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WHY ARE CROP CANOPY SENSORS NOT MORE POPULAR?

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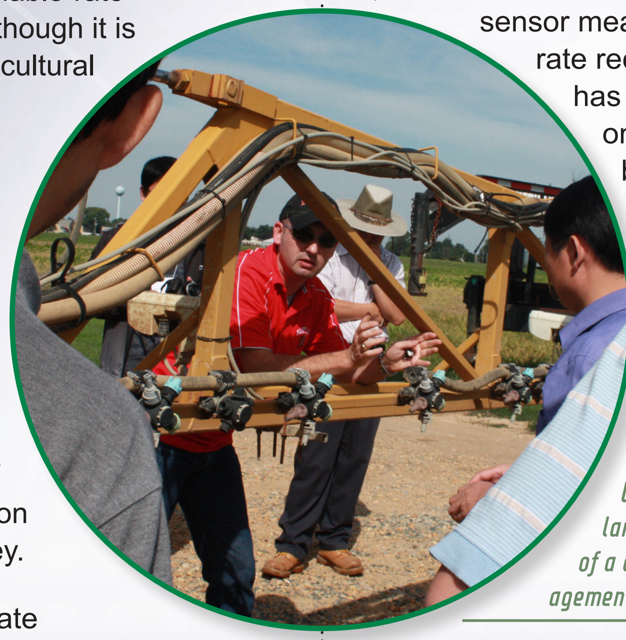
Crop canopy sensors first appeared in the commercial marketplace nearly 15 years ago. Despite the technology's long tenure in the precision agriculture space, current estimates of adoption rates are quite low compared with other precision services and variable-rate technologies. Although it is common for agricultural technologies to experience delayed adoption, crop sensors have never been used in more than 4% of the market area according to the biennial Purdue/CropLife Precision Ag Dealer Survey.

Other variable-rate technologies (map-based fertilizer, lime, pesticides, and seed) debuted in the survey in the early 2000's as occupying 4 to 8% of the market area, but adoption rates of those services have increased to 14 to 40%, while sensor use has remained constant. Similar growth in adoption of sensor technology was anticipated by the industry. In 2011, the first year sensors appeared in the survey, adoption was estimated to be 3% but expected to grow to 11% within the next three years. However, in the 2013 survey, adoption was at 4% and remained at 4% in the 2015 survey. Expectations remain high as the adoption of sensors is expected to increase to 12% by 2018, but what are some of the barriers that need to be overcome for adoption rates to increase as expected?



Dr. Josh McGrath, University of Maryland, describes the use of a crop sensor for N management on a Delaware farm.

The necessity of fertilization algorithms (the set of equations that convert sensor measurements into N rate recommendations) has been perhaps one of the biggest barriers to adoption. When crop sensors debuted in the marketplace, very few fertilization algorithms had been established and those that had, had not been validated outside the regions where they were created. The technology was reliable, but the science needed to take advantage of the tool across a wide geography was lacking. Over the past decade, several research groups have successfully developed N rate algorithms for a wide variety of crops and environments that are available for free and are compatible with commercially available sensors. A recent paper published by top university researchers working with canopy sensor technology noted that "Wide-scale adoption [of sensor

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> *"Wide-scale adoption [of sensor technology] is at some point expected as sensor [research] groups come together with more unified algorithms."*

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Adoption of sensors faces the same barrier as other variable-rate strategies in that it's difficult for growers to find value in the technology unless fertilizer rates are reduced. Sometimes, VRT results in an input reduction; however, another common result is simply a redistribution of the same rate of product into various management zones in the field, which can result in increased yield and fertilizer efficiency, but is more difficult to measure. PA service providers and consultants are addressing this challenge by establishing reference areas or "checks" within management zones that make it easier for growers to evaluate the effectiveness and ROI of the VRT. High and low N reference areas are already integral parts of many existing algorithms.

One barrier that sensor technology faces that other VR approaches don't is the "black box" nature of the real-time application. Map-based VR fertilization strategies allow the grower to see a prescription map prior to the application being made. Because sensor-based applications are made in real-time, there is no pre-application evaluation of the fertilizer rate distribution. One technology that is expected to eliminate this obstacle is UAVs. Research conducted at the University of Nebraska demonstrated that NDVI measurements collected using a crop sensor mounted on a UAV were highly correlated with measurements collected using a ground-based sensor. This approach will allow fertilizer prescription maps to be rapidly developed and evaluated by the grower prior to the sensor-based applicator entering the field.

Another development that may facilitate higher adoption of sensors is the ability to incorporate additional layers of information into existing fertilization algorithms resulting in even better performance. A recent multi-state research project led by scientists at USDA-ARS in Columbia, MO, evaluated the potential to incorporate soil and weather information into the University of Missouri N rate algorithm for corn. The study was conducted across 32 locations in 8 states in the Midwest US. They found that their ability to use the sensor to determine the economically optimum N rate improved when soil and weather variables were combined and added into the existing N rate algorithm. Many opportunities exist in PA to collect site-specific soil and weather data, which makes enhancing existing algorithms in this manner quite feasible.

Crop sensor technology for on-the-go nutrient management should become more mainstream for N fertilizer applications in the next few years. Reliable N rate recommendation systems have been developed for a variety of crops across multiple regions. Existing N rate algorithms are being enhanced with additional site-specific information such as soil characteristics and weather. Fertilizer prescription maps are being generated using UAV imagery. Reference plots are being included in zone management approaches to evaluate the effectiveness of VRT. All of these developments should lead to higher adoption rates of sensor technology. Dr. Brian Arnall, precision agriculture specialist at Oklahoma State University, agrees that sensor use will increase in the future. During his presentation at InfoAg 2015, he said "I really don't know why more people don't use the sensors. I have much more confidence in my ability to make an accurate N recommendation using the sensor than I do in our soil-test based recommendations for P or K".