Cornell University

Adapt-N Increased Grower Profits and Decreased Environmental N Losses in 2011 Strip Trials

Background

Research has demonstrated (summarized by van Es et al., 2007) that soil and crop management practices, combined with weather conditions during the early growing season, greatly affect N losses and are therefore critical factors in determining optimum N rates. The difference in fertilizer N needs from one year to the next could easily be 100 lb N, and generalized N recommendations are inherently imprecise. In a recent case study, we highlighted the 2011 impact of early- vs. late planting on recommended N rates (*What's Cropping Up?*, Vol. 21, No 4).

It is not possible to accurately determine at the beginning of the growing season how much N fertilizer will be needed for that year's crop, because some critical processes that affect N losses have not yet passed. Most growers fertilize for a worst-case scenario and apply "insurance fertilizer" – they put on in excess of what is needed in most years. This reduces farm profits and causes high environmental losses. Seasonal corn N needs can be estimated much better in the late spring to guide sidedress applications. Adapt-N is an online decision support tool (http://adapt-n.cals.cornell.edu) designed to help farmers precisely manage nitrogen (N) inputs for grain, silage, and sweet corn. It uses a well-calibrated computer model, and combines user information on soil and crop management with high resolution weather information, to provide N sidedress recommendations and other simulation results on nitrogen gains and losses. We have completed the first year of beta-testing through on-farm strip trials in New York, which are presented in this factsheet.

Methods

We completed 18 replicated strip trials on commercial and research farms throughout New York during the 2011 growing season. They involved grain and silage corn, with and without manure application, and different rotations (corn after corn, corn after soybean, and corn after a clover cover crop; Table 1). Treatments involved two rates of nitrogen, a conventional "Gower-N" rate based on current grower practice and an "Adapt-N" recommended rate. A simulation was run for each field prior to sidedressing to determine the Adapt-N rate. In 2011, due to seasonal weather conditions, all Adapt-N rates were lower than conventional N rates (by 15 to 140 lbs/ac; Table 1). Growers then implemented field-scale strips with 3 or 4 replications for each treatment (except NY8 and NY9, where only single yield strips were measured due to time and equipment constraints).

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).

Table 1. 2011 Replicated field-scale strip trials implemented in NY to compare current Grower N application rates with N rates recommended by the Adapt-N tool. N rates represent total N in lb/acre applied as inorganic fertilizer in 2011.

Trial Info				Fertilizer N Treatments (lb N/acre)		
Field Trial	Harvest	Manure	After soy	Grower	Adapt-N	Difference (A-G)
NY3	grain	no	yes	179	97	-82
NY4	grain	no	no	242	102	-140
NY5*	silage	yes	no	180	165	-15
NY6	grain	yes	no	150	120	-30
NY7	silage	yes	no	84	34	-50
NY8	grain	no	no	175	132	-43
NY9	grain	no	no	158	92	-66
NY11	grain	no	no	172	141	-31
NY12*	grain	no	clover cc	85	45	-40
NY12b*	grain	no	clover cc	95	45	-50
NY18	grain	no	yes	180	65	-115
NY21	silage	yes	no	109	66	-43
NY22	grain	no	yes	183	60	-123
NY24*	grain	no	no	198	146	-52
NY25	silage	no	no	140	106	-34
NY26	silage	no	no	140	119	-21
NY27	grain	no	no	175	100	-75
NY28	grain	no	no	175	100	-75

Table 2. Agronomic, environmental and economic assessment of model performance. 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 $5.50/bu grain, $50/T silage, and $0.60/lb N.

Average Change due to Adapt-N Use in:		Corn grain after corn	Corn grain after soy	Silage corn
Average (Adapt-N - Grower-N)*	N fertilizer input (lb/ac)	-66	-107	-37
	Yield (grain: bu/ac; silage: T/ac)	-1	-14	0.3
	Simulated N leaching losses (lb/ac)	-39	-38	-11
	Simulated total N losses (lb/ac)	-52	-69	-19
	Profit ($/ac)	$34.74	-$11.08	$38.76

Partial profit differences between the Adapt-N recommended and Grower-N management practices were estimated through a per-acre partial profit calculation:

Profit = [Adapt-N yield – Grower-N yield] * crop price

– [Adapt-N N use – Grower N use] * price of N

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, a grain price of $5.50/bu was assumed ($6.50/bu minus $1.00/bu for drying, storing and trucking from PA Custom Rates; USDA, 2011). For silage, $50/T was assumed based on reported NY silage prices of $25-75/T. The price of N fertilizer was assumed at $0.60/lb N (prices ranged from $0.49 - $0.75/lb N in NY). Total N losses to the environment (atmosphere and water) and N leaching losses were estimated for each treatment by running model simulations with all N inputs through the end of the growing season (30 October). Agronomic, economic and environmental outcomes of these trials were then used to assess Adapt-N performance.

Results

Errors were made in model and/or trial implementation in a few cases (labeled with * in Table 1): A clover cover crop was improperly simulated as an incorporated sod, resulting in a low Adapt-N recommendation and substantial yield losses. In other cases, Adapt-N fertilizer and manure inputs did not reflect real field applications, or N applications were made too late in the season. The lesson here is that correct input information is, of course, needed for Adapt-N to provide an accurate recommendation. The resulting yields and simulations from the above four trials were not representative of 2011 Adapt-N performance, and these trials were therefore removed from further analysis.

Agronomic, economic and environmental comparisons between Grower-N and Adapt-N treatments for each trial are provided in Figure 1, and as averages in Table 2. A comparison of grain and silage harvest data (Fig. 1a & 1b) shows that differences in yields were negligible and statistically not significant for almost every trial, despite substantially reduced N rates applied for the Adapt-N treatment (Tables 1 and 2). A case study describing one of these trials, conducted at Donald & Sons Farm, in Moravia, NY, where 140 lb of N were saved without yield loss, is available online: http://adapt-n.cals.cornell.edu/pubs/.

When the previous crop was soybean (3 trials), yield losses from the lower Adapt-N rate were found in every case

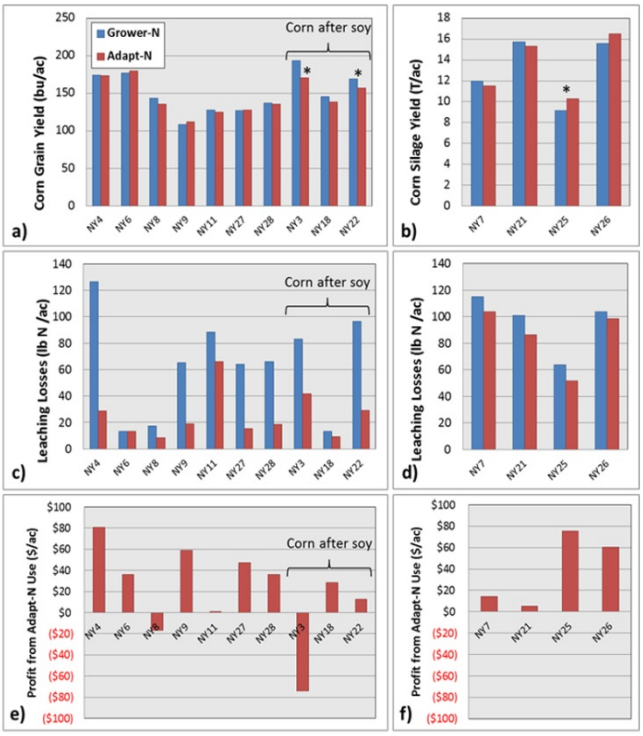

Figure 1. Yield and N leaching losses from Grower-N vs. Adapt-N treatments. Partial profit gain (positive) or loss (negative) from using the Adapt-N recommendation, relative to grower's current practices. (* Yields were statistically different at p < 0.05)

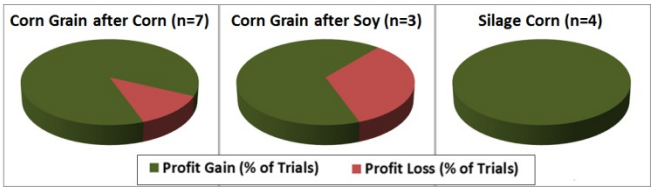

Figure 2. Proportion of trials showing profit gains (green) or losses (red) as a result of using the Adapt-N recommendation compared to current grower N management. Profit calculations assume $5.50/bu grain, $50/T silage, and $0.60/lb N.

(Fig. 1a), although the grower N rates were well above economic optimum N rates. We determined that Adapt-N overestimated the soybean N contribution, and thus provided low N recommendations in these three cases. The 2011 version of Adapt-N used a flat 30 lb soybean N credit, but also simulated immobilization of N in stover in corn-after-corn rotations, effectively almost doubling the N credit for corn following soybean. We believe that part or all of the soybean 'N credit' should mostly be regarded as an absence of an immobilization penalty for corn-corn rotations. Changes will be made to the Adapt-N tool to reflect these findings for the 2012 growing season.

Estimated leaching losses (Fig. 1c & d), as well as total N losses (Table 2) decreased as a result of reduced N application rates for the Adapt-N treatment. On average, leaching losses decreased by 38 lb N/ac in grain trials, and by 11lb/ac in silage trials. There was less room for improvement in silage trials because lower fertilizer rates were used after manure applications.

Most trials resulted in profit gains from the use of Adapt-N, ranging from $1 to $80/acre, (Fig. 1e & f). Average profit gains were $35/acre for corn after corn and $39/acre for silage corn (Table 2). Corn after soybean trials registered an average loss of $11/acre due to one trial with high yield loss (NY3). This was the only trial out of 14 (7%) where profit loss was significant. Fig. 2 indicates the low risk of profit loss (<14% overall before the correction of the soybean N credit), and high probability of improved profits (86%) of using Adapt-N in 2011.

Our data suggest that after minor adjustments of the Adapt-N tool, it will be even better equipped to give accurate recommendations. Growers who tend to use high amounts of nitrogen will realize large savings. In a much wetter year, increased profitability would come from appropriately applying more N at sidedress time in order to prevent yield reductions from N losses. In the long term we expect that environmental losses will decrease in both dry and wet years, because this tool provides strong incentives to shift N applications to sidedress time.

Conclusions

From beta-testing on commercial farms throughout NY State in 2011, we determined that the value of the Adapt-N tool was substantial. The tool was quite successful in adjusting for the effects of seasonal conditions to accurately recommend N fertilizer needs. Also,

- N application rates were significantly reduced (15 to 140 lb/acre).
- Grower profits increased on average by $35/acre, except in corn after soybean (due to model inaccuracies that are being corrected for the 2012 growing season).
- N losses to the environment were decreased substantially (5 to 120 lb/acre).

Adjustments to the Adapt-N tool will improve ease of use and accuracy for the 2012 growing season. The Adapt-N tool and information about it is accessible to stakeholders through any device with internet access (desktop, laptop, smartphone, and tablet) at http://adapt-n.cals.cornell.edu.

Acknowledgments

This work was supported by grants from the NY Farm Viability Institute and the USDA-NRCS Conservation Innovation Program. We are grateful for the cooperation in field activities from Bob Schindelbeck, Keith Severson, Kevin Ganoe, Sandra Menasha, and Anita Deming of Cornell Cooperative Extension, from Dave DeGolyer, Dave Shearing and Jason Post at the Western NY Crop Management Association, and from Eric Bever and Mike Contessa at Champlain Valley Agronomics. We also are thankful for the cooperation of the many farmers who implemented these trials.

References

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. http://adapt-n.cals.cornell.edu/pubs/pdfs/vanEs_2007_Managing_N_for Weather_Ch2.pdf. [URL verified 2/22/12]

Web Resources

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

Authors

Bianca Moebius-Clune, bnm5@cornell.edu;
Harold van Es, hmv1@cornell.edu;
Jeff Melkonian, jjm11@cornell.edu;
Department of Crop and Soil Sciences, Cornell University, Ithaca NY, 14853. Adapt-N was developed as part of the Computational Agriculture Initiative, supported by a special grant from USDA-NIFA.

Funded by NY farm viability INSTITUTE