A New Era For N

Forget what you know about N—it is time to rethink how rates are set

BY CHARLENE FINCK

Time to reboot your nitrogen (N) knowledge and start anew. Dramatic University of Illinois research shows that the way most of us have set N rates for corn the past 30 years often costs money in over-applied N. The 1.2 rule, where 1.2 lb. of N is applied for every expected bushel of yield, has proven itself inaccurate—even though it is the pyramid that everything related to N in agriculture is built upon.

Officially called the Proven-Yield Method, the rule has underpinned N rates for decades and has been the basis upon which the vast majority of researchers, agronomists and policy officials have evaluated N practices.

Even so, the new Illinois research shows that the average cost of using the 1.2 rule at 102 sites was an extra $20 per acre with average overapplication of 72 lb. of N. Overall, the extra cost ranged from $2 to $45 per acre (see table below). The overapplication ranged from 4 lb. to 182 lb. per acre.

The out-of-pocket costs for the extra pounds, of course, vary with N prices—which are high and climbing. The figures presented here were based on N costing 25¢ per pound.

The Illinois researchers demonstrated this through a series of N response trials conducted throughout Illinois to evaluate the Illinois Soil N Test (ISNT), as well as the 1.2 rule. ISNT is a laboratory test that quantifies the amount of organic N available for mineralization in the soil.

Of the 102 sites in the study, 33 showed no economic response to N, meaning that adding extra N did not impact yields enough to pay for the N. The Proven-Yield Method was 9% effective in predicting these sites, compared with 94% for ISNT.

PHOTO: DARRELL SMITH

Work with a soil test that estimates the available organic N in the soil led University of Illinois researcher Richard Mulvaney and his team to challenge the way N rates are set.

"These research findings clearly point us in another direction for deter- ▶

How the Proven-Yield Method Performed

	Sites Studied		Errors in Proven-Yield Recommendation: Number Pounds of Nitrogen		Errors in Proven-Yield Recommendation: Economic Cost Per Acre	
Rotation[1]	Type	Number	Range (Pounds/Acre)	Average (Pounds/Acre)	Range (Dollars/Acre Extra)	Average (Dollars/Acre Extra)
Manured Within 1 Year	Nonresponsive	18	0 to 142	70	$0 to 36	$17
	Responsive	4	-77 to 76	64	9 to 43	28
Continuous Corn	Nonresponsive	7	138 to 210	182	34 to 53	45
	Responsive	16	0 to 139	78	0 to 35	20
Corn After Soybeans	Nonresponsive	4	145 to 172	159	36 to 43	40
	Responsive[2]	45	-112 to 105	49	0 to 69	16
Corn After Alfalfa	Nonresponsive	4	94 to 110	101	23 to 28	25
	Responsive	1	——	4	——	2
Corn After Wheat	Responsive[3]	3	-16 to 94	41	3 to 23	10
All Sites	Nonresponsive	33	0 to 210	108	0 to 53	27
	Responsive	69	-115 to 139	55	0 to 69	17
Total		102	-115 to 21 lb.	72 lb.	$0 to 69	$20

[1] Had not received manure for at least one year prior.

[2] Includes two sites where corn followed double-cropped wheat and soybeans.

[3] Includes one site where corn followed double-cropped wheat and milo.

SOURCE: UNIVERSITY OF ILLINOIS

When the Proven-Yield Method of 1.2 lb. per bushel of expected yield was used to set nitrogen (N) rates, the result, on average, was overapplication by 72 lb. per acre at an average extra cost of $20 per acre. Yields at nonresponsive sites didn't increase when N fertilizer was added, while yields at responsive sites went up.

mining nitrogen rates," says Richard Mulvaney, University of Illinois soil scientist, who led the team of individuals from the natural resources and environmental sciences department. "This proves that your yield goals aren't the deciding factor in how much N you need—the soil is, since it contributes most of the N used by the corn crop."

Yield goals aren't the deciding factor in how much N you need—the soil is

Overall in the study, N applications determined with the customary 1.2 rule were accurate within 20 lb. on 18% of the sites. At the same time, 13% of the sites were underfertilized by 22 lb. to 115 lb. per acre and 69% were overfertilized by 20 lb. to 210 lb. per acre.

Of the sites that were overfertilized, 30 were completely nonresponsive, while 41 showed some response to N fertilization—but not as much as predicted by the 1.2 rule. The results varied considerably among sites and were strongly dependent on soil type and management practices.

"With high N prices, tight ag margins, hypoxia and water-quality issues, this work has tremendous implications," says Rick Vanden Heuvel, soil scientist and private agronomist with VH Consulting Inc. in Hudson, Wis.

The Illinois team's results and conclusions will soon be published in the Soil Science Society of America Journal, a peer-reviewed publication serving the profession. "A lot of research has pointed out problems with the Proven-Yield Method, but this is the first time this method has been evaluated on a site-by-site basis, which is far more meaningful to farmers than averaging results from several sites or years," Mulvaney says.

Recognizing the failings of the 1.2 rule and understanding why it isn't accurate is the first critical step toward improving N rate recommendations. That is what much of the current study does. From there, Mulvaney and others at Illinois and other universities are working on a soil-based system for making N recommendations.

"Everyone in the industry was trained on the yield-based method, and few have ever challenged it," says Tim Smith, researcher on Mulvaney's team. "While assuming that it works, we as a profession have set aside what we know about the N cycle and marched ahead. All of us are responsible for using such an inaccurate method for so long."

Now that Smith and Mulvaney—and fellow researchers Saeed Khan and Tim Ellsworth—are taking a closer look at the process, the N cycle is shining through. Of course, as they and others take a more comprehensive approach, it's obvious that finding a precise replacement method isn't easy.

N is a high-stakes nutrient—for corn, the farmer and the environment. Its pivotal role in yields and ultimately, farm income, and the impact it has on the environment, make it paramount that the input is applied accurately and responsibly. Yet, it is a incredibly complicated nutrient.

"Nitrogen is very complex and a bit unpredictable," explains Bob Hoeft, long time University of Illinois Extension soil fertility specialist. "And because it is so important to corn yields, it is not something that you can have failures with."

Hoeft, who is now head of the university's crop sciences department, has a long history with N recommendations. As the father of the Proven-Yield Method, he added the 1.2 rule to the 1975 Illinois Agronomy Handbook. Now, even he says it is time for change. "The Proven-Yield Method has always been a guide to give farmers a range for N rates as they go from field to

PHOTO: DARRELL SMITH

Illinois Soil N Test samples are best when taken 2' deep, which makes a hydraulic probe handy. Here, Cory Muhlbauer helps Farm Journal Field Agronomist Ken Ferrie take samples for ongoing work at the University of Illinois.

FARM JOURNAL'S Role

In the past decade, FARM JOURNAL has devoted considerable effort to studying nitrogen (N) in our test plots. As a part of that drive to understand more about the complex nutrient, we quickly integrated the Illinois Soil N Test (ISNT) into the Farm Journal Test Plots. Including the University of Illinois as a test plot partner provided a ringside seat to ISNT developments.

After a sneak peak at the results that led to the peer-review journal article, we agreed to help University of Illinois researcher Richard Mulvaney and his team learn more about the impact planting populations have on N needs. In 2005, we planted four large-scale plots that look at the interaction between the two.

At press time, two are under drought conditions and two have adequate moisture. "I'm actually kind of excited that two of the replicated plots are in the drought," says Ken Ferrie, Farm Journal Field Agronomist. "That will let us see the impact soil moisture has on the availability of organic N in the soil."

We'll keep you posted on initial results in a future issue.

field," he says. "The system is seldom on the low side of N recommendations, which is actually good in many ways. It's safer—especially if you're renting land in a competitive environment like Illinois—to be slightly on the high side. You can't afford to not have enough N."

Hoeft says work is underway to devise a new N recommendation system—hopefully for the 2007 crop year. "We'll probably go away from the Proven-Yield Method for corn after beans and perhaps stick with a variation for corn-on-corn situations," he says. "We may be able to lower the coefficient or give a range based on area and soil types. At this point, we don't know if ISNT will fit into the new system, but it might." (At press time, Mulvaney says his team is not included in the process.)

Analyzing the soil's N supply. Meanwhile, the majority of the current efforts with ISNT focus on understanding when the technique doesn't work and why. In general, for ISNT to be successful and accurate, conditions must be conducive to soil N mineralization, as well as crop N uptake and utilization. Rotations, plant populations, the amount of organic carbon in the soil and drought have to be taken into account when using ISNT.

In working with ISNT, Mulvaney and his team discovered that higher populations require a higher test value because of the higher N demand. The same is true in areas with a heavy input of crop residue. The residue is a source of organic carbon, and the N is tied up during decomposition by the soil microbes.

"Over and over again, we've seen the reaction or interaction of high populations with N needs," says Ken Ferrie, Farm Journal Field Agronomist. "The high populations put more carbon back in the soil—and change the soil environment for future corn plants."

In general, this work helps farmers start to quantify the variability they've seen in fields for a long time. "We were seeing big differences in N needs in fields long before the organic N [ISNT] test was even developed," Ferrie says. "When you look at a soil's ability to supply N to the crop, you have to take in the history of the farm."

The variability points to the potential—and the need for—variable-rate planting and N applications. "There is tremendous potential for using ISNT, not only to optimize N rates but also to identify areas within the field where soil reserves can be exploited by increasing plant population," says Saeed Khan, soil scientist on Mulvaney's team.

With these answers come even more questions on the N management front. "This is a new paradigm and a major shift," Mulvaney explains. "We now look at many things in a different light and have a myriad of research possibilities for the future. Now, it's time for us—farmers and researchers alike—to learn as much as we can as fast as we can and come up with a better way to manage N. A soil-based approach is the key." FJ

For More Information

Check for additional info and research updates at *www.aminosugarNtest.com*, a site established by Richard Mulvaney and his research team.