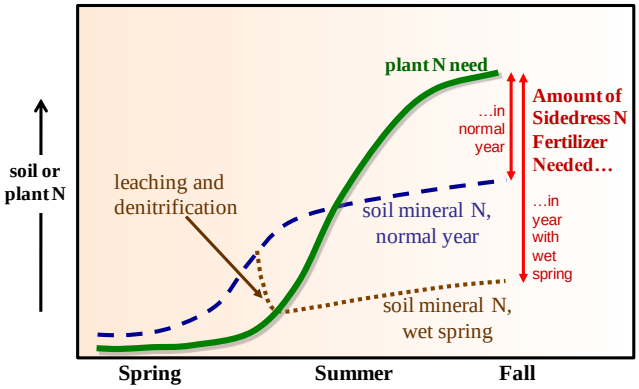
Cornell University

Adapt-N: An Adaptive Nitrogen Management Tool for Corn Production

Background

Nitrogen management is of key importance in corn production systems because of the high cost of N fertilizer, the relatively large N inputs that are used, and public concerns over N pollution of the environment. Recent studies have shown that variation in soil N associated with early season weather contributes to 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 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. In a fairly dry spring nitrogen mineralizes, and remains in the root zone where the crop can take it up. However, in a wet spring (see the brown 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. This makes it hard to know how much nitrogen is actually needed in any given year. Therefore many growers pay for "insurance fertilizer". So, currently, N is 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).

Adaptive N Management: Incorporating the Weather Component

THE ADAPT-N TOOL is a new approach for managing N that was developed to provide more precise N recommendations 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 are based on the effects of local early-season weather on N dynamics in an individual field. It uses basic soil-, management- and crop-information provided by the grower. By basing recommendations on local conditions, the tool improves N use efficiency, thus improving farm profits, while reducing environmental N losses.

Benefits of using Adapt-N

Economic and logistical benefits: More accurately estimating your N needs will allow you to spend LESS money on fertilizer in the average year (about 3 out of 4 years) by adjusting fertilizer rates based on weather conditions in the spring. Using the tool saves time, as there is no need for in-season soil sampling or waiting for test results. There is currently no cost for using this online tool, and you will receive the N-recommendation instantaneously, when it is convenient for you.

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 (N_2O), a potent greenhouse gas, because N needed later by the plant is applied at sidedress time. Applying crop N requirements at planting can lead to high levels of denitrification,

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particularly under no till or minimum tillage and on poorly drained soils during wet springs. Remember: N lost to the environment is N you paid for, that your crop cannot use.

How to Use the Adapt-N Tool

What information is needed?

- Latitude and longitude for the field location (using directions and link provided online, if needed). Note that Adapt-N is currently available for the Northeastern U.S., and for Iowa. Coverage will be expanded in the future.
- Soils: coarse, medium, or fine texture in the Northeast; or soil type in Iowa, field slope, % organic matter
- Tillage: fall plowing, spring plowing (date and depth), or conservation tillage (25, 50, 75 or 100% residue cover on surface)
- Manure applications for current and past two growing seasons: date, rate, N content (lbs ammonium-N and organic-N/1000 gals), surface applied or incorporated.
- Sod in last 3 years: % legume in the sod, method and timing of sod management (surface kill/incorporation).
- Rotating out of soybean? (yes/no)
- Starter/additional N fertilizer: type, date of application, depth and rate of each application
- Crop: planting date, cultivar (silage/grain/sweet corn and maturity class), expected harvest population, expected yield in that field that year.

How do I begin using the tool?

To register, and get your user ID and password to access Adapt-N, please contact Jeff Melkonian (jjm11@cornell.edu). Then, go to the Adapt-N website at http://adapt-n.cals.cornell.edu/, read the directions provided in the manual section, and click on the 'Adapt-N Sign in' button. You will be able to enter any number of fields, and receive weather- and input-adjusted information about N dynamics, including an in-season nitrogen recommendation. Field information will be saved in your account.

How does the model work?

The model combines field-specific information, the most up-to-date high-resolution climate data, and a dynamic simulation model (Precision Nitrogen Management (PNM) model). The PNM model is composed of a corn growth and N uptake model, linked to a soil process model. It simulates 1) water and solute transport, 2) chemical and biological N transformations in the unsaturated soil zone and 3) N uptake, growth and yield of the corn crop. The PNM model has been extensively used and tested for applications in the Northeast, and is currently being beta-tested for on-farm use in New York and Iowa.

The PNM model automatically links to 'high resolution' weather data, i.e., weather data available on a 3 mile x 3 mile grid (developed by the Northeast Regional Climate Center and stored on a database at the Cornell Center for Advanced Computing). Linking to these high resolution climate data allows us to apply the PNM model to individual farms via Adapt-N, the web-based tool that is built around the PNM model. Information provided by the grower for a given field is processed by the PNM model. The model then calculates the recommended sidedress N rate and many other variables. The tool can also be used to evaluate N management strategies in hind sight at the end of the season. The model was developed in 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 by the Computational Agriculture Initiative.

Web Resources

See **http://adapt-n.cals.cornell.edu** for more detailed information about adaptive N management, related scientific papers, directions on how to access and use the Adapt-N tool for adaptive N management in your fields.

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