Northern NY Agricultural Development Program
2013 Project Report

Implementing the Adapt-N Tool in Northern New York: Reducing Cost, Mitigating Losses, and Adapting to Climate Change

Project Leader(s):

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Collaborators:

- **Michael Davis**: Cornell Willsboro Research Farm
- **Eric Young**: Miner Institute
- **Kitty O'Neil** (Eastern NNY Regional Specialist - Clinton, Essex, Franklin, St Lawrence) **Mike Hunter** (Western NNY Regional Specialist – Lewis and Jefferson)
- **Anita Deming** (Essex, Clinton), Cornell Cooperative Extension
- **Eric Bever:** Champlain Valley Agronomics Consulting (Clinton, Franklin, Essex)
- **Peg Cook**: Cook's Consulting
- **Joe Lawrence:** Lowville Farmers Coop (Lewis)

Cooperating Producers:

- Clinton County: Bruce Dimock, Brian Sipley, Ed Carter
- Essex County: Lee Garvey, George Sayward
- Franklin County: Steve Gokey
- Lewis County: Bernie Gohlert
- Further growers involved in running simulations through their ag service providers, particularly through Champlain Valley Agronomics and Cook's Consulting.
- A total of 22 NNY-based users have run simulations for over 350 locations as of 2013.

Background. Nitrogen management on Northern NY's corn silage and grain acres is costly and risk-filled for producers, and inefficient and variable crop N use results in high

environmental impacts. Excessive nitrate levels in surface and groundwater are persistent concerns, and greenhouse gas impacts from agricultural soil N_2O losses are large. Yet, corn yields can be severely limited by nitrogen in wet years, like 2013, when heavy rains cause excessive losses.

Farmers therefore tend to over-apply N fertilizer and/or manure to maximize their returns to N applications in the presence of high uncertainty around the optimum N rate. This uncertainty is mostly associated with early-season weather-impacts on N availability. For example, a manured field may need no N inputs after a relatively dry spring, but 100 lbs/ac in after wetter spring weather. Without knowing what kind of year it is, the farmer will generally apply at a high rate. This is especially pertinent for dairy farmers who often have great difficulty estimating the manure N contribution under variable weather conditions, and are concerned about yield losses from wet conditions.

To effectively account for the variability, we have developed, and are testing, a dynamic N recommendation systems, the Adapt-N tool (http://adapt-n.cals.cornell.edu), which is data-driven and accounts for field-specific sources of variability (weather, soil type, organic N sources, soil and crop management, etc.). When using the tool to inform in-season N application, early season weather effects can be incorporated into the recommendation, so that N management precision is significantly improved. This reduces overall inputs and environmental losses, and improves farmer profits.

Adapt-N is a new web-based computational tool. It generates in-season N recommendations for corn and additional diagnostic information. Three key components make up this N management decision support tool: 1) a well-calibrated simulation model (Melkonian *et al.*, 2005) that simulates key C and N transformations, water dynamics, and corn growth, 2) daily high resolution rainfall and temperature data on a 3 x 3 mile grid (DeGaetano and Belcher, 2007; DeGaetano and Wilks, 2009), and 3) field-specific inputs provided by the user through a cloud-based interface that can be accessed from any device with internet access.

The tool accounts for soil characteristics (organic matter, type, rooting depth, etc.), crop management (date of planting, maturity class, population, expected yield, rotation, tillage, and cover crops in 2014), and past fertilizer and manure applications. Adapt-N simulates location-specific crop and soil N dynamics and provides a real-time recommendation and graphs of field specific dynamics such as mineralization of N from OM, soil nitrate content, denitrification (in 2014) and leaching losses, etc. Generating a nitrogen recommendation requires only several minutes once the information has been gathered, and the recommendation is updated daily, based on weather. Soil testing, in contrast, is much more expensive and time-consuming, and offers lower precision and information quality. A daily email/text alert feature is available, and batch uploads of data are supported, allowing for more rapid inputting of numerous fields, and easy continuous monitoring of N availability during the growing season.

Methods. This project has focused on three important objectives: 1) to beta-test the Adapt-N tool's recommendations against current grower practices on NNY farms to

assess whether the tool's recommendations can increase grower profits and decrease unnecessary N inputs, and to expand education and on-farm implementation of the Adapt-N tool in the NNY, 2) to obtain nitrate leaching data from the Willsboro farm lysimeter plots to document the water quality benefits of using Adapt-N, 3) to enhance the precision of Adapt-N recommendations by incorporating further soil test information inputs related to soil health, particularly N mineralization and water dynamics, as well as information gained from on-farm use, into future versions of the tool.

1) On-farm testing and implementation. More than 20 NNY growers have been involved, 9 in trial implementation, and additional growers in simulating fields on their farms. Growers who hosted trials worked with the project team to establish strip trials with at least two rates (Adapt-N recommendation vs. their current N management practice) and 3-4 replications in most cases. In a few cases intermediate or low rates were also included. Soil health, soil nitrate, and corn stalk nitrate were assessed, and yields were measured at harvest. Partial grower profit differences (Adapt-N minus Grower-N) were calculated. These results were added to the growing national dataset we are collecting to allow us to assess Adapt-N performance and needs for model adjustments.

2) Willsboro lysimeter study. Adapt-N vs. "Grower-N" treatments were implemented at the Willsboro Research Farm lysimeter sites: 16 plots each on sand and clay soils, in continuous corn, under no-till and plow-till. Drainage water samples were collected from the lysimeters (drainage tiles routed to allow for sample collection) at key time points in the fall and spring following treatments, and N content was quantified, to allow us to assess differences in water quality in Adapt-N vs Grower-N plots.

3) Model and Interface Improvements. Soil samples from research and commercial farms were analyzed using newly developed protocols for soil proteins (an indicator of the highest N-containing component of organic matter) and respiration (an indicator of microbial activity). These indicators will be included in the Cornell Soil Health Test, and are being assessed for their potential contribution to improved N recommendations in Adapt-N by various methods (including a greenhouse study to quantify N mineralization potential of soils representing a range in these characteristics). Additional soil health characteristics will be similarly assessed.

Results:

1) On-farm testing and implementation. Testing of the tool in Northern NY has been challenging over the last 3 years due to extreme weather conditions across the region, from drought to excessive rainfall, and associated issues, such as early crop stunting, disease pressure, pests, and weeds, as well as some establishment errors or logistical barriers (trial layout, lack of ability to sidedress less than 50lb N/ac). Such conditions have prevented planting, sampling, sidedressing, and/or harvesting in some trial fields. Particularly the wet spring of 2013 prevented successful establishment of the majority of our trials, and made data from several others that were completed unusable for model improvements. However, between all three years the NNY data look promising, and, particularly in the context of state-wide on-farm data (67 trials from 3 yrs) suggest NNY growers can improve profits and N use efficiency.

NNY results (2011-2013): Table 1 in Appendix A shows results by trial for the successfully completed NNY trials, Table 2 summarizes these results. Out of 12 successfully completed trials 9 met both of the following criteria: a) an Adapt-N rate *and* Grower-N rate treatment were in place, and b) N rate comparisons differed by more than 15lb N/ac (N rate differences of only 3, 10, and 11lb N/ac were not considered useful comparisons). The results from these 9 trials can be summarized as follows:

- 7 out of 9 trials had increased profit with the Adapt-N treatment (78%)
- The average profit was $23/ac
- In 8 out of 9 cases the N input was decreased, by an average of 37 lb/ac.

A 10th trial (Bernie Gohlert's 2013 trial), not included in the summary, due to lacking Adapt-N vs. Grower-N comparison, will nevertheless be useful in calibration. The applicator hired to do the sidedressing was unable to apply as small an amount as 30 lb/ac recommended by Adapt-N in 2013. However, the trial did provide us with a 0 vs. 50 lb/ac comparison, with 16bu/ac of additional yield ($p = 0.005$) with additional N. Thus Adapt-N correctly identified the need for more nitrogen, and the recommended rate of 30 lb/ac was likely enough to gain the additional 16 bu/ac.

For context, Appendix B summarizes results from all 2011-2012 trials (New York and Iowa; Table 4) and 2013 New York trials (Table 5). In short: in drier years (2011-2012) Adapt-N decreased N applications in NY by 66lb/ac, increasing grower profits in 80% of cases (more with proper use of the updated tool) by $31/ac on average, with minimal yield reductions. In 2013 with very wet spring conditions, Adapt-N increased N inputs by 28lb/ac on average over grower rates, for a yield gain of 24 bu/ac on average, and a profit increase in 90% of trials, by $106/ac on average.

2) Willsboro lysimeter study. Adapt-N vs. "Grower-N" treatments were implemented at the Willsboro Research Farm lysimeter sites. The Adapt-N rates was 20 to 35 lbs per acre lower on average in 2011-2012, but 20 lb higher in the clay loam in 2013 due to the wet spring (Table 1). Yield and profit analyses for these sites are included in the analysis above. Drainage water samples collected from lysimeters indicated lower water quality impacts under Adapt-N management (Table 3).

Yields did not differ significantly from N reductions in 2011-2012, nor did they differ significantly from moderately increased N inputs in D1 in 2013 (based on only 14 plots, as two were replanted; plots were highly variable due to early weather stress). In-field variability often makes it difficult to assess whether treatments have an effect, especially when the difference in rates is low. However, the evidence we do have suggests that the model did reasonably well here. 2011 Adapt-N plots certainly showed no trend of yield loss (measured yield values were higher on average), and additionally, we can see that leachate concentration after the 2011 growing season were significantly higher in D1 Grower-N plots ($p=0.008$), and trended toward higher values ($p=0.15$) in D5 Grower-N plots (Table 3), suggesting excess N was applied. 2012 Adapt-N plots were noted to have an appearance of slight N stress, and when the model was rerun for a retrospective recommendation in the winter following that season, high resolution data appeared to have been error-corrected, resulting in somewhat higher recommendations,

that would have possibly been more appropriate. Spring leachate samples only were taken following the 2012 growing season, due to droughty weather and lack of tile flow. These trended toward higher concentrations under Grower-N ($p=0.15$) in D5, and did not differ in D1, corroborating small differences in excess N remaining after uptake. In 2013, Grower-N plots in the Drainage 1 field appeared to be nitrogen deficient.

3) Model and Interface Improvements. On-farm trial results have been used to adjust the model underlying Adapt-N annually. Improvements have been made to soil type representation and availability in the tool, simulation of denitrification transformations (including estimation of nitrous oxide coming in 2014), and to the calculation of the recommended rate that incorporates price-ratio and risk related factors. Based on greater variability seen in trials that have received manure (both in NNY and other Northeast trials), we will be adjusting this risk factor for manured locations for the 2014 version. The model's ability to represent drainage (or lack thereof) is also being enhanced this winter. Development of two new service-lab protocols related to organic matter quality and microbial activity (soil protein content and respiration) was completed. These protocols are currently being moved into Cornell's Nutrient Analysis Laboratory. All Adapt-N trial samples have been analyzed for these indicators. A beta soil health module for Adapt-N will be developed for testing in 2014.

Conclusions/Outcomes/Impacts

In short, suggested management practices that flow from this research are as follows:

Growers will benefit economically from using Adapt-N for in-season N applications, and society will benefit from the environmental improvements.

Every field being planted to corn should be carefully entered into Adapt-N (making sure that all inputs are representative of field realities), sampled for organic matter content, and any compaction/root zone depth issues should be assessed.

A representative analysis of any manure applied to the field is essential.

Preplant/starter applications of N fertilizer should be minimized, so that precise adjustments in a given year's N rate can be made in-season when weather effects on N availability, yield potential, and root zone can be made most appropriately.

Data to date suggest that, while not perfect, Adapt-N will improve NNY grower profits in 70-80% of locations, on average by $20-30/acre, more in wet years where the increased profits come from maintained yields, and with lower risks with appropriate tool use.

So far farmer and service provider response has been positive, and we are receiving critically useful suggestions about interface improvements, and improvements in our on-farm testing design as we move forward. For example, as we have accumulated a large dataset on grower profits showing that the tool improves grower management, we can now turn our attention to zeroing in on whether Adapt-N is providing the best possible recommendation through trials with more than two N rates.

Outreach

Weather impacts on N availability have come to the forefront of N managers minds over the last years as a number of extreme events (rain as well as drought) have shown these dynamics in the field during the conceptual learning process our team has promoted. Project outreach to the NNY region has included in-person visits for formal conferences and meetings, as well as informal visits and phone conversations with collaborators, multiple training webinars, and a number of publications (see links provided in Reports section). Our websites for both Adapt-N and Soil Health are now linked from the NNYCCE website, and the NNYADP website features several articles on Adapt-N. Slides from the Tile Drainage Conference (Miner Institute, October 2013), and update slides being prepared for the upcoming webinar are included with this report.

Awareness of and appreciation for the capabilities of the Adapt-N tool are increasing in the North Country, especially among agricultural service providers (consultants and extension educators) who tend to be more inclined toward new computer-based tool developments. As of this winter, a total of 22 NNY-based users have run simulations for over 350 locations as of 2013. During a week-long visit to NNY in late August, Bianca Moebius-Clune met with collaborators to discuss progress, gather feedback, provide updates, and establish connections and baseline understanding with new collaborators. While weather challenged implementation in 2013, the new tool features that were added, such as batch uploading of data and improved daily recommendation alerts are increasing excitement about the tool's capabilities. Peg Cook (Cook's Consulting) used this feature for most of her clients' fields in 2013. Eric Young (Miner Institute) simulated most of Miner's corn fields in 2013, and plans to adjust recommendations and conduct multiple trials in 2014. Mike Hunter noted that the daily alert feature would make educating growers about N dynamics much easier. He plans to increase tool use in 2014.

The growing collaboration with Champlain Valley Agronomics (CVA), one of the largest consulting firms in the Eastern part of NNY has been particularly successful. They have implemented multiple trials on their clients' farms over the last two years, have increased simulations on client fields, and have been educating their clients about weather impacts on N availability, and how Adapt-N can be used as a valuable N management tool. CVA is committed to continuing to use Adapt-N, increasing locations simulated annually (ultimately with the goal to simulate the majority of corn acres), and their use of Adapt-N recommendations. They will work with Kitty O'Neil, our new Eastern NNY field crops specialist who will be implementing further field trials in 2014.

Next steps

Our new public-private partnership with the start-up company *Agronomic Technology Corporation* (ATC; recently announced) will enable us to make faster improvements to the tool's accuracy and usability. They will provide better customer service and data management capabilities which will increase use by ag service providers such as CVA who are largely limited by time. ATC will also continue to provide the tool for free to collaborators who are contributing to research for tool improvement. An increased push for 2014 NNY trials (using our 2nd year allocation of NNYADP funds – thank you!) will

be facilitated through this partnership. We are planning to conduct a larger number of trials, and to include some trials with additional rates (ideally at least 4 rates), and to continue our outreach. We are currently organizing the 4/3 Intensive Adapt-N Training Webinar. In addition to participation via personal computers, several host sites in NNY will allow interested participants to join a group for the webinar.

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Reports and/or articles

Selected publications by project team: Please note that additional publications as well as recorded webinars are available on our Project Websites for Adapt-N and Soil Health:

Adapt-N Training Manual by Bianca N. Moebius-Clune, M. Carlson, H.M. van Es, J.J. Melkonian, A.T. DeGaetano, and L. Joseph. 2014

Award-Winning Adapt-N Farm Tool Has Northern New York Roots. Northern New York Agricultural Development Program News. 2013

Adapt-N Uses Models and Weather Data to Improve Nitrogen Management for Corn by Bianca Moebius-Clune, H. van Es, and J. Melkonian. Better Crops. Vol 97:7-9. 2013.

What's Cropping Up? 5/2013: Adapt-N Proves Economic and Environmental Benefits in Two Years of Strip-Trial Testing in New York and Iowa by B. Moebius-Clune, M. Carlson, H. van Es, and J. Melkonian. Adapt-N Increased Grower Profits and Decreased Nitrogen Inputs in 2012 Strip Trials by B. Moebius-Clune, M. Carlson, Harold van Es, and Jeff Melkonian. Case Study – Part II: Central NY Farm Applies Adapt-N Rates on Whole Farm, Saves Money and Reduces Environmental Impact by B. Moebius-Clune, M. Carlson, D. Moebius-Clune, H.van Es, J. Melkonian and K. Severson.

Selected popular press articles: Corn and Soybean Digest, July 26, 2013. Adapt-N tool calculates for weather extremes and soils. Farm and Dairy, June 10, 2013 How much nitrogen does your field really need?

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