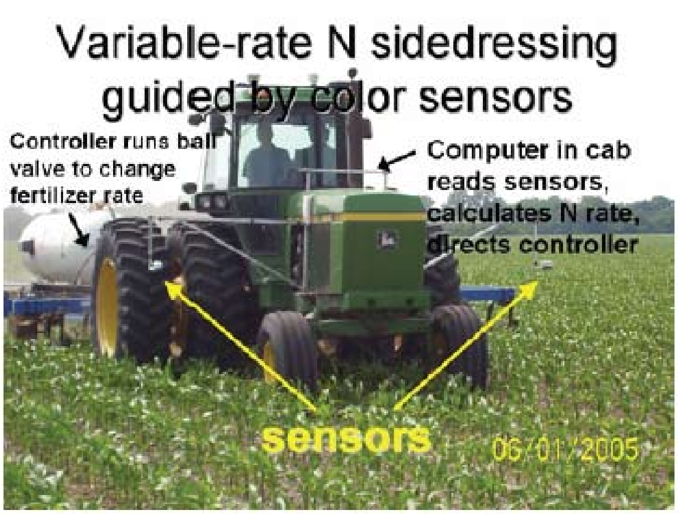
Crop Sensors for Managing Nitrogen

By Peter Scharf

2008 was a challenging year for nitrogen fertilizer management. Much of the fertilizer applied for the corn crop was lost due to heavy rainfall before the crop could take it up. This led to widespread nitrogen deficiency and, in my rough estimate, yield loss of 460 million bushels of corn across the midwest (see article in last issue).



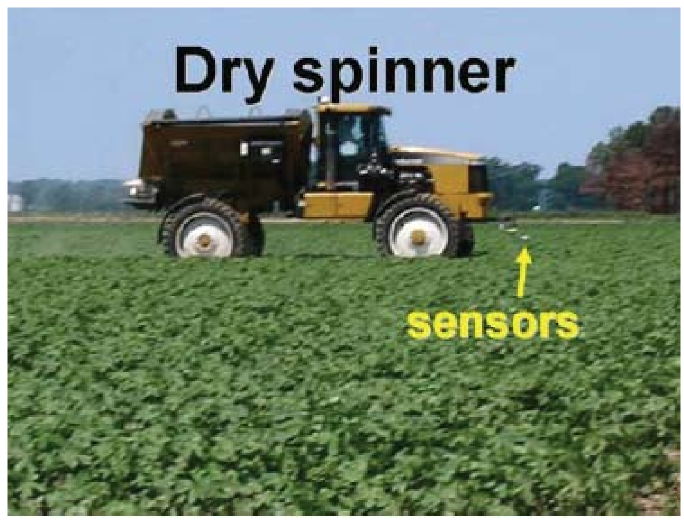
It turned out to be a great year for sensorbased nitrogen management to shine. In this system, the biggest nitrogen application is made to the growing crop. Sensors detect the crop color–when the crop is dark green, a low rate is applied, and when the crop is light green or yellow green, a high rate is applied. Sensors detect crop color around ten times per second, and a new N rate command is given once per second.

This system requires an applicator that has a mechanism for changing rates while driving. Virtually any type of fertilizer application equipment can be set up to do this. The photographs show a range of applicators that we have used in on-farm demonstrations of sensor-based N applications.

We have demonstrated sensor-based N management extensively in corn, had our first demonstration in cotton in 2008, and are starting a project to develop interpretations for wheat. I believe that sensor technology can be successful and profitable in all three of these crops, and potentially in grass and milo as well.

Some people who work with the sensors are hesitant to use them on small corn. My research with John Lory in the late 1990s suggested that they could work just fine on small corn, by which I mean a foot tall. This has recently been confirmed by research in Pennsylvania. Over the past five years, we have done a total of 88 on-farm demonstrations of sensor-based N management with the corn anywhere from 1 to 7 feet tall. In 56 of these demonstrations, we have had good comparisons between sensor-based N management and the current producer rate. There has been no trend for the system to be more successful or profitable on bigger or smaller corn–average profitability has been the same at every height.

However, I am uncomfortable with using sensors to make decisions on corn that is less than a foot tall. None of the three demonstrations that we did on corn less than a foot tall were economically successful.



For most Missouri producers who sidedress corn, they normally start on corn that is 4 to 8 inches tall and finish in corn that is 12 to 20 inches tall. Thus, even for people who currently sidedress, some adjustment to their management is needed to start using sensors. Starting to sidedress when corn is 12, as opposed to 6, inches tall means a higher risk that the job won't be finished by the time the corn is too tall for tractor clearance. My suggestion is either to have a high-clearance backup plan or to limit the acreage managed with sensors to keep the risk low. Targeting fields that have the most variable soils or management histories would be one smart way to limit acreage managed with sensors. Another would be to target fields with the greatest likelihood that lower fertilizer rates could produce full yield, for example manured fields.

Sidedressing, regardless of how N rate was chosen, was an effective strategy for N delivery this year. In my tests near Columbia, sidedress treatments on average yielded 44 bu/acre more than preplant treatments. Plots with sidedress N had N deficiency symptoms in August, but the symptoms were much more severe in plots that received their only N application just before planting.

In twelve 2008 demonstration fields for which our analyses are finished, sensor-based sidedressing is $29/acre ahead of sidedressing a flat rate chosen by the producer. This is due to several fields where the sensors diagnosed that N need was on average higher than the rate chosen by the producer, and the diagnosis was correct, resulting in higher yields than with the producer N rate. This comparison did

not include a timing component. I feel sure that the same producer N rate, applied all pre-plant, would have produced even lower yields due to N loss before crop uptake. The benefits of sensorbased management in 2008 were due to both timing of the main N application and more accurate diagnosis of the crop's N need.

In contrast, economic benefits to sensor use in our past on-farm demonstrations (2004-2007) have been primarily due to savings on nitrogen fertilizer. In those fields, we saved an average of 23 lb N/acre relative to the rate the producer would normally use with no effect

on average yield. Our biggest goal with sensor-based N management is to cut back in smart places–places where the soil is supplying a substantial amount of N to the crop, so that reducing the fertilizer rate doesn't hurt yield.

In those places where cutting back on N fertilizer rate doesn't hurt yield, NOT cutting back on N means that there will be unused N left in the soil after harvest. In winter and spring, precipitation is greater than evaporation, with excess water moving down and sideways off of fields. Chances are good that the unused N will move with the water (as nitrate) and end up emerging in a spring or seep. In order to help producers to avoid this scenario, the Natural Resources Conservation Service has made sensor guided sidedressing eligible for cost-share assistance in its EQIP program. The incentive for 2009 is $36.70/acre/year with a 2-year commitment to the practice. The Missouri Department of Natural Resources also supports the practice and has funded our on-farm demonstrations in 2007 and 2008.

Everyone wants the nitrogen to end up in the crop and not in the water. Crop sensorsare one of the new tools that can help producers to accomplish this goal.

The main reason that sensors can improve nitrogen management is the wide range in how much N the soil supplies to the crop. The amount supplied by soil can vary widely from field to field, from year to year, and from place to place within a field. This makes the best N fertilizer rate difficult to predict.

From 2000 to 2002, we studied eight production corn fields by putting an average of 50 small nitrogen rate experiments all across the field, allowing us to measure the most profitable rate at 50 different places in the field. We found that, in 7 of the 8 fields, ANY uniform N rate would have been off target by more than 35 lb N/acre in more than half of the field. We also found that the average amount of N needed varied widely from one field to another.

2008 was a good example of year-to-year variability in soil N supply. Typically when I have taken deep soil samples in spring before fertilization, I have found 50 lb N/acre in forms (nitrate and ammonium) available to the crop. This year, that 'baseline' soil N was probably mostly lost before the crop could take it up. More N was released from soil organic matter during the season, but in wet fields the amount released was limited by lack of oxygen and lower soil temperatures than in a normal year.

Not only was 'baseline' soil N lost in 2008, but a great deal of fertilizer N applied preplant was also lost. The biggest benefit to sensor-based N applications this year would have been avoiding the nitrogen loss, yield loss, and environmental degradation associated with preplant applications.

In this article, I have mainly discussed using crop sensors to guide planned nitrogen applications. 2008 gives another example of a highly beneficial use of the sensors: guiding rescue N applications when N has been lost. Nitrogen loss is almost always patchy and is controlled by where water goes in fields. This can be easily seen in the photograph in the last issue (http://ppp.missouri.edu/newsletters/ipcm/archives/v19n1/a2.pdf). Applying the same rate of rescue N to a whole field would result in a lot of fertilizer being wasted on areas that don't really need it. Sensors can identify the areas where the crop is N-deficient and put on high rates, while cutting back in areas where deficiency is not detected.

We will be conducting on-farm demonstrations of crop-sensor-guided nitrogen applications again in 2009 for both corn and cotton. We bring sensors, computer, and GPS, temporarily install them on your (or your retailer's) fertilizer applicator, and fertilize part or all of a field so that you can see them in action without an up-front investment of money and time. If you're interested in participating, call me at (573) 882-0777.

I'm also planning another newsletter article dealing with more advanced and practical aspects of using sensors to manage N–watch for it within the next month or so.

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