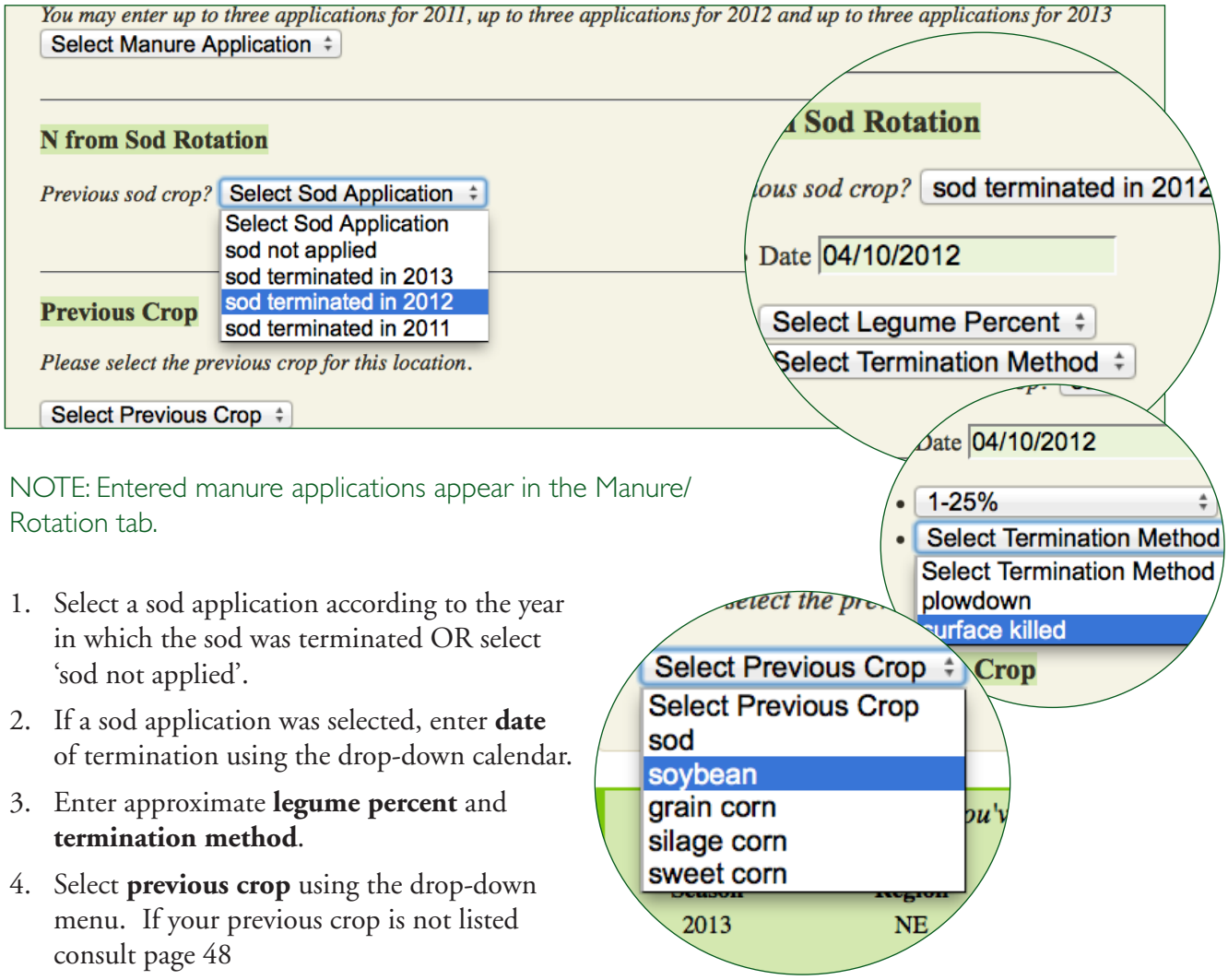
2. Enter **date** of application.
3. Enter **manure incorporation** from the 'Select Manure Incorporation' drop-down menu.
4. Enter amount of **manure added** in tons/ac or gal/ac.

Manure Incorporation
Injecting manure to reduce N volatilization.



5. Enter **Ammonium N analysis** and **Organic N analysis** in additional inputs that appear after selecting units.
6. Enter **Percent Manure Solids** from the drop-down menu and click the 'Submit When Complete' button.

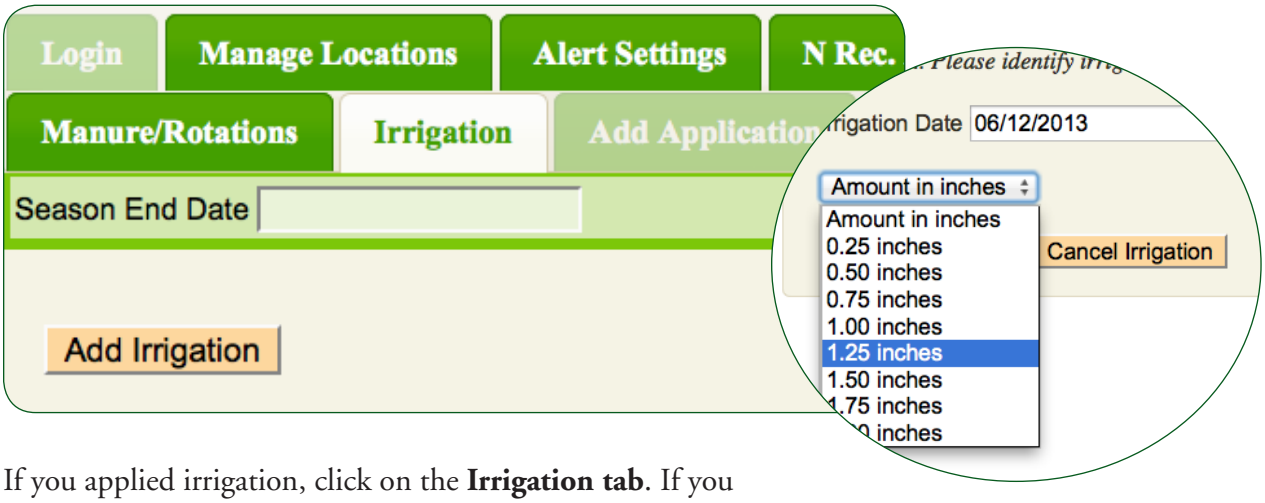
Sod & Previous Crop Information



NOTE: Entered manure applications appear in the Manure/ Rotation tab.

1. Select a sod application according to the year in which the sod was terminated OR select 'sod not applied'.
2. If a sod application was selected, enter **date** of termination using the drop-down calendar.
3. Enter approximate **legume percent** and **termination method**.
4. Select **previous crop** using the drop-down menu. If your previous crop is not listed consult page 48

Entering Management Information – Irrigation Tab



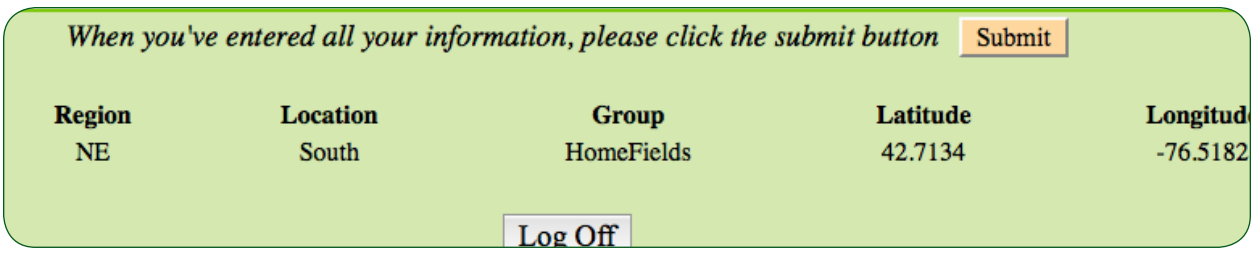
If you applied irrigation, click on the **Irrigation tab**. If you did not apply irrigation, skip this section. The **Irrigation tab** is used to enter irrigation applications, or, if you are scenario testing, the irrigation tab can be used to simulate the effect of additional rainfall. The tab allows you to enter the date of irrigation and the inches of irrigation applied. If you apply fertilizer in irrigation water, add a fertilizer application corresponding to the rate and type of fertilizer applied.

1. Click the 'Add Irrigation' button under the Irrigation tab.
2. Enter the date of irrigation and the amount of irrigation applied (in).

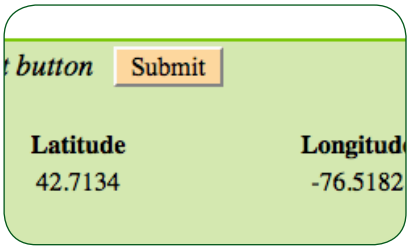
4. Running a Simulation to Generate a N Sidedress Recommendation

Once all input fields have been entered into Adapt-N, you can now generate sidedress recommendations and other useful N information in the **Results** section. Adapt-N can be used to provide:

- ***In-season recommendations***. Sidedress recommendations for the current date can be generated by simply clicking the 'Submit' button at the base of the window. The simulation will run to 1 day prior to the current date
- ***Retrospective simulations***. Sidedress recommendations for previous dates or seasons can be generated by entering a date in the 'Season End Date' box at the top of the window.



In-Season Recommendation

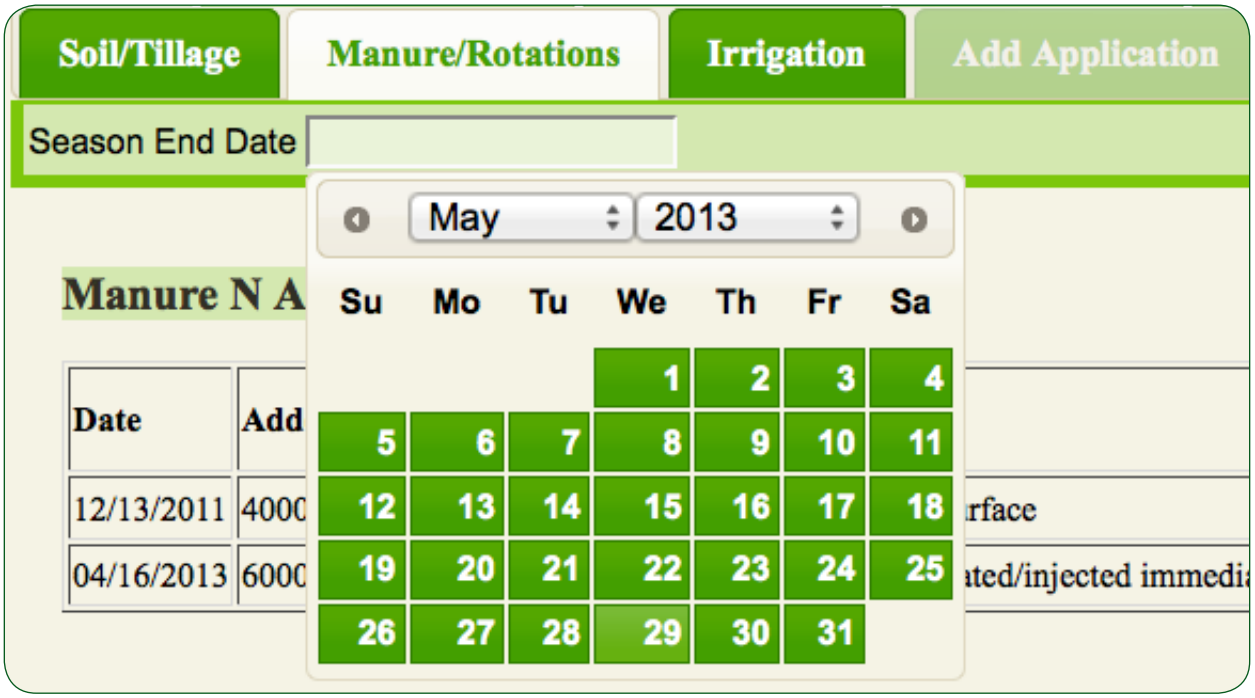


1. Click the 'Submit' button after entering all the component information.

IMPORTANT NOTE: To generate the most accurate recommendation, run Adapt-N as close to the actual sidedress date as possible. This is particularly important because there is a 1 day lag in weather data, and denitrification processes take several days to fully take effect.

Retrospective Simulations

1. Enter date in the 'Season End Date' box using the drop-down calendar. The season end date is the last day the simulation runs through.
2. Click the 'Submit' button at the base of the window.



IMPORTANT NOTE: If you are looking to recreate what a recommendation would have been on the day of sidedress, you will need to enter that date. Please note that the recommendation itself is not meaningful when the simulation is run through the end of the season. However, the graphics for simulation results that are provided can be used to understand later season dynamics and estimate N remaining.

5. Interpreting the Results

The Adapt-N sidedress recommendation appears at the top of the Results window when you run a simulation. However, Adapt-N provides *a lot* of additional information that may be useful for N management decisions on your farm. The **Results** tab gives you access to:

- ***Sidedress N Recommendation.*** Amount of N that is required to reach the 'Expected Yield' provided as an input (and a confidence interval). For more information about how the sidedress recommendation is generated see page 17.
- ***Calculation Variables***. The variables used by the model that influence the recommendation (for detailed definition see page 17).
- ***Excess N***. An estimate of the excess N in the system is provided, if the N recommendation is 0.
- ***Root Zone Crop Available*** Water. The estimated amount of water available in the root zone
- ***Full Report and Graphs***. To access the full report click on the link at the base of the window. The report provides:
    - Input summary
    - Sidedress N Recommendation
    - Excess N
    - Calculation factor values
    - Soil water values
    - Graphs detailing N dynamics, crop growth, temperature, and rainfall data.

Results Tab

Sidedress N Recommendation. Sidedressing at beginning of/during rapid N-uptake phase allows more precise estimation of N needs. The uncertainty range (+/- 1.15 SD) indicates potential losses from fertilizer application.

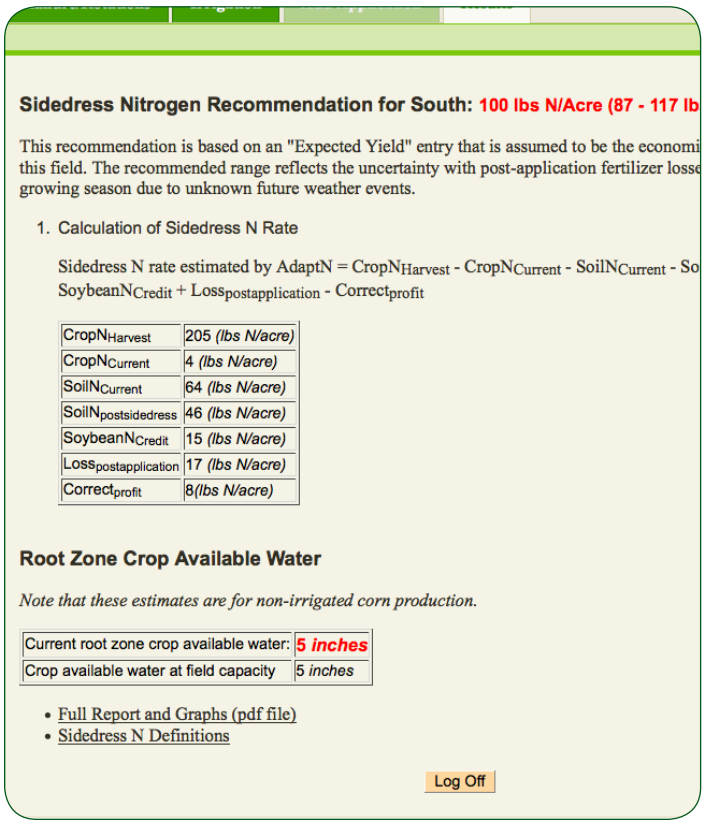
NOTE: Excess N will be listed when Adapt-N recommends no sidedress N (recommendation of 0 lbs/ac).

Equation. Mass balance used to calculate Sidedress N Recommendation.

Equation Variables. see page 17 for more info.

Root Zone Crop Available Water. Compared to field capacity content.

Links. The Full Report also shows simulations graphs. Sidedress N Definitions are provided.



Sidedress Nitrogen Recommendation for South: 100 lbs N/Acre (87 - 117 lb

This recommendation is based on an "Expected Yield" entry that is assumed to be the economi this field. The recommended range reflects the uncertainty with post-application fertilizer losse growing season due to unknown future weather events.

1. Calculation of Sidedress N Rate

Sidedress N rate estimated by AdaptN = $CropN_{Harvest}$ - $CropN_{Current}$ - $SoilN_{Current}$ - So $SoybeanN_{Credit}$ + $Loss_{postapplication}$ - $Correct_{profit}$

$CropN_{Harvest}$	205 *(lbs N/acre)*
$CropN_{Current}$	4 *(lbs N/acre)*
$SoilN_{Current}$	64 *(lbs N/acre)*
$SoilN_{postsidedress}$	46 *(lbs N/acre)*
$SoybeanN_{Credit}$	15 *(lbs N/acre)*
$Loss_{postapplication}$	17 *(lbs N/acre)*
$Correct_{profit}$	8*(lbs N/acre)*

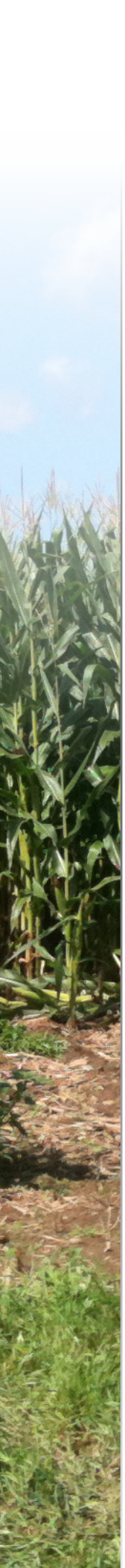
Root Zone Crop Available Water

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

Current root zone crop available water:	5 *inches*
Crop available water at field capacity	5 *inches*

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

Log Off



Full Report and Graphs

The Adapt-N Report lists the simulation end date, current date, and all other input information. The report also provides a summary of the variables used to calculate the recommendation.

Adapt-N Report Graphs are provided for the following variables:

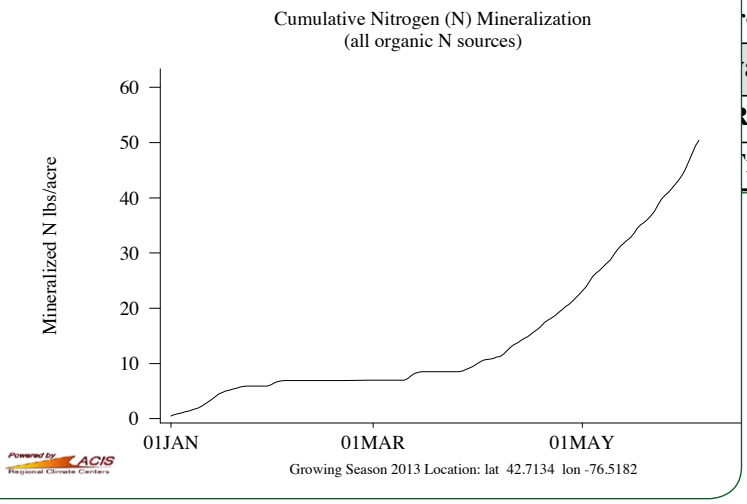
1. Cumulative N Mineralization (lbs/ac)
2. Cumulative N Uptake by the Crop (lbs/ac)
3. Cumulative Total N Losses (lbs/ac)
4. Cumulative N Leaching Losses (lbs/ac)
5. Coming in 2014: Cumulative N2O Losses (lbs/ac)
6. Nitrate N in the top 12 inches (lbs/ac)
7. Inorganic N in the Root Zone (lbs/ac)
8. Growing Season Daily Rainfall (in)
9. Growing Season Cumulative Rainfall (in)
10. Post-Emergence Growing Degree Days (GDD)
11. Corn Vegetative Growth Stage
12. Growing Season Average Temperature (F)
13. Nitrous Oxide Losses (coming in 2014)

Adapt-N Report

Settings	
Current Date	06/07/2013
Simulation End Date	06/04/2013
Field Name	South
Group Name	HomeFields
Latitude	42.7134
Longitude	-76.5182
Soil/Field Input	
Soil Type	NY Soil Series: Lima
Rooting Depth	22-26 inches
Field Slope	less than 3%
Soil Management	Conservation tillage
% Surface Residue Cover	50%
Preplant Soil Test	test in the last 3 years
Sample Depth	12 inches
Soil Organic Matter	2.43%

Sidedress N and Crop Available Water	
Sidedress N recommendation	**100 lbs N/Acre**
	(87-117 lbs N/Acr
CropN (Harvest)	205 lbs N/acre
CropN (Current)	4 lbs N/acre
SoilN (Current)	64 lbs N/acre
SoilN (postsidedress)	46 lbs N/acre
SoybeanN (Credit)	15 lbs N/acre
pplication)	17 lbs N/acre
ofit)	8
ailable Water	
oot Zone	5 inches
ield Capacity	5 inches

Adapt-N Report



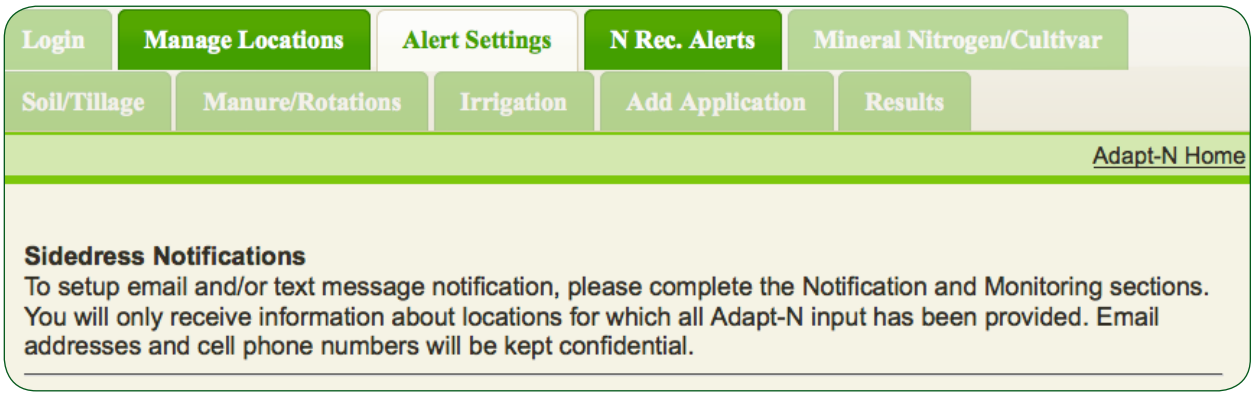
Cumulative N Mineralization. An example of one of the many graphs provided by Adapt-N. Graphs in the Full Report provide insight into the N dynamics of the corn system.

6. Setting Up Daily Alerts and Viewing Updated Recommendations

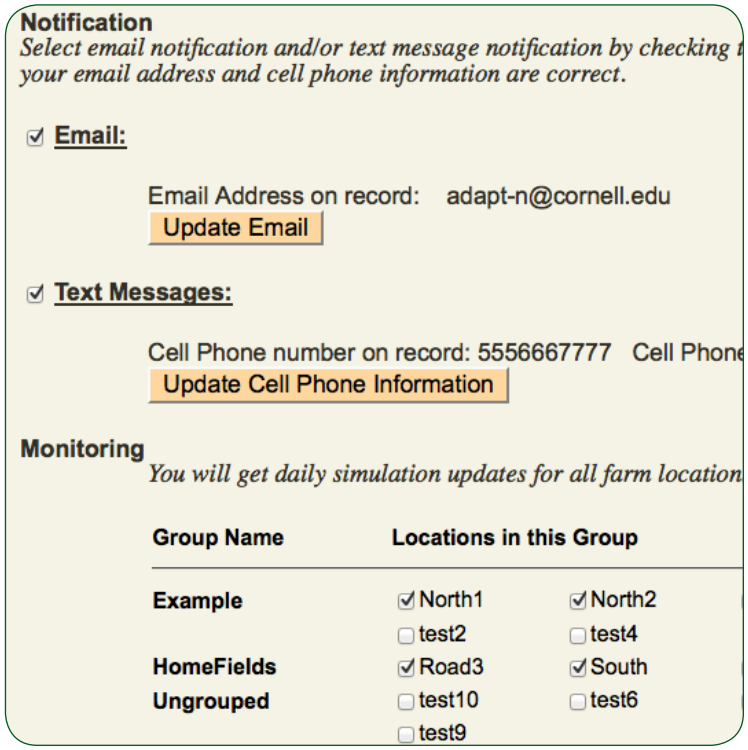
Adapt-N provides daily recommendation updates for all completed field locations in your account. Alerts are active during the growing season. With daily alerts, users do not have to manually simulate each location. Instead, daily alerts are accessed through the interface, and users can sign-up to receive alerts via email or cellphone text. Daily Alerts are managed through two tabs:

- ***Alert Settings tab.*** Use this tab to sign-up for daily email and/or cellphone text updates. Also, check off which fields you would like to receive daily updates for.
- ***N Rec. Alerts tab***. This tab provides immediate access to daily N recommendations, crop available water, leaf growth stage, and soil N for all completed locations. You can also access the Full Report and Graphs (shown on the previous page) for each completed location from this tab.

Alert Settings Tab



1. Click on the **Alert Settings** Tab.
2. ***To sign-up for email alerts:*** Click 'Update Email' and enter your email address. Click 'Submit Email Update'. The Adapt-N Team will process your email update as quickly as possible.
3. ***To sign-up for text alerts:*** Click 'Update Cell Phone Information", enter your cell phone number and select your carrier from the drop-down menu. Click 'Submit Cell Phone Update'. The Adapt-N Team will process your email update as quickly as possible.
4. Check off locations that you would like to receive updates for.



Nitrogen Recommendation Alerts Tab

The **N Rec. Alerts** tab automatically provides you with up to date sidedress N recommendations, crop available water, leaf growth stage, soil N, reports and graphs. Accessing this information through the **N Rec. Alerts** tab is much more efficient than simulating each field individually in the interface. The **N Rec. Alerts** tab provides a quick overview of all locations. Monitoring of crop growth stage and available soil nitrogen can help inform timely sidedress applications.

1. Click on the **N Rec.** Alerts tab During the growing season, information on the **N Rec. Alerts** tab is automatically updated daily for all locations with completed input information.

Login | Manage Locations | Alert Settings | N Rec. Alerts | Mineral Nitrogen/Cultivar | Soil/Tillage | Manure/Rotations | Irrigation

Add Application | Results

Adapt-N

Summary of Adapt-N Simulation Results: 6/6

Group	Location	N Recommendation[1] *lbs. N/Acre*	Crop Available Water[2] *inches*	Leaf Growth Stage	Soil N[2] *lbs. N/Acre*	details
Ungrouped	Aldrich East 24-1	140(124 - 161)	5	3	48	Report & Graphs (pdf file)
	Aldrich East 24-11	105(94 - 120)	5	3	66	Report & Graphs (pdf file)
	Aldrich East 24-13	120(107 - 137)	5	3	61	Report & Graphs (pdf file)
	Aldrich East 24-14	140(124 - 161)	5	3	48	Report & Graphs (pdf file)
	Aldrich East 24-4	155(135 - 175)	5	3	44	Report & Graphs (pdf file)
	Aldrich East 24-5	115(107 - 125)	3	3	46	Report & Graphs (pdf file)
	Aldrich East 24-7	110(103 - 120)	3	3	51	Report & Graphs (pdf file)
	Aldrich East 24-8	70(64 - 82)	5	3	85	Report & Graphs (pdf file)
	Aldrich East 24-9	120(109 - 140)	5	3	60	Report & Graphs (pdf file)
	Aldrich West 25-2	145(127 - 165)	5	3	45	Report & Graphs (pdf file)
	Aldrich West 25-3	110(105 - 123)	3	3	48	Report & Graphs (pdf file)
	Aldrich West 25-7	125(113 - 146)	5	3	55	Report & Graphs (pdf file)
	Doane 4-10	130(125 - 146)	3	4	36	Report & Graphs (pdf file)
	Doane 4-13	160(140 - 183)	5	4	37	Report & Graphs (pdf file)
	Doane 4-16	115(110 - 128)	3	4	41	Report & Graphs (pdf file)
	Doane 4-2	155(138 - 179)	5	4	39	Report & Graphs (pdf file)
	Doane 4-3	165(143 - 188)	5	4	34	Report & Graphs (pdf file)
	Doane 4-4	125(112 - 143)	5	4	54	Report & Graphs (pdf file)

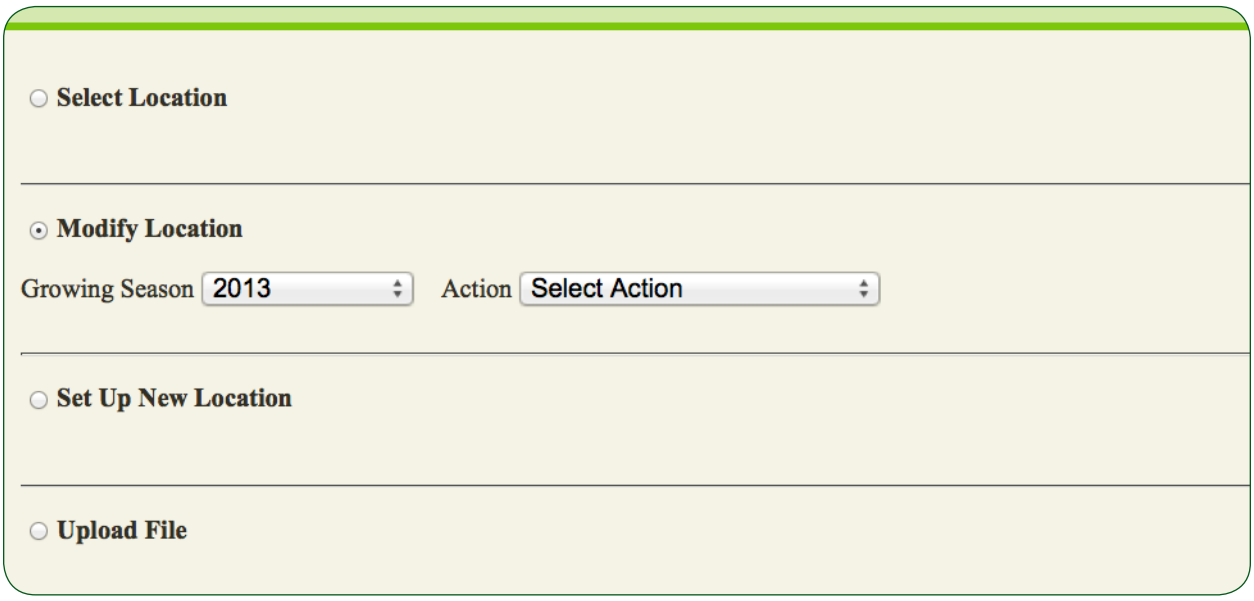
N Rec. Alerts tab screenshot courtesy of Robert and Rodney Donald of Donald & Sons Farm. Robert and Rodney implemented Adapt-N rates on their entire farm with single strips of their old rate in each field for comparison during the 2012 growing season. Read more on page 68.

[1]Negative values next to 0 N recommendation indicate root zone N available in excess of crop needs.
[2]Values for water and N available in the entire root zone

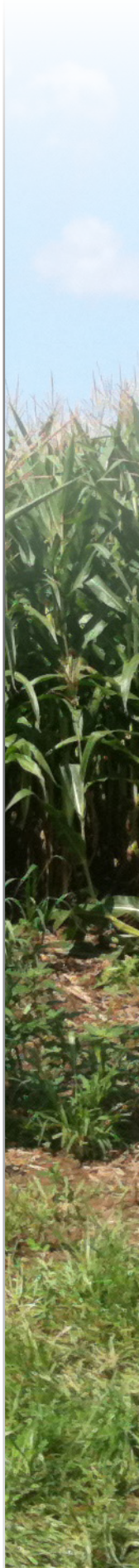
7. Modifying Locations

The **Modify Locations** tab can be used to manage and edit existing locations and to copy existing locations. Use the **Modify Locations** tab to:

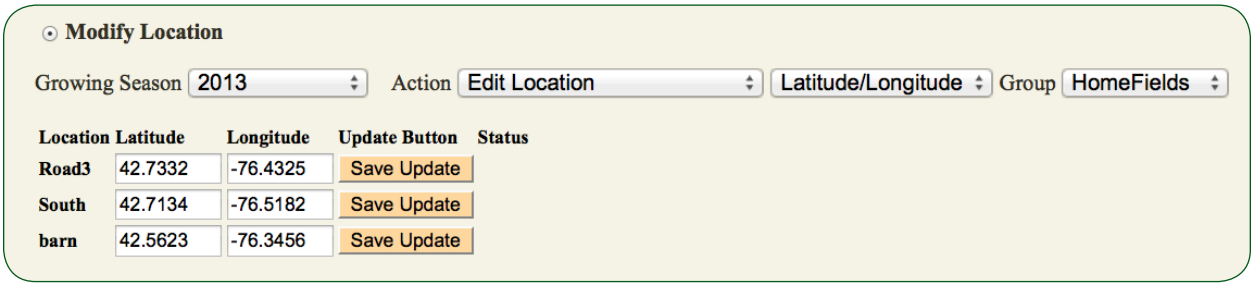
- **Delete** locations.
- **Copy** existing locations.
- **Edit** the Latitude, Longitude, Expected Yield, Tillage System, Soil Type, and Soil Test (organic matter) information of existing locations.
- **Manage** locations through Group Management by 1) Creating groups, 2) Removing a location from a group, and 3) Adding a location to a group.



1. In the Manage Locations tab, click on Modify Location and select growing season from the drop-down menu.
2. The 'Select Action' drop-down menu provides access to all Modify Location functions
   a. To Delete a Location: Select 'Delete Location' from the 'Select Action' drop-down menu. Then, select the group in which the location is located from the 'Select Group' drop-down menu and select the location from the 'Select Location' drop-down menu. Click 'Submit When Complete'.
   b. To Copy a Location: Select 'Copy Location' from the 'Select Action' drop-down menu. Then, select the location from the 'Select Location' drop-down menu and enter a name for the new location. Click 'Submit When Complete'.



Editing Location Info

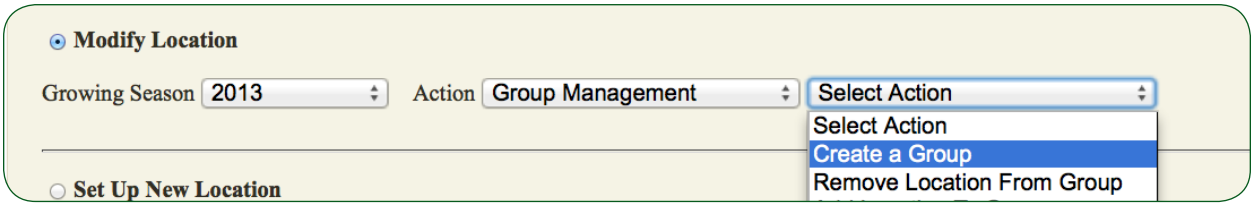


1. Select 'Edit Location' from the 'Select Action' drop-down menu.
2. Select an edit function from the 'Select Type of Edit' drop-down menu: Latitude/Longitude, Expected Yield, Tillage System, Soil Type, or Soil Test.
3. Select group from the 'Select Group' drop-down menu.
4. Enter edits by location in the boxes that appear. Click 'Save Update' for each location that you make changes to.

NOTE: The Edit location function is a great way to efficiently add and/or update information in the interface.

Managing Groups

Group Management, found under '**Modify Location**,' can help organize locations in your account. **Group Management** allows you to:



- Create groups.
- Remove a location from a group.
- Add a location to a group.

1. Select 'Group Management' from the first 'Select Action' drop-down menu to appear.
2. Select group function from the 2nd 'Select Action' drop-down menu to appear.
3. ***To Create a Group***: Enter the **name** for the new group and check the locations that you would like to add to the group. Click 'Submit When Complete'.
4. ***To Remove a Location(s) from a Group***: Select the group that the location(s) is in from the 'Select Group' drop-down menu that appears. Check off the locations that should be removed from the group. Click 'Submit When Complete'. Locations that you removed will be moved to the 'Ungrouped' group.
5. ***To Add a Location(s) to a Group***: Select the group that you would like to add location(s) to from the 'Select Group' drop-down menu that appears. Check off the locations that should be added to the group. Click 'Submit When Complete'. You will only be able to add locations to a new group if they are not already grouped.

8. Batch Uploading Files with Location Information

The **Batch Upload** allows users to more efficiently create locations and upload management information in Adapt-N, using comma separated value (CSV) files. With CSV files, a type of plain text file, users enter large amounts of data at once. CSV files can be created in several programs, including Excel, Numbers, and TextEdit, as well as by many database programs, such as those often used by consultants and large farms to store farm management information.

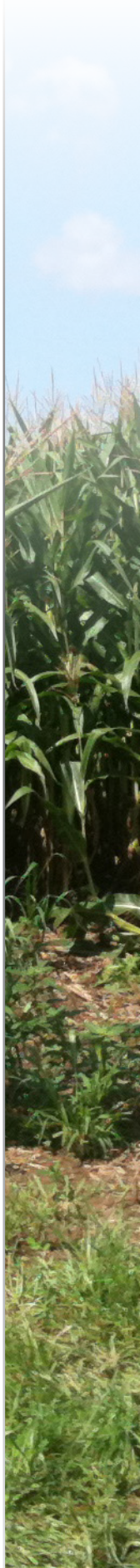
Users create files for each component in the interface (i.e. location, manure, fertilizer, etc.), and upload each file individually. **Batch Upload** requires precisely formatted CSV files according to the instructions posted on the site. Due to the specificity of the instructions, and the fact that they will change over time as the feature develops, explanation of this feature in the manual will be limited to a brief overview.

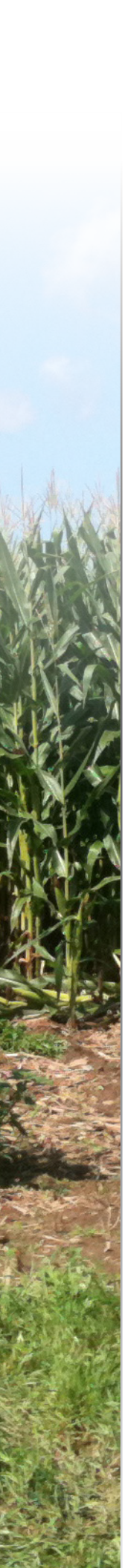
A note of caution: error checking with the batch upload feature is not as robust as in the interface. Therefore, we recommend that users are thoroughly familiar with setting up locations and adding location data through the Adapt-N interface before using the batch upload option. This feature utilizes the same input format as the interface, and familiarity with inputting information via the interface will help minimize errors when using the batch upload format.

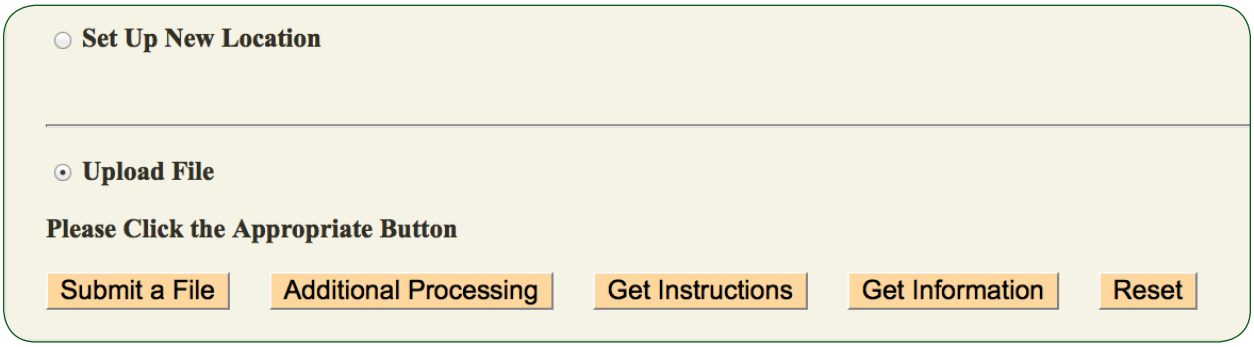
We also advise that, where possible, locations and location data be entered or verified through the Adapt-N interface since error checking in the interface format is more robust.

This section of the manual includes a brief description of the following components of the **Batch Upload** feature:

- ***Batch Upload Menu***. All of the information required to successfully upload files to Adapt-N can be accessed from this menu.
- ***CSV files***. A quick look at creating CSV files in Excel.
- ***Upload Processing Report***. After uploading a file, a processing report details errors in the file and/or information processed by the interface.
- ***Missing Information***. A great tool for checking the completion status of your locations.
- ***Additional Processing***. Delete manure and fertilizer application efficiently.







Batch Upload Menu

Click ***Submit a File*** to browse files and select the appropriate CSV file for upload.

Click on ***Get Instructions*** to access instructions for creating CSV files, adding locations, and uploading component information.

Click ***Reset*** to clear the CSV file window

Keep track of existing locations and missing information. Also use ***Get Information*** to view sample CSV files.

Efficiently delete fertilizer and manure applications with ***Additional Processing***

Creating CSV Files

	A	B	C	D	E	F	G
1	location	group	region	latitude	longitude		
2	west5	not grouped	ne	42.4507	-76.46		
3	westrd2	not grouped	ne	42.4509	-76.4614		
4	route5	not grouped	ne	42.4498	-76.4595		
5	wroute5	not grouped	ne	42.449	-76.4697		
6	north3	not grouped	ne	42.4486	-76.4578		
7	END						

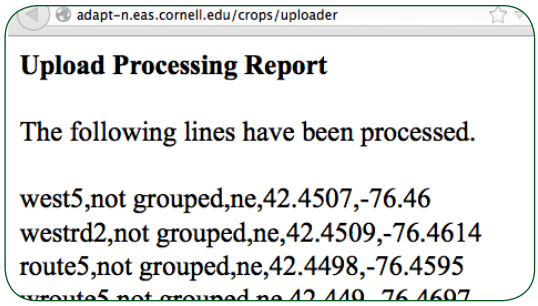
1. Create a location.csv file to add locations to the interface with **Batch Upload**. The CSV file above was created in Excel. The same information is shown on the right in a CSV file created in TextEdit.

```
location,group,region,latitude,lo
west5,not grouped,ne,42.4507,-76.
westrd2,not grouped,ne,42.4509,-7
route5,not grouped,ne,42.4498,-76
wroute5,not grouped,ne,42.449,-76
north3,not grouped,ne,42.4486,-76
END
```

2. Enter the appropriate column headings and fill in the corresponding information. Refer to the instructions for each component found under **Get Instructions** frequently to ensure that information is input correctly.
3. Type 'END' at after the last entry.
4. Save the file as a CSV file with the appropriate file name (i.e. location.csv, manure.csv, fertilizer csv, etc.). Consult the instructions for the proper file name.

Upload Processing Report

The **Upload Processing Report** tells you what lines in the CSV file were processed and if there were errors in the file. Each time you upload a file to Adapt-N you will receive an **Upload Processing Report**.

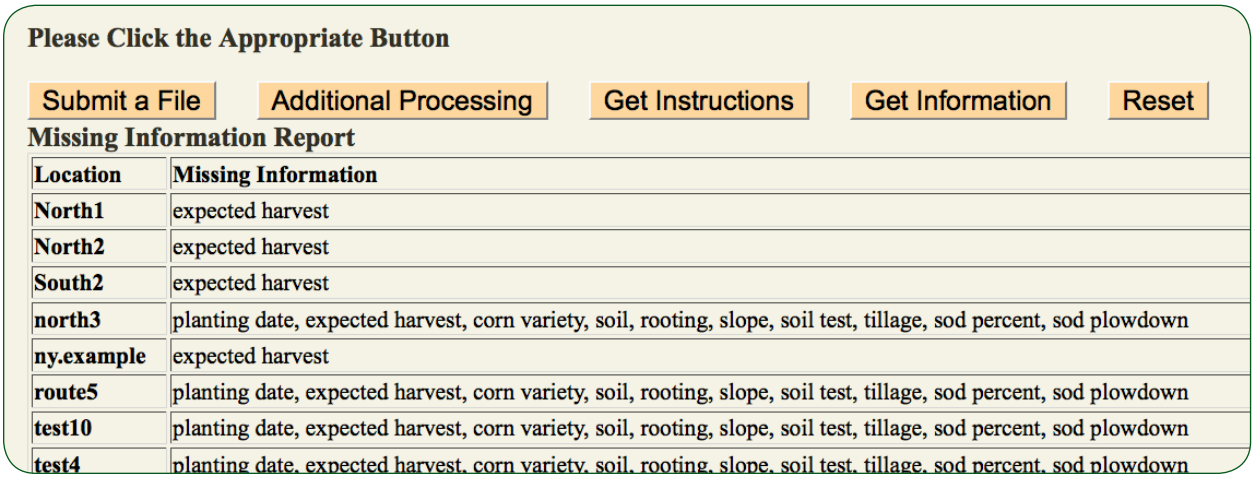

adapt-n.eas.cornell.edu/crops/uploader

Upload Processing Report

The following lines have been processed.

west5,not grouped,ne,42.4507,-76.46
westrd2,not grouped,ne,42.4509,-76.4614
route5,not grouped,ne,42.4498,-76.4595

Missing Information


Please Click the Appropriate Button

Submit a File | Additional Processing | Get Instructions | Get Information | Reset

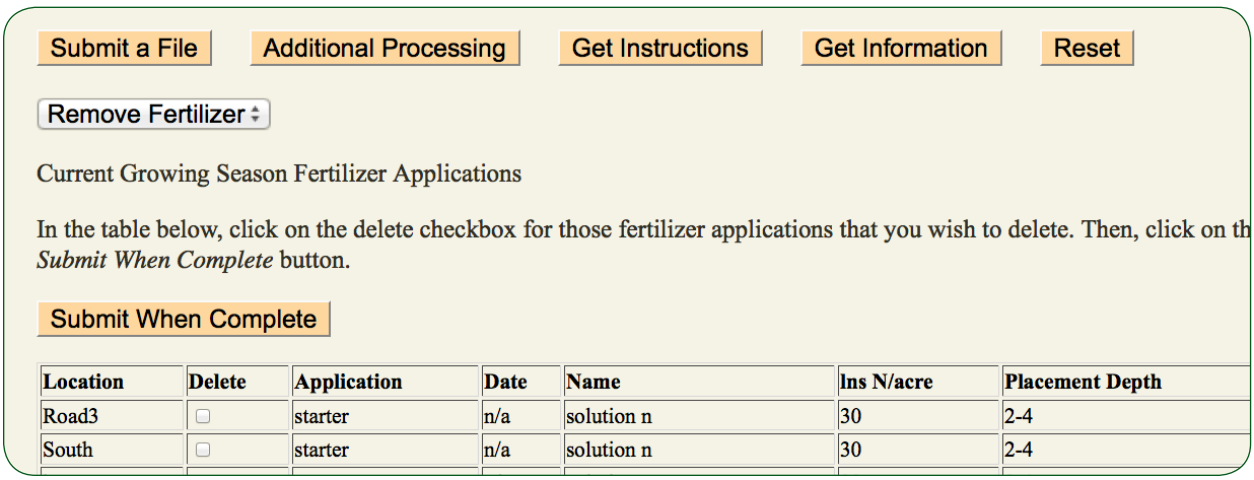
Missing Information Report

Location	Missing Information
North1	expected harvest
North2	expected harvest
South2	expected harvest
north3	planting date, expected harvest, corn variety, soil, rooting, slope, soil test, tillage, sod percent, sod plowdown
ny.example	expected harvest
route5	planting date, expected harvest, corn variety, soil, rooting, slope, soil test, tillage, sod percent, sod plowdown
test10	planting date, expected harvest, corn variety, soil, rooting, slope, soil test, tillage, sod percent, sod plowdown
test4	planting date, expected harvest, corn variety, soil, rooting, slope, soil test, tillage, sod percent, sod plowdown

Click on **Get Information** and select ***Missing Information***

Missing information shows up for all locations, including locations created through the interface. Missing Information is a good tool for tracking down inputs that are missing.

Additional Processing


Submit a File | Additional Processing | Get Instructions | Get Information | Reset

Remove Fertilizer

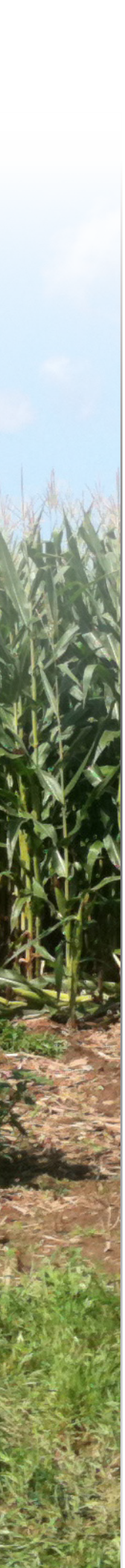
Current Growing Season Fertilizer Applications

In the table below, click on the delete checkbox for those fertilizer applications that you wish to delete. Then, click on th
Submit When Complete button.

Submit When Complete

Location	Delete	Application	Date	Name	Ins N/acre	Placement Depth
Road3	☐	starter	n/a	solution n	30	2-4
South	☐	starter	n/a	solution n	30	2-4

1. Click on **Additional Processing** and select ***Remove Fertilizer*** from the drop-down menu.
2. Check off the applications you would like to delete and click 'Submit When Complete'.



9. Input Information: What is most important?

In general, all of the information requested by Adapt-N is relevant and will contribute to the accuracy of the tool's recommendations, but some inputs will have more of an impact than others. Some parameters can be estimated within broad ranges, while others need to be more precise to achieve accurate Adapt-N recommendations. In this part of the manual, we classify the importance of input information roughly by component.

Location & Timing

Input	!	Comments
Region	High	Defines which version of model is used, which soil types are available.
Field Coordinates	High	Use map tool or GPS. To at least 4 decimal places for accurate weather data
Growing Season	High	Make sure to select correct year for purpose (retrospective run, current season recommendation)
Season End Date	Low/ High	Ignore for real-time recommendations. Important to use correctly for *retrospective* analysis.

Fertilizer & Cultivar

Input	!	Comments
Expected Yield	High	Don't underestimate, but be realistic. Base this on yield records. VRN potential is high.
Fertilizer Info	High	Amount and depth, date
Fertilizer Type	Med	Fertilizer type has a smaller impact than above factors. The model does not yet include the effect of stabilizers, but these can be simulated with application date manipulations.
Date of Planting	Med	Accuracy within a couple of days is fine.
Harvest Population	Low	Approximate value is fine.

Soil & Tillage

Input	!	Comments
Organic Matter	High	Representative soil sample, ideally to 12" and by management unit
Soil type	Med	Texture or soil series if available
Rooting depth	Med	Need estimate. + or - 3" is fine. Default ok unless you have compaction issues
Slope	Low	Approximate value is fine.
Type & Depth of Tillage	Med	Affects stover & resulting N dynamics. Approximate depth value is fine.
Spring plowing	Med	Approximate dates are fine.
Conservation Tillage	Med	Approximate surface residue is fine. Note that the percentage refers to % of previous crop's residue remaining on surface, not % soil cover.

Manure & Rotation

Input	!	Comments
Representative Manure Test	High	Manure analysis varies widely by year, batch, storage, and animal source. Include ammonium N and organic N analysis.
Representative manure management	High/ Med	Requires accuracy for current yr applications. Potential for high ammonia volatilization loss if surface applied. Calibrate spreader – know what you are applying!
Sod info	High/ Med	Crucial to input if in rotation history. Accuracy in % legume required. Date & kill method, especially if in current year. Note that sod (perennial, established for at least 3 yr) is NOT the same as a cover crop (no input available yet).
Previous Crop	High	Critical to note if after soybean (direct credit and change in simulation of N dynamics due to residue)
Irrigation	High	Critical to input accurately if used

Irrigation

Input	!	Comments
Irrigation	High	Critical to input accurately if used

4. Common Questions & Adapt-N Troubleshooting

This section of the manual includes commonly asked questions and answers related to using Adapt-N, how the tool functions, and N dynamics in agricultural systems. The questions are organized in categories:

- Getting an Account and Signing In.
  Questions related to getting started in Adapt-N.
- Setting Up Locations.
  Questions related to creating locations in the interface.
- Inputting Management Information for a Location.
  Questions related to management inputs, organized loosely by component.
- Error Messages.
  Common error messages and why you may be receiving them.
- Puzzled by the Recommendation?
  A look at reasons why the Adapt-N recommendation may not be more or less than you anticipated.
- End of Season and Retrospective Analyses.
  Information related to application of Adapt-N for end of season evaluations and retrospective determination of in-season recommendations.
- N Recommendation Alerts.
  Technical questions related to the daily N alerts feature.
- Corn System Dynamics.
  Conceptual questions related to N dynamics in corn systems.
- About Adapt-N.
  General questions related to the capabilities and functions of Adapt-N.
- Batch Upload.
  Common questions related to the batch upload feature.

Getting an Account and Signing In

1. What information will I need to enter in Adapt-N to get a N recommendation?

- **Latitude** and **longitude** for the field location
- **Preplant, starter, and additional/sidedress N fertilizer:** type, date of application, rate, depth of application.
- **Cultivar**: Silage/grain/sweet corn, maturity class, expected harvest population, planting date, expected yield in that field that year.
- **Soils**: either textural class or soil type, rooting depth (default available), approximate field slope, % organic matter from a recent soil test and depth of sample.
- **Tillage**: fall plowing, spring plowing (date and depth), or conservation tillage and % residue of

previous crop remaining on surface (estimate 25, 50, 75 or 100%).

- **Manure applications** date, rate (in gallons/acre or tons/acre), N content (in lbs ammonium-N and organic-N /1000 gals), incorporation method and timing.
- **Sod rotation** within last 3 years: Percent legume in the sod, method and timing of sod kill/incorporation.
- **Previous crop**

Also, see page 4 for more information.

2. What should I do if my account name and/or password are not working?

Ensure that both your account name and password are formatted as they were originally provided to you. Try copying and pasting the username and password from the email in which they were provided to you. Most often usernames and passwords do not contain any capital letters. The interface is case sensitive. Click the Log In button rather than hitting the Enter button after entering your username and password. Make sure that you are using Mozilla Firefox; Adapt-N runs best with the Firefox browser.

3. Will data I enter in Adapt-N be kept confidential?

Yes, all data you enter into your Adapt-N account are kept strictly confidential and will not be used for commercial purposes.

Setting Up Locations

4. Where is Adapt-N available? What do I do if my region is not available in Adapt-N?

As of the 2013 growing season, Adapt-N is fully available for the 13 Northeastern U.S. states (soil types only for New York), Iowa, Minnesota, Wisconsin, Illinois and Indiana. It is also available in beta-mode for the following areas: Eastern parts of KS, NE, SD, and ND; and all of MO, MI, KY, OH, VA, WV, and NC. See the map of 2013 Adapt-N geographic coverage. If your region is not available in the drop down menu, then you will need to use the Adapt-N version for a neighboring state. The tool is intended to be made available fully for all U.S. areas east of the 100th meridian (rain-fed agriculture) within the next couple of years.

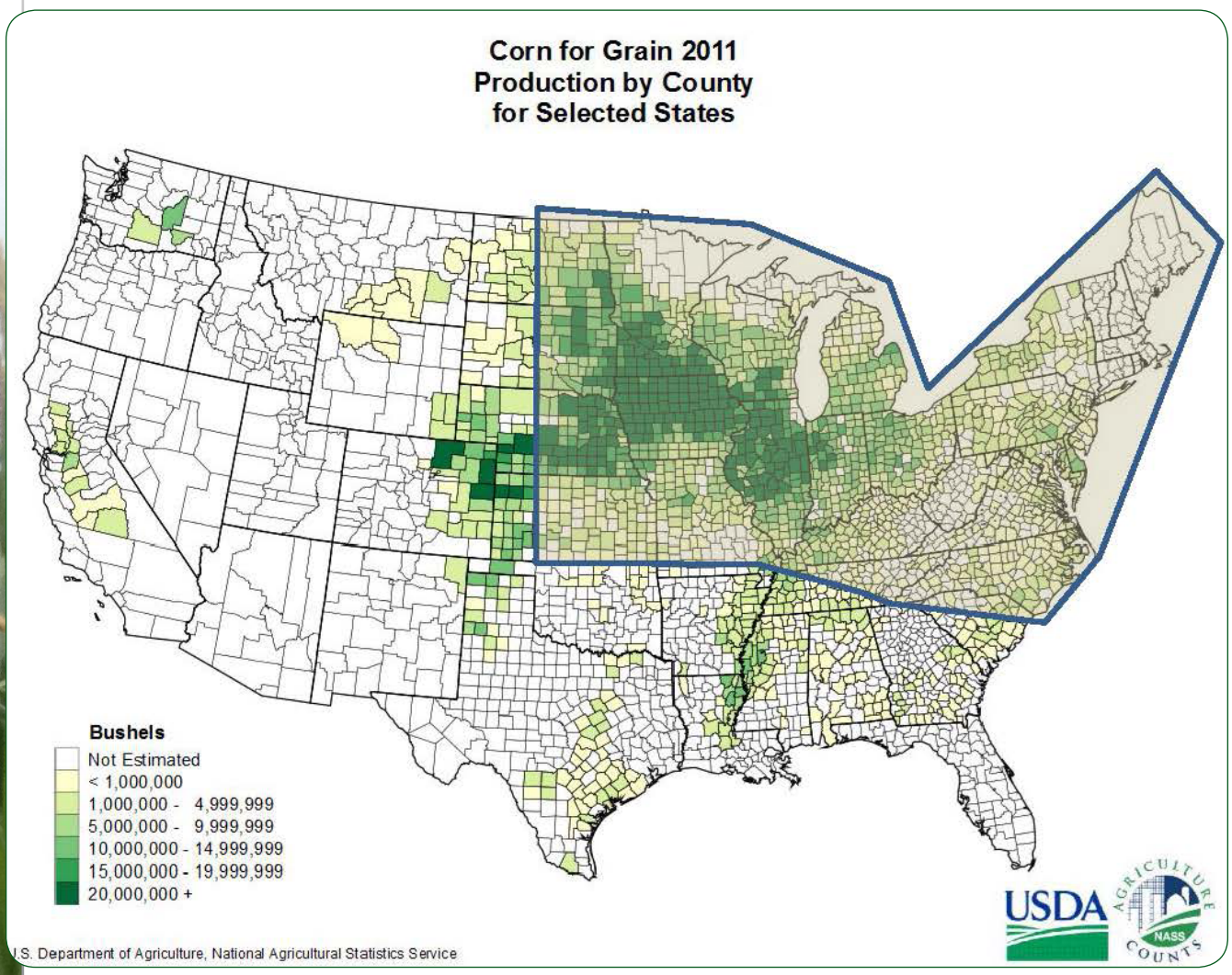
5. How can I get the exact latitude and longitude of my field?

Latitude and longitude of a field location are important to achieving accurate Adapt-N recommendations, due to the large influence of weather on nitrogen activity in the soil. If you do not

have your own GPS or otherwise stored location information, you can use the map tool provided in the Adapt-N 'Manage Locations' tab to select the exact location of the field when you enter it in Adapt-N.

6. How many decimal places should I use for my locations?

Latitude and longitude values should be to at least 4 decimal places, but no more than 10.



COVERAGE

Adapt-N geographic coverage 2013: the vast majority of rain-fed corn production in the US can access Adapt-N recommendations.

Inputting Management Information for a Location

7. I use N stabilizer products – how can I account for this in Adapt-N?

Adapt-N does not simulate various stabilizer products as of the 2013 growing season. There is a need for good data on their dynamic activity in response to daily changes in temperature and soil moisture conditions. We will incorporate these products as data become available. A work-around that may or may not give you more accurate results is to use the product claim (such as preventing nitrification for 30 days) and input your fertilizer application into Adapt-N for an accordingly later date. However, remember that total N needs cannot be predicted accurately in the fall or spring before corn planting, so the greatest money savings and environmental benefits will come from shifting the bulk of the N application to sidedress time, when needs can be much more accurately determined.

8. What should I select for Previous Crop if my previous crop is not an option in Adapt-N?

The purpose of providing a previous crop is to provide the model with information about remaining crop residues and their influence on N availability (immobilization in high carbon residue, or additional N in legume residue). We are working on incorporating cover crops and other crops into the Adapt-N rotation options. In the meantime, if the crop planted in the previous year is not listed as an option under Previous Crop, a crop with a similar growth pattern (planting density, crop residue) should be selected. Here are a few suggestions about how to generate the most accurate results, given current limitations.

- **Small grains, straw harvested:** Substitute silage corn for small grains, if straw was harvested, or remaining straw is minimal. The reason for this is that, like silage, small grains after straw harvest leave a minimal amount of surface residue, so that little immobilization of nitrogen occurs. The amount of root residue left by densely planted grains is likely similar to more broadly spaced, but larger, corn root residue.
- **Small grains, straw left on surface**: When following small grains where straw was not harvested (if residue is still fairly thick by corn planting time) use "grain corn" as the previous crop, so that some immobilization of N in residue will be accounted for, although imperfectly.
- **Vegetable crops/potatoes**: Substitute soybean for vegetable crops/potatoes, but be sure to add the soybean N credit listed on your results page to your Adapt-N recommendation (15 lbs or 25 lbs, depending on location and soil type) for non-legume vegetable crops. Like soybeans, most vegetable crops leave minimal residue, but most do not fix nitrogen.

- **Cover Crops:** Currently your best option is to use a cover crop credit (if applicable) as suggested by your local extension system. We plan to have a beta-module for cover crops available for testing for the 2014 season (see also Question 14).

9. *Should I create different field locations if soils or yield potentials differ within a single field?*

Ideally, each field location in Adapt-N should be created to represent a management unit with the uniform soil type, organic matter, yield potential, and other important characteristics that change across a field. If such factors differ significantly within a field, then we highly recommend simulating these zones separately. This way, Adapt-N can generate recommendations specific to soil/crop conditions that more accurately represent actual N needs. Adapt-N, in conjunction with variable rate fertilizer application equipment, soil sensors to create fine-scaled organic matter maps, and GPS technology, can provide more precise recommendations than when used on a whole-field basis.

However, if your technology does not allow you to apply variable rates, we recommend one of two approaches: 1) select the dominant/most representative soil series, soil texture, etc to attain an overall recommendation for the entire field, or 2) select several dominant soil series, textures, organic matter contents, etc, run several simulations for the same field, and choose one of the higher recommended rates among representative simulations. Although this approach is not ideal from an environmental perspective, significant yield loss in a large portion of a field can be expensive (generally more expensive than some over-fertilization). Using variable rate approaches is best both economically and environmentally.

10. *How do I estimate percent crop residue on surface for my conservation tillage practices, and how much does it matter?*

Only a very general estimate of the % residue remaining from the previous year's crop is needed (the options in Adapt-N are 25, 50, 75, or 100%). For some guidance on estimating, you can use the percent surface residue values detailed in the Cornell Guide for Integrated Field Crop Management, available online at http://ipmguidelines.org/FieldCrops/Chapters/CH02/CH02-8.aspx. The guide provides values (% of original) for most tillage operations. To attain surface residue you multiple the values for each operation times the original percent surface residue. For example, if you started with chisel plowing with sweeps (70-85% surface residue remaining), and then field cultivated with duckfoot points (60-70% surface residue remaining), you would have approximately 50% surface residue remaining; (0.80)*(0.65) = 0.52.

Remember that an estimate is sufficient, as this input has only a small impact on the N recommendation. Adapt-N models decomposition of incorporated residue, and slightly adjusts temperature and moisture conditions.

11. How do I input a fertilizer application that was applied in irrigation water?

Input a fertilizer application equivalent to the amount of N fertilizer applied on the same date as the irrigation application.

12. Why can't I input manure applications prior to fall of last year? How do I account for earlier applications?

Depending on what region your field locations are in, Adapt-N may only allow you to input manure applications from the previous fall and more recent at this point. The regions where this applies are dominated by swine manure applications which are largely ammonium-N (and a low amount of organic N), therefore crediting only 1 year back is appropriate. Regions where the dominant manure is dairy allow for crediting three years of applications. We will be working on improving options throughout covered regions as resources become available in the future. For the moment we recommend a work-around: simply subtract from the Adapt-N recommendation the N credit recommended by your local extension office.

13. Is it better to use Soil Series or Soil Texture for Soil Information?

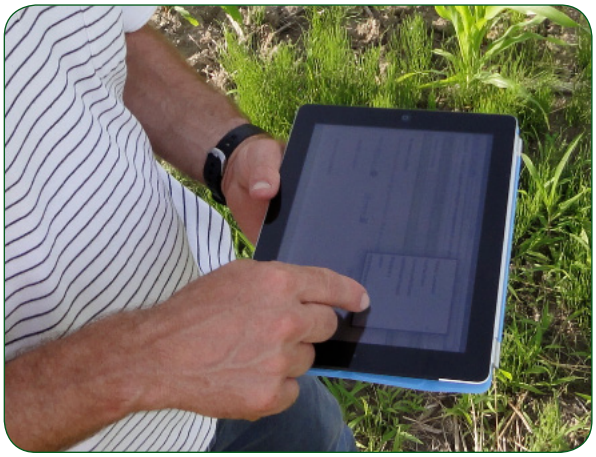
If you know your soil series, you are likely to get a more accurate recommendations using soil series when entering soil information. If the soil series differs across the field, but texture does not you can choose either the dominant soil type or that texture if you do not have the ability to do variable rate N (VRN) application. If you do have VRN capacity, see Question 9.

14. How do I account for cover crops in my rotation?

At this point, Adapt-N does not yet incorporate cover crop inputs, but we hope to have a beta-module ready for testing in 2014. The sod input does not provide an accurate approximation of cover crops and will result in artificially low recommendations, because a perennial sod generally provides more nitrogen than a cover crop. In 2011 trials, a clover crop was input as a sod application and resulted in yield losses due to insufficient N provided at sidedress time. For now the best work-around is to estimate a N credit you expect from your cover crop, if applicable, and subtract this from the Adapt-N recommendation.

15. How do I determine my expected yield?

We recommend estimating expected yield by using the second-highest yield out of the past 5 years as a good starting point. If at sidedress time you have reason to believe that yields that year will be lower or higher than this (for example, if the crop was planted late and early season condi-tions were poor so that you anticipate that some yield potential has been lost), you can further adjust your expected yield. Also, you may want to consider adjusting expected yield by manage-ment unit in your fields, based on yield monitor data.



16. What depth should I take my soil sample at for soil organic matter (SOM)?

The better the inputs, the better the model can simulate N dynamics. SOM samples taken to a 12" depth, rather than 6 or 8" depth, will provide more information about the actual organic matter content that contributes to N availability. Also, be sure to know the depth to which your samples were taken. NRCS soils data are used to estimate SOM content for parts of the soil profile for which no information is available. These may or may not represent your field.

17. How important is accurate soil organic matter (SOM) information to N rec-ommendations?

SOM directly impacts the Adapt-N recommendation, and therefore is extremely important to generating accurate N recommendations in Adapt-N. Adapt-N uses SOM to predict how much N the soil will provide through mineralization over the course of the season, and how much of mineralized N has been lost from the system. The soil's contribution to available N, based on weather influences, is represented dynamically in the SoilN factors included in the sidedress calculation (see page 17). As SOM increases, the soil's potential to provide N increases, thus lowering the Adapt-N recommendation. Inaccurate SOM measurements can lead to artificially high or low recommendations. Because SOM can vary significantly across a field, so variable rate N application will increase precision of recommendations (see Question 9).

18. How often should I test my soil organic matter (SOM)? Is it better to use an old SOM test result or the interface default?

We recommend testing for SOM every 3 years.

SOM changes slowly when management changes, but can vary greatly within the same soil type. Because Adapt-N uses default SOM values from NRCS soil pedons if you do not provide a value, it would generally be better to use a measured value (even if it may be 5 years old) than to not provide a value. We highly recommend using representative, recently sampled SOM test results, because this is an input of high importance for properly simulating dynamics and providing accurate recommendations.

19. I have a range of organic matter values for my fields, how should I enter these data in Adapt-N? Should I use the high values or the low values? Or, should I just use an average on the whole field?

To attain the most accurate Adapt-N recommendations it is best to create field locations in Adapt-N for each management unit (discrete field sections based on soil characteristics, i.e. organic matter content, soil type, etc. – see Question 9) If you do not have the ability to apply variable N rates, then assess what organic matter contents represent the largest areas in your field. From an economic perspective, you may then want to use an organic matter value in the lower part of your range, to prevent expensive yield loss. However, be aware that this means you will be over-applying N in sections of the field with high OM content.

Errors Messages

20. Why am I receiving an error message related to the dates I have entered into the interface?

Make sure that dates are for the growing season you are simulating or within the range of dates acceptable for a specific component (i.e. fertilizer applications, manure applications, spring tillage, etc.). Use the calendar tool to ensure that dates are entered in the correct format. Often, mistakes related to dates are a result of not using the calendar tool to select dates.

21. Why am I receiving an error message telling me to refresh/reload my browser or log back in?

This can occur for several reasons. Here are the most common ones:

- When users are using the back button of the browser. To avoid generating this error, use the tabs to navigate the interface and not the back button.
- When an account is idle for too long so that the session expires. After a certain amount of time without activity you will need to log back in.
- When multiple users are logged into the same account. We strongly recommend against this, as the account's data may become corrupted when multiple users use the account at once.

Puzzled by the Recommendation?

22. My Adapt-N recommendations are really low – much lower than what I usually apply. What's going on?

There are several reasons why Adapt-N may recommend a low rate. They may have to do with dynamics in the field or with use of the interface:

Dynamics in the field:

- Conventional static recommendation systems (same recommendation each year, not accounting for weather factors) account for the high uncertainty in N availability by recommending higher rates than needed in an average to dry year in order to not leave a farmer short in N in wetter-than-average years. Since Adapt-N explicitly incorporates the impact of weather, you can expect to receive a lower-than-normal recommended rate from Adapt-N after a normal or dry spring.
- If an adequate amount of fertilizer or manure was already applied at or before planting, or soil organic matter content is high and has provided significant available N, and these contributions have not been lost due to heavy rainfall, then very little or no additional nitrogen may be needed. Check the pdf full report for N mineralized and losses to help in gaining an understanding of the system.
- If you use a low expected yield input, then the total amount of N needed will be low

Interface use pointers:

- Adapt-N can only be as accurate as the inputs provided. Make sure to double check all your inputs.
- Particularly, check that you have entered correct values for fertilizer and manure inputs and soil organic matter content. Low recommendations can occur from accidentally entering high SOM values, and fertilizer and manure amounts or analysis values. Also make sure the expected yield you are using is reasonable (see Question 15).
- If you are using the batch upload feature, make sure that you don't have duplicate fertilizer applications in the system, as this would artificially decrease recommended rates (see Question 40).

23. I have applied a lot of fertilizer at my location, but the recommended rate is still very high – what's going on?

There are several reasons why Adapt-N may still recommend a high rate when fertilizer inputs are high. They may have to do with dynamics in the field or with use of the interface.

Dynamics in the field:

- High early-season rainfall can cause high N losses from the system. In such years, Adapt-N may recommend higher rates than expected.
- If a large amount of fertilizer or manure was applied at or before planting, losses in the early season may have been high. Check the pdf full report for rainfall and resulting estimated N losses thus far this season.
- If you use a high expected yield input (see Question 15 for choosing a reasonable input), then the total amount of N needed will be high
- Another possibility is that your location has a soil with very low organic matter. Organic matter strongly influences Adapt-N recommendations. In a low SOM soil, the amount of N provided through mineralization will be low, potentially requiring higher fertilizer inputs.
- If expected yield is high, and organic matter is low, then more fertilizer will be needed. Check the 'Sidedress N Definitions' to see how the recommended rate was calculated. Organic matter influences the amount of N in the soil at sidedress time, and N losses due to leaching and volatilization.

Interface use pointers:

• The Adapt-N model simulation will only run to the day prior to the current date, due to the lag period in attaining the high resolution weather data. If you input a fertilizer application for the current date, or after the Season End Date (the last day that the simulation runs through chosen by the user), then the model will not account for that fertilizer application. For example, if you apply anhydrous ammonia on 4/15/2013 in the interface, and run the model through 4/14/2013, the model will not account for the 4/15/2013 fertilizer application. Therefore, you will get a recommendation as if this N had not been applied. The graphs in the 'Full Report and Graphs (pdf)' link at the bottom of the Results page, are very useful for viewing changes in soil N over time, N mineralization, and other useful indicators of the system. You can see how fertilizer applications later than the Season End Date are not included in the simulation.

- As of the 2013 growing season, the model likely over-predicts winter losses from fall applied nitrogen after drought. This is because the model initializes its simulations with the assumption that the soil is at field capacity. After a drought, this overestimates water contents in the profile, and thus concurrent leaching and denitrification losses. This can then result in high recommended N rates. Adapt-N was designed and calibrated for spring and in-season applied nitrogen, as fall application is a poor and inherently inaccurate practice that risks high N losses. We are however working to incorporate good model capabilities to deal with fall applications and subsequent transformations during the winter. As a temporary workaround, we suggest that after a drought, the date of fall N application that is entered into the tool be changed from fall to early spring (e.g., March 1, or the day on which the soil's field capacity was first recharged would be appropriate). Please check our website for updates that are not reflected in this edition of the manual.
- As of the 2013 growing season, the model does not yet incorporate N stabilizers. If you have used such products but not accounted for this in Adapt-N, the recommendations may be higher than needed. We are working to incorporate such products as data on their effects in relation to temperature and moisture become available (also see Question 7).

24. Using Adapt-N Beta for newly added states: When I run the Adapt-N simulation for the same field location, but using different regions' Adapt-N versions, why do I get a different N recommendation and slightly different graphs?

Simulating the same locations, with the same textural class, is likely to generate slightly different recommendations when using Adapt-N versions for different regions. This is because textural classes are based on different soil pedons for each region. The soil pedon selected is deemed the most typical soil series for the textural class in a specific region. For example, in the Northeast, the "loam" soil is modeled based on data collected for a specific Honeoye pedon. Differences in soil properties (bulk density, water retention, and texture) influence how soil water and N activity are modeled, thus impacting N recommendations.

Late Season, End of Season & Retrospective Analysis

25. Can I use Adapt-N to generate mid to late-season N recommendations?

The sidedress N recommendation that Adapt-N provides is not accurate outside of the early growing season, between about V2 and V15, certainly no later than tasseling. We recommend that sidedressing is implemented between V6 and V12 for best results. Before V6, accuracy is lower as much of the early-season weather influences have not yet been determined. After V12 the risk of N-stress to the corn crop increases when available N has been used, while further losses due to wet conditions are unlikely to be significant due to large transpiration rates. Benefits of sidedressing have been shown up to V16, although uptake efficiency can decrease, especially with drought.

As long as cumulative nitrogen uptake by the crop continues to increase, while inorganic N and nitrate in the top 12 inches are at low levels and decreasing, emergency N applications can be considered. If crop N uptake has plateaued, a late N application will be unlikely to benefit yield, and will result in profit losses due to cost of application, as well as environmental losses with wetter fall and winter weather.

Note that, while the sidedress N recommendation provided by Adapt-N is only valid during the sidedress window (not for end of season runs, due to the way it is calculated, see p 17), the graphs provided in the Full PDF Graphs section are valid and provide useful insight into nitrogen dynamics in the field throughout the entire growing season.

26. Why does Adapt-N still give me a N recommendation in September when my crop is close to harvest?

Adapt-N is set up as a tool for in-season sidedress recommendations (see Question 25 for timing), but does not automatically stop providing recommendations when the window for sidedressing has passed. While the sidedress N recommendation provided by Adapt-N is only valid during the sidedress window (not for end of season runs, due to the way it is calculated, see p 17), the graphs provided in the Full PDF Graphs section are valid and provide useful insight into nitrogen dynamics in the field throughout the entire growing season.

27. How do I retrospectively evaluate what would have been my Adapt-N recommendation for the previous growing season?

You can run Adapt-N at any time of year for the present year or a past year to compare recommendations between years, fields, and management systems. Here are several pointers for doing this appropriately:

- ***Season End Date for retrospective runs:*** For a retrospective analysis of what rate Adapt-N would have recommended, you will need to use an appropriate "Season End Date" in the tool. This input field is found in the top left corner in interface. When you are ready to run the simulation for a location, enter the date on which sidedressing was done, or a reasonable date on which sidedressing would have been done (if no sidedressing was performed), then submit the simulation. The model will simulate through that date, allowing it to provide a representative recommendation.

- ***Sidedress timing***: While simulation information in the graphs of the pdf are representative through the end of the season, the sidedress recommendation is not usable when the model is run beyond the reasonable sidedress/rescue application window (no later than tasseling), because of the way the recommendation is calculated (also see Question 25).
- ***Expected Yield***: When end-of-season comparisons are made between Adapt-N and other recommendation systems through retrospective runs, an appropriate expected yield should be used. Adapt-N is used as a predictive tool in the early growing season, and this means that the expected yield should be based on an achievable yield, as determined at sidedress time, based on the real-world field-specific situation. Please enter this expected yield in the tool, rather than the actual yield achieved (if different) at the end of the season. We recommend that the achievable yield is targeted as approximately the second highest yield achieved out of the last five years, unless there are clear indications at sidedress time of reduced or increased yield potential. (For example, if yields in 2008-2012 were 200, 215, 190, 185, 120, then an appropriate expected yield for 2013 would be 200 bu/ac). The post-season evaluation should not be based on the achieved final yield of that growing season, as this may have been impacted by late-season processes like drought (such as 120 bu/ac in the 2012 example above), weed competition, hail, or pest pressure, that cannot be predicted at sidedress time. This would not be representative of the use of Adapt-N or other recommendation systems in a real-world scenario, where an optimum N rate must be predicted in late spring or early summer.
- ***Statistical Power:*** If you perform your own statistical analysis of results from trials that compare N rates, be aware that limited statistical power and relatively subtle yield differences for a single replicated experiment may reduce the ability to find statistically significant differences among N rates. This does not necessarily imply that an agronomic response was not present, but that it is difficult to prove its statistical significance if the yield difference was not pronounced, or the field was very variable. This becomes less of a problem with the combined analysis of multiple field trials, allowing for a more robust evaluation of the treatment effects. Also, we have evaluated past trials by incorporating both input and output effects of the treatments, yielding a partial profit analysis (see Chapters 5 and 6).

Nitrogen Recommendation Alerts

28. Why are recommendations and reports for my field locations not appearing in my N Rec. Alerts tab?

Each field location has to have completed information entered in order for Adapt-N to run successful simulations and generate daily recommendations that appear in the N Rec Alerts tab. Simulations of each complete location are done each night, and will be reported in this tab the next day.

29. Why am I not receiving my recommendation alerts via email or text?

- Each field location must have completed information entered to run successful simulations.
- Each field location for which an alert is desired needs to be checked in the Alert Settings Tab.

- The mode of notification (email or text messages) must be checked in the Alert Settings Tab, and a working email/phone number and carrier must be on file for your account (if you have provided a new email or phone number, the team will implement this as soon as possible after you have selected this option).
- Alerts are only active during the growing season.

Corn System Dynamics

30. Is splitting my N applications a good way to reduce N losses and increase N use efficiency?

Yes, split applications can significantly increase your ability to prevent N losses and save money by not paying for excess nitrogen. Ideally, we recommend applying only starter N fertilizer at planting, and applying the bulk of the needed N at sidedress time, when N needs can be more precisely determined.

Split sidedress applications: Some growers who have access to high clearance equipment even split their sidedress applications into two applications. This can further reduce losses, especially if the first sidedress application is made relatively early (before V6) and is thus still more subject to losses and less precise. In 2011, when users in NY sidedressed at V4-6 (a bit early), with no significant rain to cause further losses, their recommended rates decreased as the season progressed, so that more N was available than needed that season. Because predictability of crop N needs increases as the season progresses, potential for savings likewise increases when you wait to apply N, as long as the crop does not become N deficient.

31. How do I use Adapt-N to inform rates used when splitting my N applications?

To use Adapt-N to perform split applications (split beyond starter and one sidedress), run Adapt-N on the date of 1st sidedress to ensure that you are not exceeding total anticipated crop N needs. Enter the amount of N applied at first sidedressing to each field into Adapt-N. Then, run Adapt-N on the 2nd date of sidedress to assess crop N needs and determine the additional amount of N to be applied (if needed).

If planning split sidedress applications, apply less than the recommended amount at V4-8 (perhaps, 1/4-2/3 the amount, depending on soil N supply capacity, timing, and plans for the season). Several weeks later remaining N needs can be met with an additional high-clearance application, possibly adjusting expected yield, in addition to accounting for remaining early season weather for a more precise rate. N losses become unlikely after about V12, because the corn crop uses enough water to generally prevent wet soil conditions. For best N use efficiency, all needed N should be applied by about V12.

32. Should I add extra N to the Adapt-N recommendation if I am sidedressing less than a week after a heavy rainfall event?

Ideally you should wait to sidedress until at least 2-5 days after heavy rain, and then use the recommended rate. 2-3 days may be enough in coarse soils, while 3-5 days should be adequate for heavier soils. This is because there is a 1 day lag in the weather data, so that the rain event will not show up in the simulation until 1 day after it occurs. Leaching happens rapidly, and leaching losses are the primary losses in sandy soils that may allow for field-traffic 2-3 days after heavy rain. Denitrification processes take a few days to fully manifest after heavy rain, so that full losses due to the event are not accounted for until about 3-5 days after the event. Finer soil textures where denitrification processes are more dominant also take longer to become trafficable.

In either case, the most up-to-date recommendation available should be used. If the concern is that the crop may outgrow the equipment's ability to sidedress, and it is possible to get into the field less than 2-5 days after the event, then small amounts of insurance N (for example the high end of the range Adapt-N provides) can be considered. However, note that the precision of the recommendation, as well as soil dynamics, improve when waiting to sidedress for 2-5 days after heavy rain. Balancing timing in terms of weather, soil N status and equipment limitations is part of why more people are moving to high clearance equipment, which broadens the sidedress window and thus reduces risks.

33. Should I apply spring pre-plant or fall N fertilizer in addition to using Adapt-N for sidedress recommendations?

Ideally, we recommend applying only starter N fertilizer at planting, and applying the bulk of the needed N at sidedress time, when N needs can be more precisely determined. Most growers apply 15-45 lbs N/ac of starter fertilizer, depending on the system. Fall and spring pre-plant applications can result in large economic losses from purchasing excess N, and large N losses to the environment. A conservative change may be to shift fall applications to spring, or to reduce preplant applications to ½ or ¾ of original rates, and determine additional needs at sidedress time using Adapt-N.

About Adapt-N

34. Does the Adapt-N system recommend the date I should side-dress?

Adapt-N does not recommend the date of sidedress. However, Adapt-N users can sign-up for daily alerts, which allow users to monitor crop growth stage, available N in the root zone, and updated N recommendations for each location in Adapt-N. This information can be used to determine the appropriate sidedress time. We suggest sidedressing between V6 and V12 (see Question 25 on timing), depending on available equipment, and whether the crop is at risk of running out of nitrogen. Note that daily alerts are only generated for fields with completed input information – see Questions 28-29).

35. How does the system address the risk of rainfall events and subsequent N losses after the date of sidedress?

The later you sidedress, the bigger the crop, the deeper the roots and the greater the transpiration rate. Thus, the risk of N losses due to extreme wetness rapidly decreases after about V6, while the risk of drought (and thus excess N) increases.

36. Can I use Adapt-N to generate variable rate fertilizer application recommendations?

Adapt-N is a great tool to use in conjunction with variable rate fertilizer application equipment (see Question 9 for more on this). In order to use Adapt-N to generate variable rate applications, you can upload field locations based on management units (see Chapter 3 for an overview of how to do this). Then, use the N rec. alerts tab to access N recommendation fields all at once and upload data to your system. You may also be interested in the Donald & Sons Farm case study article for more information on this (Chapter 6).

37. Does Adapt-N have the capability to import organic matter maps and create a variable rate fertilizer application map?

As of 2013, Adapt-N just provides the recommendations by location, and you will need to create your own map, but ways to integrate with GIS technology are being explored. You can create locations using the upload feature for your fields based on management units, and then download the recommendation information from Adapt-N daily N rec. alerts to your variable rate equipment. We have added a batch upload feature to Adapt-N to facilitate the creation of many locations in the interface at once. With the upload feature, users can upload information for each component in separate CSV files (see Chapter 3 for an overview of how to do this).

38. How does Adapt-N account for a previous soybean crop?

The soybean N credit is modeled using two components. Adapt-N dynamically and mechanistically models immobilization of N in the past year's crop residue. Thus more N is immobilized after corn than after soy. Additionally, Adapt-N uses a partial credit of either 15 lbs or 25 lbs depending on the region and soil type, to account for further N contributions from a soybean crop.

39. What N losses are included in the graph of Cumulative Total Nitrogen Losses?

The Cumulative Total Nitrogen Losses graph shows model-simulated losses from volatilization, denitrification and nitrate leaching loss pathways.

- Volatilization is a physical/chemical process of ammonium becoming gaseous ammonia and is almost exclusively related to manure spreading, especially when not incorporating manure.
- Denitrification is a biological process that occurs during very wet and warm conditions, over several days, when soils become anaerobic. This occurs especially when wetness is prolonged, and with enough available carbon present. As of 2013, we are not yet providing information on nitrous oxide emissions separately, but ongoing work will allow us to provide estimates of this in 2014.
- Nitrate leaching is a physical process of available nitrates in solution moving out of the rootzone as rain water is translocated through the soil profile. Cumulative nitrate leaching is also shown as a separate graph.

Batch Upload

40. Is it possible to edit an existing fertilizer application using an Upload file?

It is possible to edit starter fertilizer applications, but not preplant/sidedress applications. This is because the interface allows for multiple preplant/sidedress applications but only one starter fertilizer application.

In order to edit existing fertilizer and manure applications you need to manually delete the existing fertilizer application before uploading the new application. You can use the Additional Processing tab to efficiently delete multiple fertilizer applications at the same time and to view all existing fertilizer applications in your account. The upload support does not allow you to upload identical fertilizer applications on the same date or to add more than four fertilizer applications per location.

41. Why can't I upload manure applications prior to fall of last year?

The Adapt-N interface has different settings for different regions. It is possible that your region only accepts manure applications for the current year (also see Question 12). Go to the Get Instructions tab and click on Manure instructions to determine the manure settings specific to your region.

42. Why are the dates I entered for fall plow and conservation tillage not appearing in the inter-face?

The interface does not require dates for fall plow or conservation tillage and therefore does not process the input. Only spring plow requires a date. If you do not provide a date for spring plow then you will receive an error message. The system simply ignores dates provided for fall and conservation tillage.

43. What component information can I change by uploading new inputs in my CSV file?

You can change starter fertilizer, crop/planting info, soil info, tillage info, sod info, and previous crop info. You cannot change preplant/sidedress fertilizer application or manure application information.

43. Excel has multiple CSV formats, which is the correct format?

Newer versions of Excel have several CSV formats: Comma separated values (.csv), Windows comma separated (.csv), and MS-DOS comma separated (.csv). All of these formats are compat-ible with the Upload Feature.

5. Adapt-N in the Field – 2011 & 2012 Strip Trial Results

We conducted a total of 84 strip trials in 2011 and 2012 in NY (56), Iowa (27) and Minnesota (1) to test how well Adapt-N predicts corn N needs at sidedress time. Yield data and estimated leaching losses from all 84 trials show that, when used correctly, the Adapt-N tool significantly increased grower profits and decreased environmental losses. Thus, Adapt-N provided an economic benefit to growers, while also minimizing N losses to the environment in almost all instances.

This manual section summarizes the results of 84 trials and describes specific trials that provide insights into how to most effectively use Adapt-N (also see summaries on how to make best use of Adapt-N, page 18, and on choosing inputs, p 43.)

Methods

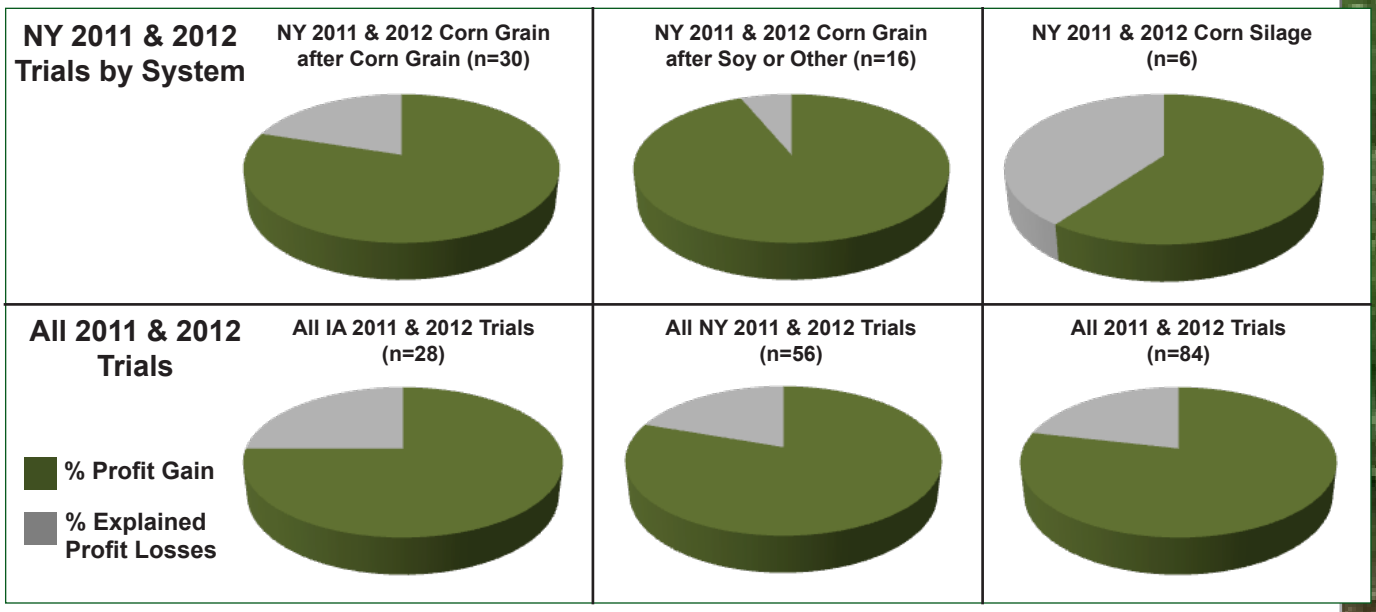
We completed 18 replicated strip trials in 2011, and 42 in 2012, on commercial and research farms throughout New York. We also conducted 9 strip trials in 2011, and 19 in 2012 on commercial farms throughout Iowa (1 trial in Minnesota is included with the Iowa trials in 2012). The trials involved grain and silage corn in fields with varying management history (i.e. organic amendments, crop rotation, tillage practices, etc.). Sidedress treatments involved at least two rates of nitrogen, a conventional "Grower-N" rate based on current grower practice and an "Adapt-N" recommended rate. A simulation was run for each field just prior to sidedressing to determine the weather-adjusted Adapt-N rate.

Yields were measured by weigh wagon, yield monitor, or in a few cases by representative sampling (two 20 ft x 2 row sections per strip). Partial profit differences between the Adapt-N recommended and Grower-N management practices were estimated through a per-acre partial profit calculation. Yields were used as measured, regardless of statistical significance, since the statistical power to detect treatment effects is inherently low for two-treatment strip trials. For corn grain, a 2011 grain price of $5.50/bu and 2012 price of $6.00/bu were assumed. For silage, $50/T was used in both 2011 and 2012, based on reported NY silage prices. A nitrogen fertilizer price of $0.60/lb was used, based on reported NY and IA fertilizer prices.

Total N losses to the environment (atmosphere and water) and N leaching losses in 2011 and 2012 were estimated for each treatment through model simulations through October 30 for 2011 NY trials, and through December, 15 in 2012 trials.

More detailed descriptions of the 2011 and 2012 methods were provided in previous WCU articles (Moebius-Clune et al., 2012; Moebius-Clune et al., 2013).

TRIAL LOCATIONS Map of 2011 and 2012 trial locations. Map courtesy of Google maps and batchgeo.com.



PROFIT GAINS Proportion of trials with profit gains (green) or losses (gray) as a result of using the Adapt-N recommendation compared to current grower N management in 2011 and 2012 trials. Profit calculations assume $0.60/lb N for all trials, $6.00/bu grain for 2012 and $5.50/bu grain for 2011, and $50/T silage for both years. Trials with profit losses due to underestimated yield potential are included, so success rates reported here can be improved to an estimated 88% through proper use of the most up-to-date version of the tool.

Economic Benefits

Profit gains from the use of Adapt-N were considerable. Profits increased in 80% of all NY trials, in 75% of all IA trials, and in 79% of all 84 trials when growers followed Adapt-N recommendations. Profit gains of $27/ac on average ($31/ac in NY, $20/ac in IA) were primarily attributed to fertilizer cost savings due to lower Adapt-N recommended rates without significant yield losses. Profit gains were also achieved in some instances where Adapt-N recommended higher N rates, and consequent yield increases were achieved (3 trials). Adapt-N rates resulted in average N input reductions of 66 lbs/ac in NY, 32 lbs/ac in IA, and 54 lbs/ac overall. Yield losses decreased by only 1 bu/ac on average in the 84 trials (a statistically insignificant yield loss), indicating that Adapt-N's reduced N recommendations were generally justified.

Because of the potential impact of field variability on the results of a single trial, analysis of all 84 trials provides the most meaningful assessment of Adapt-N performance and likelihoods for improving grower profits. A look at specific trials can provide insight into effective use of the tool. Yield losses (not always statistically significant), and sometimes profit losses, occurred in several 2012 trials where the user's 'expected yield' input in Adapt-N was an underestimate of the yield achieved with the higher N rate (7 trials in 2012). Adapt-N is a precise tool that already fully accounts for the risks of uncertainty and differential losses from over and under-fertilization. If the yield potential of

HARVEST Strip trial harvest at one of the trial fields in Iowa. Photo courtesy of Tucker Consulting.

the field is higher than the 'expected yield' provided to the model, Adapt-N is more likely to recommend insufficient N to achieve a higher yield. Therefore, a good estimate of expected yield is crucial to attaining accurate N recommendations. Analyzing 3 to 5 years of yield history to determine the expected yield input will maximize the accuracy of yield predictions and thus improve Adapt-N recommendations.

Adapt-N recommended a higher N rate than grower practice in 10% of trials, mostly due to wet spring conditions. In 3 of these 8 trials, the higher N rate resulted in a profit increase due to corresponding yield gains, thus justifying the higher N rate. In the 5 instances where a higher Adapt-N rate resulted in profit losses, unpredictable late-season drought conditions resulted in substantial yield reductions below the expected yield in both treatments. Due to insufficient water availability, the crop was unable to make use of the additional N applied in the Adapt-N treatment, thus the additional N fertilizer cost contributed to profit losses. While such individual situations are not preventable, because post-sidedress drought cannot be predicted by tools currently available, assessment of all trials shows that use of the Adapt-N rate provided increased profitability, while decreasing N inputs, in most cases.

In 2011, Adapt-N recommendations in corn-soybean rotations were low due to a deficiency in how Adapt-N implemented soybean N crediting. However, savings from N reductions in 80% of these trials were large enough to compensate for the respective yield reductions. This error

was corrected, and no further profit losses occurred in 2012 trials where corn followed soybean (Moebius-Clune et al., 2013).

Large N input reductions achieved with the use of Adapt-N can often compensate for small yield losses with the lower N rate. For example in one of the 2012 Iowa trials, Adapt-N recommended 0 lbs N/ac as compared with the conventional N rate of 75 lbs N/ac. Despite a yield reduction (9 bu/ac), the Adapt-N rate did not decrease profit (+$1/ac), due to the large reduction in sidedress fertilizer and operational expense. This trial is one of many that demonstrate that growers currently applying high rates of N can realize significant profit gains by using Adapt-N even if yields are somewhat reduced.

Average Change due to Adapt-N Use		2011 & 2012					
		NY Corn grain after corn grain (n=30)	NY corn grain after soy or other (n=16)	NY silage (n=10)	All NY trials (n=56)	All IA trials (n=28)	Grand Mean for NY and IA (n=84)
Average (Adapt-N - Grower-N)*	N fertilizer input (lb/ac)	-79	-65	-28	-66	-32	-54
	Simulated N leaching losses (lb/ac)	-9	-15	-3	-10	-1*	-8
	Total simulated N losses (lb/ac)	-63	-46	-29	-52	-2*	-39
	Yield (grain: bu/ac; silage: T/ac)	-3	0	0	-1	0	-1
	Profit ($/ac)	30	44	11	31	20	27

TABLE 1. Agronomic, economic and environmental assessment of model performance in 2012. Values are average differences resulting from Adapt-N use (Adapt-N minus Grower-N treatment) such that a negative number indicates a decrease due to Adapt-N, a positive number indicates an increase due to Adapt-N. Profit calculations assume $0.60/lb N for all trials, $6.00/bu grain for 2012 and $5.50/bu grain for 2011, and $50/T silage for both years.

Environmental Benefits

Adapt-N reduced N rates by 54 lbs N/ac on average, in 90% of trials, resulting in significant reductions in N losses to the environment. By the end of the growing season, simulated N leaching losses decreased by an average of 10 lbs N/ac, and total N losses decreased by an average of 34 lbs N/ac. In 2012, simulated total N losses and particularly leaching losses of sidedress-applied excess nitrogen remained relatively low by December due to widespread dry conditions during the growing season in NY and especially in IA. Further losses of residual excess N have occurred over the winter and spring months of 2011-2012 and 2012-2013. In silage trials, the pre-plant application of manure, and consequent lower inorganic fertilizer rates at sidedress time, limits the potential magnitude for reductions in N losses in comparison with non-manured fields, although Adapt-N can nevertheless significantly reduce fertilizer application in these systems.

Conclusions

Two consecutive growing seasons of on-farm strip trial testing have shown that Adapt-N is an effective tool for N management in corn systems, resulting in profit gains in 79% of trials, on average by $27/ac ($31/ac in NY and $20/ac in IA). When accounting for the now implemented correction of a soybean credit model deficiency, and underestimated yield potential inputs, we estimate that profit gains would have been achieved in 88% of trials to date. Other pointers for attaining the most accurate Adapt-N recommendations include:

- Estimate expected yield based on 3 to 5 years of accurate yield information.
- Use representative manure test results from actual manure inputs to reduce the margin of error associated with manure applications.
- Create field locations in Adapt-N by discrete management unit. Determine management units by several key factors: i.e. soil type, historical yield data, and organic matter content.
- Take management unit specific soil samples at least every 3 years to determine an accurate organic matter content value, ideally to a 12" depth.
- Run Adapt-N on the sidedress date if possible – use the daily alert feature for automatic updated recommendations on all fields.

In summary, Adapt-N strip trial results from 2011 and 2012 have shown that using Adapt-N to predict corn N needs at sidedress time provides economic advantages to growers as well as environmental benefits due to more precise management of N. Adapt-N thus provides a strong incentive to shift N applications to sidedress time, ultimately increasing grower profits and reducing N losses to the environment in both wet and dry years.

Modified from article published in What's Cropping Up? by Moebius-Clune, B., M. Carlson, H. van Es, and J. Melkonian. Adapt-N Proves Economic and Environmental Benefits in Two Years of Strip-Trial Testing in New York and Iowa. Vol., No., pp., 2013.

6. Donald & Sons Farm – A Case Study

Farm Background

Donald and Sons Farm in Moravia, NY grows about 1,300 acres of corn and soybean annually. Robert and Rodney Donald have been practicing variable rate N application for a number of years, taking advantage of their RTK-GPS system for soil sampling, input applications and yield monitoring. Until 2011, the farm used N application rates recommended by a commercial Midwest nutrient analysis laboratory, based on soil tests done by field management unit. The Donalds applied the bulk of their fertilizer N at sidedress time, as they knew that early season applications run the risk of losses during wet springs.

Recommendations ranged across their farm from 195 to 260 lbs of total N per acre, of which the Donalds applied 22 at planting. In 2011, they spent $107,000 on N fertilizer – four times what they spent in 2000, due to increasing prices and a shift toward ever-higher recommended rates as yield potentials increased.

Anhydrous sidedress rig ready to head to the field.

These large expenditures were a strong incentive to seek new tools to optimize application rates. As Rodney put it, "Money talks…and with what we are getting in corn for what we are putting on in ammonia, we're not gaining." In 2011, the Donalds decided to collaborate on the NY state-wide Adapt-N beta-testing effort. After the dry spring, the Adapt-N recommendation for their trial field was only 80 lbs N/acre, while their standard recommendation was 220 lbs N/acre. To their surprise, there was no yield penalty from reducing the N rate by 140 lbs N/acre. In state-wide trials, 2011 Adapt-N results were also very promising: 86% of trials showed higher profits using the Adapt-N rate, with an average increased profit of $35/acre.

"Once you get the hang of the program it's easy to use."

"I was pretty amazed with the program," said Robert, who decided to participate in a workshop on Adapt-N at Cornell University in March 2012. He added, "Once you get the hang of the program it's easy to use."

The Adapt-N tool is transforming the way N recommendations are made by using high-resolution climate data and a dynamic simulation model to provide weather-adjusted, site-specific, in-season nitrogen recommendations. What sets Adapt-N apart from other methods for determining crop N needs is its explicit accounting for the interaction between early season weather and other factors like soil characteristics and management decisions. After a dry spring, N that has mineralized from organic sources or was applied early in the season remains available in the soil, so less needs to be sidedressed. But in a wet spring, N is easily lost from the system and thus more fertilizer N must be applied. That difference between years could be as much as 100 lb N/ac. Not only does such unmanaged uncertainty cut deeply into growers' profits, but the environmental consequences are significant: leaching of excess nitrate affects water quality, and denitrification contributes to emissions of nitrous oxide, a potent greenhouse gas, that also depletes the ozone layer. Realizing that recommendations from Adapt-N could lead to significant savings for the farm (estimated at $70,000 for 2011 after a very dry spring with low losses) the Donald Brothers decided they were on board.

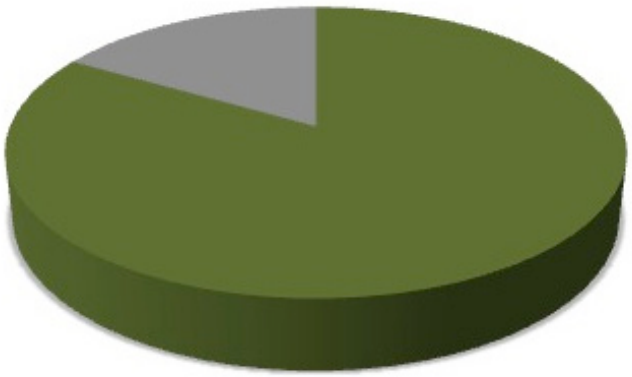
Adapt-N data card used with RTK-GPS on 922 acres of corn. Check strips sidedressed with "Old Way" data card that contained their conventional rates.

Trial Info		Fertilizer N applied			Yield		Profit ($/ac)
Trial ID	Prior crop	Old Rate (lb/ac)	Adapt-N (lb/ac)	Difference (A-O)	Old Rate (bu/ac)	Adapt-N (bu/ac)	Difference (A-O)
1	COG	222	162	-60	201	206	$68
2	COG	258	187	-71	235	227	-$8
3	COG	222	152	-70	149	152	$61
9	SOY	206	144	-62	229	224	$8
10	SOY	201	128	-73	163	172	$100
11	COG	204	140	-64	216	203	-$43
36	COG	215	154	-61	218	212	$2
37	COG	290	184	-106	208	212	$88
38	SOY	188	118	-70	213	215	$56
39	SOY	224	138	-86	198	197	$42
40	SOY	182	136	-46	222	235	$105
41	SOY	230	161	-69	237	245	$89
42	COG	207	128	-79	206	206	$52
43	COG	250	152	-98	186	189	$75
45	COG	208	129	-79	209	198	-$14
46	COG	250	152	-98	208	205	$39
47	COG	250	150	-100	209	201	$11
48	COG	231	129	-102	227	222	$34
49	COG	278	153	-125	229	229	$74
50	COG	278	152	-126	221	218	$55
51	COG	278	167	-111	219	213	$30
52	COG	216	129	-87	209	211	$69
53	COG	278	168	-110	201	198	$47
54	COG	258	120	-138	225	204	-$42
AVERAGE:		234	147	-87	210	208	42

Comparison of yield and profit using the "Old" N application rates vs. those recommended by Adapt-N. N rates represent total N in lbs/ac applied as inorganic fertilizer in 2012.

Whole Farm Implementation of Adapt-N rates

For the 2012 growing season, the Donalds used Adapt-N on their whole farm and implemented numerous trials. Robert entered the farm's 90 management units into his account that spring via the user-friendly Adapt-N interface. "I spent one Saturday afternoon and all day on Sunday," Robert noted. Between June 8 and 21, Rodney sidedressed 922 acres of corn, using their RTK-GPS system to target their variable rates. Recommendations from Adapt-N varied from 65 to 190 lbs N/acre among management units, depending on local temperature, precipitation, soil texture and organic matter content (varying from 1-6%), as well as the date of sidedressing. On each day of sidedressing, Robert entered updated N recommendations into their system (provided by the daily automatic Adapt-N sidedress alerts) for the fields to be sidedressed that day. He transferred this information to their calibrated RTK-GPS-guided anhydrous ammonia sidedresser via a USB device to automatically adjust N rates on-the-go.



PROFIT PERCENTAGE Percent of trials with profit gain resulting from reduced Adapt-N rate (20 trials, $55/ac), profit losses resulting from underestimated expected yield input (4 trials, -$27/ac), and trials with unexplained profit losses (none).

Rodney sidedressed entire fields with the Adapt-N rate, except for single or replicated comparison strips of the conventional "old" rate implemented on 15 of their 18 corn fields. Most of the strip trials followed an AOOA design (with "A" representing the Adapt-N rate and "O" representing the grower rate).

Agronomic, Economic and Environmental Results

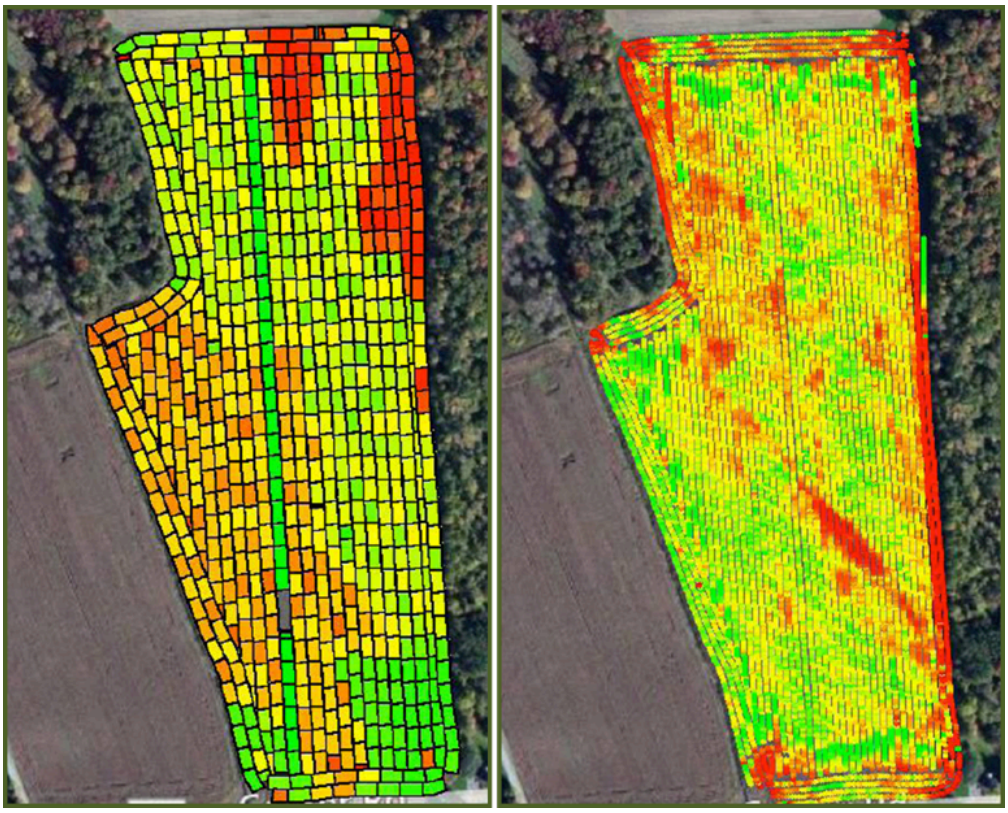
N rates as applied and yield monitor data for each trial area were retrieved from the Donalds' AgLeader software at the end of the season. Yields and fertilizer application rates were visualized in map format and quantified within management units or as field-length strips.

Based on analysis of GIS data from the entire farm, Adapt-N resulted in profit gains in 83% of the trials. Averaged across all trials, savings were approximately $42/ac, with estimated total sav-ings of over $30,000 for the farm after the fairly normal 2012 spring. Fields reached or exceeded the estimated yield potential in almost all cases, indicating that the Adapt-N recommended rates were high enough to achieve the expected yield.

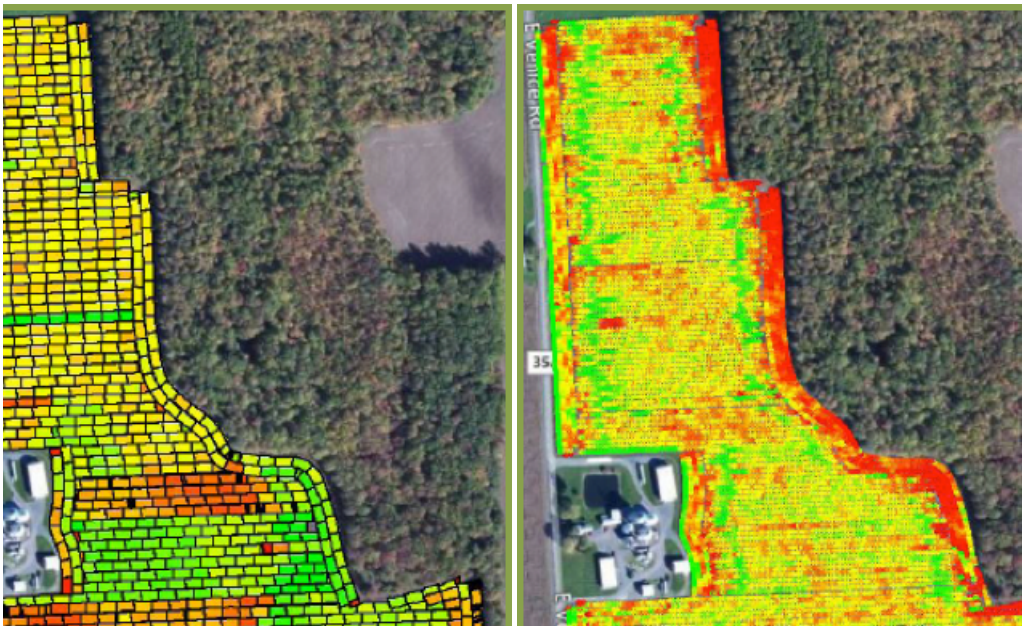
Yield losses were negligible (2 bu/ac) despite N fertilizer reductions by an average of 87 lbs/ac across all 24 fields. Yield maps visually emphasized the lack of yield response in the higher N rate strips for almost all trials, as well as the potential impact of field variability on harvest yield.

The only cases of profit loss occurred in four trials, all exceeding the expected yield by up to 35 bu/ac. Yield losses could have been minimized with more precise expected yield inputs; the Donalds had entered a flat yield potential of 200 bu/ac for all fields, rather than basing the input on past field-specific yield records. Adapt-N is a precise tool that already accounts for the risks of uncertainty and

On-the-go variable rate sidedressing of Adapt-N rates by management unit.



MAPPING TRIAL RESULTS. Top & Bottom (left): N application maps for Trials 48-50 and 38 & 39 respectively, retrieved from calibrated anhydrous sidedresser - the green strip indicates the high rate grower-N strip, and the grey rectangle indicates a zero-N section (data not discussed here). Top & Bottom (right): Yield maps retrieved from calibrated yield monitor, with no visually apparent yield increase with higher Grower-N rate in all trials.



differential losses from over and under-fertilization. Therefore, a good estimate of expected yield is critical to attaining accurate N recommendations.

Savings from whole-farm implementation of Adapt-N were coupled with significant environmental benefits. Informed by Adapt-N, the Donalds applied a non-area-weighted average of 87 lbs/ac less than recommended by A&L Laboratories across the implemented trials. The decrease in N applications reduced simulated total environmental N losses (until 12/15/2012) by an average of 70 lbs/ac, and reduced N leaching losses by an average of 10 lbs/ac. In total, they saved about 67,000 lbs of unneeded N in 2012.

Refining Adapt-N use in 2013

When asked whether they were planning to use Adapt-N again next year, Robert answered with an unequivocal "Oh yeah!" and added, "Gotta refine our use of the tool some." Robert recognizes that for a precision tool like Adapt-N, a reasonable expected yield is particularly important. One of the biggest things Robert plans to change: He will use variable estimated yields for each management unit in 2013, based on 3 to 5 years of yield records for each management unit. He noted that one of his fields in Scipio, NY "won't do 175 in the best of years. That's where N is wasted," while, "other fields can regularly reach 250 bu/ac" if given enough nitrogen. Also, he plans to use the new soil series name inputs that became available last June to further improve the precision of the recommendations.

The trials implemented at Donald & Sons Farm have greatly helped the team assess Adapt-N's performance and demonstrate the efficacy of using the tool in conjunction with GPS equipment. Growers with similar technological capabilities can likewise maximize the potential of Adapt-N to improve their profits and reduce N inputs and losses.

Modified from article published in What's Cropping Up? by Moebius-Clune, B., M. Carlson, D. Moebius-Clune, H. van Es, J. Melkonian, and K. Severson. Case Study – Part II: Central NY Farm Applies Adapt-N Rates on Whole Farm, Saves Money and Reduces Environmental Impact. Vol., No., pp., 2013.

VARIABLE RATE Robert & Rodney Donald look at VRN maps with Bianca Moebius-Clune.

Resources and Publications

The Adapt-N website has the most up-to-date list of useful resources available at http://adapt-n.cals.cornell.edu/pubs/index.html. Many of the articles can be downloaded directly. Webinars are available for viewing. Any references not available for direct download can be requested from the Adapt-N team (adapt-n@cornell.edu).

Articles

- Adapt-N Uses Models and Weather Data to Improve Nitrogen Management for Corn by Bianca Moebius-Clune, Harold van Es, and Jeff Melkonian. Better Crops. Vol 97:7-9. 2013.
- Adapt-N Proves Economic and Environmental Benefits in Two Years of Strip-Trial Testing in New York and Iowa by Bianca Moebius-Clune, Maryn Carlson, Harold van Es, and Jeff Melkonian. What's Cropping Up preview, May 2013.
- Adapt-N Increased Grower Profits and Decreased Nitrogen Inputs in 2012 Strip Trials by Bianca Moebius-Clune, Maryn Carlson, Harold van Es, and Jeff Melkonian. What's Cropping Up preview, May 2013.
- Case Study – Part II: Central NY Farm Applies Adapt-N Rates on Whole Farm, Saves Money and Reduces Environmental Impact by Bianca Moebius-Clune, Maryn Carlson, Daniel Moebius-Clune, Harold van Es, Jeff Melkonian and Keith Severson, What's Cropping Up preview. May 2013.
- Adapt-N Increased Grower Profits and Decreased Environmental N Losses in 2011 Strip Trials by Bianca Moebius-Clune, Harold van Es, and Jeff Melkonian. What's Cropping Up preview. March 2012.
- Donald & Sons Farm Sees Money-Saving Potential in Adapt-N Tool for Corn N Rate Recommendations by Marlene van Es, Bianca Moebius-Clune, Harold van Es, Jeff Melkonian and Keith Severson. 2012.
- A Case Study on the Use of Adapt-N by James LaGioia, Harold van Es, Jeff Melkonian, Bianca Moebius-Clune and David Shearing. What's Cropping Up? Vol. 21 No.4, November- December, 2011.
- Adapt-N: Incorporating weather, soils and management information to provide more precise in-season N recommendations for corn by van Es, H., Melkonian, J. and Moebius-Clune, B., Jan 25, 2011. Empire State Fruit and Vegetable Expo Proceedings, Syracuse, NY.
- Mitigating and Adapting to Climate Change through Adaptive Nitrogen and Soil Health Management, by Moebius-Clune, B., van Es, H., Melkonian, J. and Schindelbeck, B., 2010. Dealer

Meetings Conference Proceedings.

- Adapt-N Tool Helps Farmers Deal with Climate Change, Energy Consumption and Greenhouse Gas Emissions, by van Es, H., Melkonian, J., Moebius-Clune, B., Schindelbeck, B., Joseph, L., DeGaetano, A., 2010. What's Cropping Up? 20, p 6-7.

- Adapt-N: A New Tool for Adaptive N Management for Corn by Melkonian,J., van Es, H., DeGaetano, A. and Joseph, L., 2008. What's Cropping Up? 18, p 1-2.

Webinars and recorded presentations

- National webinar Precision Nitrogen Management in Corn using the Adapt-N Tool, an in-depth training in multiple sections, recorded March 21, 2013
- Basic training on how to use Adapt-N, a recorded training session provided to audience at Middlebury, VT extension office, with support from UVM on April 5, 2012. More info.
- Adapt-N: A New Nitrogen Management Tool for Sweet Corn? Webinar of presentation to audience at Cornell Cooperative Extension Capital Distirct Vegetable and Small Fruit Program's 2012 Annual Winter Meeting in Albany, NY on Feb 29, 2012. Includes overview of Adapt-N tool and preliminary 2011 results.
- Adaptive Nitrogen Management for Corn I: Processes and Management Approaches, October 2010 ASA Seminar in Continuing Education Seminars series.
- Adaptive Nitrogen Management for Corn II: Implementation Using Field and Model Tools, October 2010 ASA Seminar, in Continuing Education Seminars series.
- Adaptive Nitrogen Management for Corn Using Adapt-N: Understanding the Processes and Information Needs. Recorded at national ASA-CSSA-SSSA meetings in Long Beach, CA, November 3, 2010, as part of the Z-Series Special Session "Adaptive Management: A How-to Guide and the USDA NRCS Code 590 Standard"

Workshop Materials

Adapt-N Workshop, Ithaca, NY. March 19, 2012.

- Overview of N dynamics, environmental issues and available tools
- The Adapt-N tool: its inner workings and upcoming changes
- Adapt-N 2011 on-farm trial results
- Adapt-N guided hands-on exercise

Adapt-N Workshop Webinar, Broadcast from Ithaca, NY, and multiple host locations. March 21, 2013.

- Adapt-N guided hands-on exercise

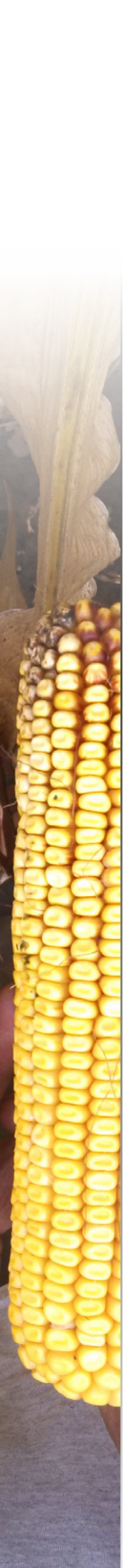
Brochure

- Adapt-N Brochure [.pdf] - We may have some glossy printed copies available. Email: Bianca Moebius-Clune bnm5@cornell.edu

Peer-Reviewed Publications, Symposium Proceedings and Manuals

On the Adapt-N tool, the models behind it, field studies and model calibration

- Melkonian, J. L.D. Geohring, H.M. van Es, P.E. Wright, T.S. Steenhuis and C. Graham. 2010. Subsurface drainage discharges following manure application: Measurements and model analyses. Proc. XVIIth World Congress of the Intern. Commission of Agric. Engineering, Quebec City, Canada.
- DeGaetano, A.T., Wilks, D.S., 2009. Radar-guided interpolation of climatological precipitation data. International Journal of Climatology 29, 185-196.
- Melkonian, J.J., H.M. van Es, A.T. DeGaetano, and L. Joseph. 2008. ADAPT-N: Adaptive nitrogen management for maize using high-resolution climate data and model simulations. In: R. Kosla (Ed.). Proceedings of the 9th International Conference on Precision Agriculture, July 20-23, 2008, Denver, CO (CD-ROM).
- DeGaetano, A.T., Belcher, B.N., 2007. Spatial Interpolation of Daily Maximum and Minimum Air Temperature Based on Meteorological Model Analyses and Independent Observations. Journal of Applied Meteorology and Climatology 46, 1981-1992.
- Melkonian, J., H.M. van Es, A.T. DeGaetano, J.M.Sogbedji, and L. Joseph. 2007. Application of Dynamic Simulation Modeling for Nitrogen Management in Maize. In: T. Bruulsema (ed.) Managing Crop Nutrition for Weather. Intern. Plant Nutrition Institute Publ. pp. 14-22.
- van Es, H.M., B.D. Kay, J.J. Melkonian, and J.M. Sogbedji. 2007. Nitrogen Management Under Maize in Humid Regions: Case for a Dynamic Approach. In: T. Bruulsema (ed.) Managing Crop Nutrition for Weather. Intern. Plant Nutrition Institute Publ. pp. 6-13.
- Sogbedji, J.M., H.M. van Es, J. Melkonian, and R.R. Schindelbeck. 2006. Evaluation of the PNM model for simulating drain flow nitrate-N concentrations under manure-fertilized maize. Plant and Soil 282: 343-360.
- Sogbedji, J.M., H.M. van Es, J.L. Hutson, and L.D. Geohring. 2001. Fate of N fertilizer and green manure in clay loam and loamy sand soils: I Calibration of the LEACHM model. Plant and Soil 229(1): 57-70.
- Sogbedji, J.M., H.M. van Es, J.L. Hutson, and L.D. Geohring. 2001. N rate and transport under variable cropping history and fertilizer rate on loamy sand and clay loam soils: II. Performance of LEACHMN using different calibration scenarios. Plant and Soil 229:71-82.
- Sogbedji, J.M., H.M. van Es, S.D. Klausner, D.R. Bouldin, and W.J. Cox. 2001. Spatial and temporal processes affecting nitrogen availability at the landscape scale. Soil & Tillage Research 58 (3-4) 233-244.
- Sogbedji, J.M., H.M. van Es, C.L. Yang, L.D. Geohring, and F.R. Magdoff. 2000. Nitrate leaching and N budget as affected by maize N fertilizer rate and soil type. J. Environm. Qual. 29:1813-1820.
- Sinclair, T.R., and R.C. Muchow. 1995. Effect of nitrogen supply on maize yield: I. modeling physiological responses. Agronomy Journal 87:632-641



- Muchow, R.C., Sinclair, T.R., 1995. Effect of nitrogen supply on maize yield: 2. Field and model analysis. Agronomy Journal 87, 642-648.
- Sinclair, T.R., Amir, J., 1992. A model to assess nitrogen limitations on the growth and yield of spring wheat. Field Crop. Res. 30, 63-78.
- Amir, J., Sinclair, T.R., 1991. A model of the temperature and solar-radiation effects on spring wheat growth and yield. Field Crop. Res. 28, 47-58.
- Amir, J., Sinclair, T.R., 1991. A model of water limitation on spring wheat growth and yield. Field Crop. Res. 28, 59-69.
- Muchow, R.C., Sinclair, T.R., 1991. Water deficit effects on maize yields modeled under current and greenhouse climates. Agronomy Journal 83, 1052-1059.
- Hutson, J.L., and R.J. Wagenet. 1991. Simulating nitrogen dynamics in soils using a deterministic model. soil use and management 7:74-78.
- Sinclair, T.R., Bennett, J.M., Muchow, R.C., 1990. Relative sensitivity of grain-yield and biomass accumulation to drought in field-grown maize. Crop Sci. 30, 690-693.
- Muchow, R.C., 1990. Effect of high-temperature on grain-growth in field-grown maize. Field Crop. Res. 23, 145-158.
- Muchow, R.C., Sinclair, T.R., Bennett, J.M., 1990. Temperature and solar-radiation effects on potential maize yield across locations. Agronomy Journal 82, 338-343.

Combining Spatial and Temporal Variability

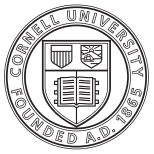
- Graham, C.J., H.M. van Es, J.J. Melkonian, and D.A. Laird. 2010. Improved nitrogen and energy use efficiency using NIR estimated soil organic carbon and N simulation modeling. In: D.A. Clay and J. Shanahan. GIS Applications in Agriculture – Nutrient Management for Improved Energy Efficiency. pp 301-325, Taylor and Francis, LLC.

Manual for LEACHM (the soil processes model)

- Hutson, J.L. and R.J. Wagenet. 2003. Leaching Estimation And Chemistry Model: a process-based model of water and solute movement, transformations, plant uptake, and chemical reactions in the unsaturated zone. Version 4. Dept of Crop and Soil Sciences. Research Series No. R03-1. Cornell University, Ithaca, NY, USA

Adapt-N Training Manual

A tool for precision N management in corn



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