Cornell University

How *Adapt-N* calculates field-specific sidedress N recommendations for corn

Background

How much N fertilizer should you provide for a corn crop? The idea is that you apply enough to satisfy your crop's demand, but not more than is needed, because N is costly and a serious environmental pollutant. Deciding on the right amount to add might be easier if the crop could take up exactly all the fertilizer you supply, and fertilizer was the only source of N for the crop. However, corn gets N from several sources, and there are many ways N can get lost from the root zone as a result of weather-related factors. For this reason, most N fertilizer calculators are very imprecise. ***Adapt-N*** is a new web-based decision support tool (url: **http://adapt-n.cals.cornell.edu**), linked to a computer model and high-resolution climate data, that recommends how much N fertilizer to apply to corn on a particular field in a particular year.

Losses of N

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 nitrate leaching below the root zone, surface runoff losses, volatilization of ammonia, and denitrification to the atmosphere in the form of N_2 or N_2O. 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 Factsheet #1). In some cases these losses need to be compensated for, while in other cases when losses are low and/or N mineralization is high, you may not need any sidedress fertilizer at all.

Sources of N

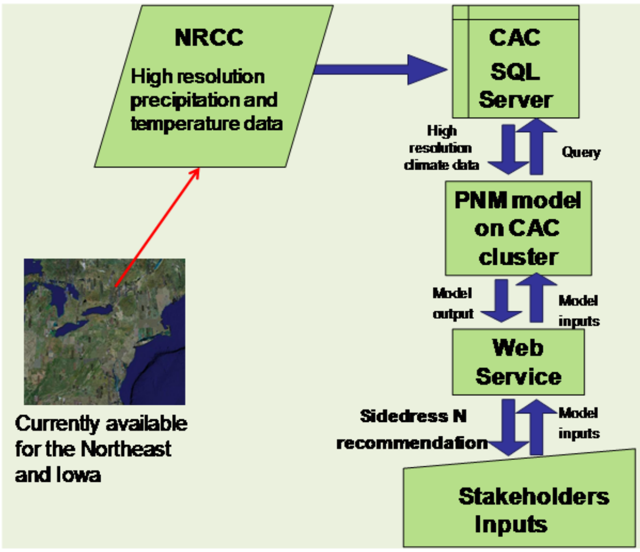
Nitrogen comes to your crop from several sources: 1) mineralized soil organic matter, 2) other organic sources like manure, and rotation/cover crops, especially legumes, 3) a small amount from atmospheric deposition (these are minor contributions), and 4) applied fertilizer. How much N you get from sources 1 and 2 depends on several factors. For example, how much manure did you apply, how much N was in each of its components and did you incorporate it? 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 your 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, but it depends on how much and when it occurs.

N 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. It takes into account 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 prediction of N needs becomes more accurate as the season progresses, because more of the season's weather is then known.

Adapt-N Infrastructure

When you log in to Adapt-N and provide your field information (see Factsheet #1 for further details), these "stakeholder inputs" (see schematic) are sent via the web to



access the Precision Nitrogen Management (PNM) model on the Cornell Center for Advanced Computing (CAC) cluster. The model queries the SQL server for the high resolution climate data for your field using the coordinates you entered. The climate data from the Northeast Regional Climate Center (NRCC) and your field management inputs are then used by the PNM model to simulate corn growth and N uptake, as well as soil processes affected by rainfall and temperature, such as water and solute transport and chemical and biological N transformations in the soil. The model calculates your field-specific sidedress N recommendation, and also provides graphs that help you understand the fate of N during the simulated season.

Calculation of Sidedress N Rate

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

$$\textbf{SidedressNrate} = \textbf{CropN}_{\textbf{Harvest}} - \textbf{CropN}_{\textbf{Current}} - \textbf{SoilN}_{\textbf{Current}} - \textbf{SoilN}_{\textbf{postsidedress}} - \textbf{SoybeanN}_{\textbf{credit}} + \textbf{Loss}_{\textbf{postapplication}}$$

CropN$_{\textbf{Harvest}}$ is the amount of N estimated to be in the corn crop at harvest time. This is calculated from your "Expected Yield" input. Estimates of N contents of grain, stover and roots are used.

CropN$_{\textbf{Current}}$ is the amount of N in your 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 (available in near-real-time, 1 day prior to date on which model is run) for your field location.

SoilN$_{\textbf{Current}}$ 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 (sod, soybean), and corn variety, maturity class, and population, where mineralization and losses are affected by the weather to date.

SoilN$_{\textbf{postsidedress}}$ is the net mineral N that is estimated to become available (mineralized N – losses of N) to the crop from the soil between the day you run the model and crop harvest. This post-sidedress N contribution is based on a 40 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 of the field. A 40 year average is used, instead of specific weather data, since post-sidedress weather cannot be predicted at sidedress time.

SoybeanN$_{\textbf{credit}}$ is an estimate of the contribution of N from a previous season soybean crop.

Loss$_{\textbf{postapplication}}$ is the estimated N loss after applying the recommended N application itself, taking into account the above processes (other losses are part of **SoilN**$_{\textbf{postsidedress}}$).

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 N content of the crop. This difference needs to be made up by sidedressing to achieve full yield.

Authors

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