# Sensors Make Sense

## *Though Expensive, Sensors Can Help Manage Nitrogen In Cotton And Corn*

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The use of sensors to manage nitrogen in cotton and corn was discussed during a field day by Dr. Peter Scharf, University of Missouri nutrient management specialist. He covered a range of the tests underway to determine the best way to use sensors to make beter N rate decisions.

He pointed to the side by side demonstrations at the Jim Stuever Farm which compared Stuever's normal nitrogen rate with areas where nitrogen rate was diagnosed and controlled by crop sensors.

"You can't tell the difference now, and we saved some nitrogen," he said.

A key to making the technology work is to have a 'reference area'. In Stuever's field there was a small house-size plot near the edge of the field that received a high rate of N fertilizer about a month before the topdress operation.

"Genetics, growth stage, and weather all affect the color, as well as whether the crop has enough nitrogen. The reference area lets us know what color the crop should be – what color it can be – given genetics, growth stage, and weather. Not all varieties are the same."

Stuever's normal program is 25 or 30 pounds of nitrogen before planting with his phosphorus fertilizer and then come back a week or two before flower and put on 80 pounds actual N as broadcast urea with Agrotain.

"We put sensors on the front of that same fertilizer applicator so we could measure how dark green the cotton was," Scharf said. "We looked at the area where we had put a high rate of fertilizer about a month previous and the sensor noted the color of that cotton. Then as we drove through the field the computer remembered the color of that cotton and compared it to the color throughout the field. If the color was the same it put out a low rate; if the color was lighter it put out a higher rate."

Scharf said the topdress application ranged from 55 to 120 pounds of actual N, compared to Stuever's normal rate of 80 pounds. He said that about three quarters of the area that they were fertilizing with sensors got the additional 55 pounds, the agreed minimum rate.

"The color of the cotton in the field suggested it was pretty close to having enough and we didn't need to put out the full rate that Stuever normally does," Scharf said. "There were a few places, probably a quarter of the field, where we put out as much or more than his normal rate. The idea is to match what we put out with what the crop needs."

Scharf further considered why a farmer would need to do this. He showed some of the research that he's done on full scale farm fields, which measured how much N was needed at different points in the field. In eight fields that were studied, five of them needed all the way from zero to 250 pounds of nitrogen per acre for corn.

"We haven't done field scale studies in cotton of exactly how much was needed all across the field. But the soil is what controls that variability in N need, and the soil is the same whether you grow corn or cotton. In the eight corn fields we studied, all of them had areas that could make full yield on 75 or less, and all of them had areas that needed 225 or more," he said. "So in every field it was a wide range and that led us to believe we need a way to address this. We need a way to know where to put more and where to put less."

The next study was on the relationship between how much nitrogen was needed and the yield. They started with corn because so many more tons of nitrogen go out on corn than any other crop.

"We're moving into cotton, we're moving into wheat, but corn was our initial focus," Scharf said. "We found that, yes, where there was more yield there was more fertilizer needed, but it was a weak relationship. Only 13 percent of the total up and down of fertilizer need was related to where the yield rose and fell. That's not enough to do a good job."

Researchers then looked at testing soil nitrate by zones, and that accounted for 17 to 25 percent of the variability.

"That's a little better but it's still not going to do a good job by itself," Scharf said. "We looked at the soil texture or conductivity and we found there was a tendency on heavier soils to need more; but that explained only 8 percent of the variability. Then we went to the color of the corn and in our different experiments that explained anywhere from half to three-quarters of the variability - which isn't perfect but it's a lot better than everything else we looked at, and that's what got us going on using sensors."

The basic idea of crop sensors is to sense the color of the crop and put out a low rate of fertilizer when they sense a dark crop; when they see a light crop that means more fertilizer is needed so they dispense a high rate of fertilizer.

"We're up to over 100 of these on-farm demos with these sensors," Scharf said. "We take loaner sensors out to farmers. We set it up in advance, get brackets built that will fit their equipment and hold the sensors in the right place, make a plan for exactly how we're going to do it, and then we come on the day and do it, but a lot of it is the prep work. We compare the sensors side by side with what they're currently doing to see if we can increase profits for them. We have 55 fields where we've had really good head-to-head comparisons and on average we made two bushels more corn and saved 14 pounds of nitrogen. There are some fields where we've saved 50 pounds of nitrogen, some fields we put on an extra 30 pounds and made an extra 20 bushels, and everything in between."

On average, the researchers are about $12 ahead; at last year's prices that would be about $22. For the farmers, much of this depends on price.

"Twelve dollars is just barely enough to think about paying for the technology and management effort and the fact that they might have to wait a week longer than they otherwise would to start fertilizing," he said. One help at this point is that NRCS has made it an eligible practice for Environmental Quality Incentives Program (EQIP) contracts in Missouri.

"It fits with their goals," Scharf said. "This is definitely an environmental winner because it just cuts the nitrogen back in the areas where there's already a lot in the soil. Those are the areas that are going to be the leaky spots. With a normal rate, there will be more than the crop can use, it will be left over after harvest and can move into the environment."

Scharf thinks that the cost share support will help producers to invest in something that's good from the production side, but even better from the environmental side.

"Cost share can raise it from something marginally economical into something really viable."

Scharf has worked with nitrogen for 20-25 years and says one can really see the difference between where it is and where it's lacking.

"You almost always get a yield response to N, but sometimes it's large and sometimes it's small," he said. "The plant is sensitive to that and it shows in the way it looks."

There's disagreement as to whether sensors can gauge phosphorus deficiency but there's agreement that they gauge nitrogen deficiency. The question is how to translate the sensor readings into nitrogen rates. Nitrogen deficiency is much more common than any other nutrient deficiency.

"Nitrogen is our number one fertilizer and we use a lot more nitrogen than any other fertilizer on a national scale and that's because it does magic for our crops," Scharf said. "We need to use our brains," he added, "we need to use information to learn things about crops to do a better job of keeping up full production while minimizing economic inputs and minimizing the environmental impacts; and to me, out of all the things I've worked on, this has been the thing I've pushed the farthest because I think it meets those goals the best."

Presently, Missouri is the only state that has a cost-share program to assist farmers wanting to use sensors.

"Missouri NRCS approached me and some of the other people at MU that are working on it and said, 'How can we be successful with variable-rate nitrogen, and can you help us write a standard for how to apply this?'" said Scharf. "At a national scale, it's not yet available, but it's been available for three years in Missouri. The amount has changed every year, ranging from $38/acre to $73/acre for a 2- or 3-year commitment to the practice. Who knows what it's going to be next year? To me it looks like there's potential for it to be good because NRCS is increasingly talking about nitrogen and asking how they can push programs that address N."

Missouri is ahead of the curve on the national scale in cost-share and also in producers who have tried sensor technology, Scharf said.

"There's been a lot of interest on the research side, but not much adoption," he said. "I went to Indiana in August for a meeting where people from all over the country gathered to talk about managing nitrogen with sensors. That's the seventh year in a row we've had this meeting, it's in a different place every year and there's always good attendance, 50 to 100. I'm going to a meeting in Austin next week on the same subject, but limited to cotton. So it's generating interest, it's not mainstream yet, but it's getting there. Ag Leader is a big precision ag company and they've just announced a new sensor product that they'll sell to farmers next year.

Cost is a drawback. The Greenseeker brand until about April was selling a minimum of six sensors for $22,500, and was the only brand widely available in the U.S. Sensors have been available in Europe for about 10 years but at more than twice that price.

"That unit was called Green-seeker Light by a lot of people," Scharf said. "Their original unit was for retail machines where they placed a sensor on every nozzle to control each nozzle independently. It cost about $1,000 a boom foot; so on a 100-foot boom it was going to cost $100,000, which is why they didn't sell many. So they decided to sell something more affordable, which was the six-sensor system. Cost was still a big obstacle for the producers I work with, so I suggested that they market a cheaper set with less sensors. In April they went that route – $18,500 for a four-sensor set. From what I've heard, the Ag Leader sensors will be less expensive yet. If you already have their Insight controller, it's going to be in the $10,000-$10,500 range to get going with some sensors. There's also another sensor that is likely to enter the market in the next year or two. AGCO and Topcon have formed a partnership and have a sensor that is in early-stage testing and it looks good."

"When you start getting competition like that, when you start getting more adoption, the price becomes more reasonable," said Scharf. "I don't know where it's going to settle out but prices getting lower would certainly help people adopt it.

"Presently, a small producer maybe can't afford to get into it, but a large producer or a retailer can. At $12 an acre, which is the average benefit that we've seen, you don't have to run it over that many acres to pay for it. Say you buy the four-sensor Greenseeker product. By the time you've run it over 1,500 acres, if you get the same benefits we've gotten, you've paid for the whole thing. A large producer or a retailer can do that in one year, even a small producer can do it fairly quickly."

The payback is both in fertilizer savings and yield gain.

"Right now over all our demo fields, it's about 50-50 in terms of money, half of the $12 an acre comes from fertilizer savings and half comes from yield increases," Scharf said. "Sometimes you need more than your normal rate and sometimes you need less and it should be able to tell both if you get yourself set up right."

One flaw with the sensors is they can't tell the difference between a crop that needs a low N rate and a crop that needs zero.

"Lots of people want them to do that, think they can do that. They want to use them for 'top-up'," Scharf said, "but they can't do that. They're good for your main application, for diagnosing where you need a little, where you need a medium rate, where you need a lot. You have to give them some room. Because they can never tell you that the crop needs none, we always put at least 30 on cotton and 60 on corn when we're using them for an application. If your pre-plant N application is too high, then you lose the opportunity to use sensors to save money on your fertilizer bill. Whatever your normal total N rate is, I'd like to see people use preplant rates at least 100 pounds below that total for corn, and at least 70 pounds below that rate for cotton. That way you keep the option open to save on fertilizer."

It's also important to be able to apply high enough rates to ensure full yield in the parts of the field that need the most N. That's not a problem with dry machines, but the range of N rates that you can achieve is currently limited on liquid machines (including anhydrous ammonia). The difference between the lowest and highest possible rates is about a factor of two.

"If you have the highest pressure you're comfortable with on your system, that sets your maximum rate. By the time you reduce that rate by half, you've cut your pressure by a factor of four and you start to get to pressures where you may not get even distribution along your boom or bar," Scharf explained. "So if you want to go from a rate of 60 to a rate of 120, that's about the widest range you can get with plain orifices. To really take sensors to their full potential, you probably should be able to apply a wider range of N rates. Fortunately, there are some new spring loaded nozzle bodies for liquid products. When pressure goes up, the hole gets bigger and you can actually more than double rate when you double pressure. That makes the whole liquid system work a lot better as far as doing variable rate.

"One guy that I know that's doing it on every acre has a high clearance Hege with an injection tool bar on the front. He has six feet of clearance, so he's got a wide window of application, and he's got the new spring-loaded nozzle bodies. He can easily go from putting on 40 pounds to putting on 150; and he doesn't have to watch his pressure gauge all the time. He used the sensors for a year before he got the spring-loaded nozzle bodies, he had to slow down and speed up all the time to get the rates he wanted without running at pressures with which he's not comfortable. He's really happy that we got him hooked up with these nozzle bodies, he said they were slick and helped him do the job a whole lot easier." Δ

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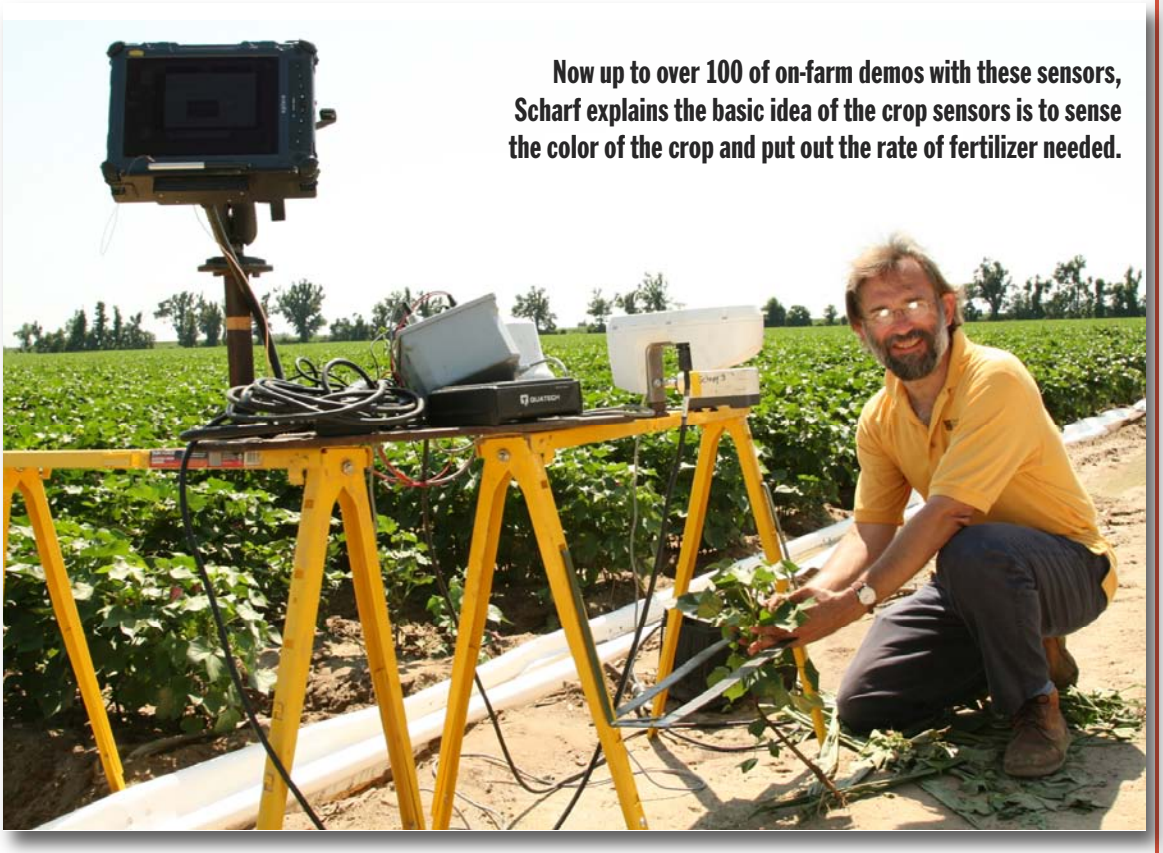

**Now up to over 100 of on-farm demos with these sensors, Scharf explains the basic idea of the crop sensors is to sense the color of the crop and put out the rate of fertilizer needed.**