Crop sensors outdo farmers at choosing nitrogen rates

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Choosing how much nitrogen (N) to put on corn fields isn't something farmers take lightly. Many factors go into the decision, including past experiences, the timing of application, yield goals, and results from soil tests.

Nevertheless, crop sensors can select N rates for corn that outperform those chosen by farmers, according to more than 50 on-farm demonstration projects conducted in Missouri from 2004 to 2008. Compared to producers' N rates, sensor-selected rates increased yield by almost 2 bushels per acre, on average, while reducing by 25% the amount of excess N that was applied to fields but not removed in grain.

As concerns about N pollution continue to mount, the sensors offer a way to cut fertilizer inputs without hurting yield or profits. "The most important thing, I think, is that we were able to make progress on both fronts: The technology slightly improved production and slightly improved environmental outcome," says the study's leader, Peter Scharf, a University of Missouri extension agronomist. "There has been talk about win-win, but really there have not been a lot of approaches that have actually [achieved] that."

Funded by the USDA-NRCS Conservation Innovation Grants program, the Missouri DNR Nonpoint Source Pollution Control program, and the USEPA Special Grants program, the study appears in the November-December issue of Agronomy Journal.

Scharf explains that although optimal N rates can vary substantially within and between fields, most U.S. corn growers still apply the same rates to entire fields or even entire farms. Many farmers in Missouri and elsewhere also spread N fertilizer months before planting, often the November before.

As fertilizer and seed costs keep climbing, however, corn producers are feeling financial pressure to apply N more precisely—in amounts that satisfy crop requirements but don't exceed them. To help farmers with this, in 1997 Scharf began studying methods for predicting where to put more N in fields and where to put less before sowing crops, since that's the system most people use. But he and his colleagues eventually turned to crop sensors, employed after plants start growing, as a more accurate means to diagnose N deficiency and sufficiency.

The sensors take advantage of what farmers know already from experience and common sense, Scharf says: Crops with enough N are darker green and taller, while N-deficient crops are lighter and shorter. After developing a technique for translating sensor output into a suitable N rate within a few seconds -- work that was published in 2009 -- Scharf and his collaborators began taking the technology to farms.

Fifty five demonstrations were eventually conducted across a broad swath of Missouri's corn-growing region. In most cases, two or three sensors were attached to N applicators already owned by farmers or their service providers, and then used to side-dress N at variable rates to corn in growth stages ranging from V6 and V16. At the same time, fixed N rates chosen by farmers were applied in other areas, allowing comparison of the two techniques.

An average of 14 pounds/acre less N was applied when sensors chose the rates, the researchers found, without affecting yields. In fact, during the exceptionally wet spring of 2008, sensor use actually boosted grain yield

by 8 bushels/acre, on average, over what producer rates achieved -- a significant bump that brought the overall yield gain with the sensors to 2 bushels/acre over all 55 fields.

Scharf believes yield increased significantly in 2008 because the sensors actually chose higher N rates than farmers did that year, better compensating for fertilizer lost through heavy rainfall. And this yield bump, coupled with an overall reduction in N fertilizer from 2004-2007, ended up increasing partial profit by an average of $17/acre across all farms.

Despite the sensors' benefits, however, "the adoption numbers are still quite small," Scharf says. Complete systems currently range in price from $10,500 to $16,500, and learning to use them involves time and expense, as well. Still, these aren't the main hurdles to wider adoption, he adds. The bigger one is getting farmers to side-dress N during the growing season, rather than fertilizing in spring before planting or even the fall before.

The unusually heavy rains of the past four years may change that. Because applying N months in advance gives it more time to leach and run off, many farmers have lost loads of it -- and, therefore, money and yield -- in recent rain-soaked years. That leaves one option: Applying the nutrient during the growing season.

"If this weather keeps up, I think we'll see more people going toward in-season N application," he says. "And that will be a big obstacle out of the way to using the sensors."

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