National Fish and Wildlife Foundation
Final Programmatic Report

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Project Name: Helping corn and cotton producers to reduce nitrogen loss using crop sensors
Recipient Organization/Agency: University of Missouri
Recipient Organization Web Address: www.missouri.edu

1) Summary of Accomplishments

The use of sensor-based diagnosis and control of variable-rate nitrogen fertilizer applications was demonstrated in 80 corn and cotton fields. Outcomes were compared for standard nitrogen fertilizer management compared to the conservation (sensor) practice. In corn, use of sensors increased partial profit by $17/acre, and in cotton by $22/acre. In both crops the increase was due to a combination of increased yield and reduced nitrogen fertilizer use. Less fertilizer applied and more in the crop means less nitrogen available to be lost from fields to water and air. Several producers and retailers have invested in and adopted this technology as a result of our demonstrations, and others are actively considering adoption.

2) Project Activities & Results

Activities

- 80 field demonstrations of crop sensors to diagnose and control nitrogen fertilizer rate were conducted in farmer fields.
- Sensors, computer, and auxiliary equipment were temporarily installed on the nitrogen fertilizer applicator of the cooperating farmer or the farmer's service provider. We then demonstrated how the equipment worked to the farmer, and made variable-rate applications of nitrogen fertilizer in the farmer's field. Adjacent to these applications, fertilizer was applied at the rate normally used by the farmer.
- Nitrogen fertilizer rate and position were recorded continuously during these demonstrations. These data were used to create maps of nitrogen fertilizer rate applied, which were shared with the farmer. They were also used to compute average fertilizer rate applied based on diagnosis by crop sensors.
- Yield data were acquired and used to compare yield outcomes with sensor-based nitrogen fertilizer applications compared to yields with the nitrogen fertilizer rate chosen by the farmer. Georeferenced corn yield data were collected from combine (harvester) yield monitors. In cotton, each treatment area was harvested into a separate module and yield and quality data were obtained from the cotton gin.
- Six field days were conducted to educate farmers about the capabilities and performance of the crop sensors for managing nitrogen. A total of 500 people attended these educational sessions.

- 26 additional educational presenations were made to a variety of groups with a total attendance of 1610. Audiences included a mix of crop advisors, farmers, farm service providers, agency personnel, and scientists.
- We had numerous discussions with both major crop sensor manufacturers regarding farmer needs and technical performance issues. Both manufacturers have adopted features or approaches that we pioneered.
- Produced a manual to assist potential adopters of crop sensors. "Managing nitrogen with crop sensors: WHY and HOW" is available online at **http://plantsci.missouri.edu/nutrientmanagement/nitrogen/sensor%20manual.pdf**
- All activities described in the grant agreement were carried out successfully.

Results

- Our primary objective was to help corn and cotton producers to reduce nitrogen loss from their fields to water and air. Although we did not measure nitrogen loss, we were able to reduce nitrogen fertilizer use while increasing crop yield and therefore crop nitrogen uptake. This means that there was less (we estimate 25% less) unused nitrogen in the system that was susceptible to loss.
- In both corn and cotton, use of crop sensors increased partial profit, and in both crops this was due to a combination of reduced fertilizer use and increased yield. Increase in partial profit was $17/acre for corn and $22/acre for cotton.
- The 80 field demonstrations that we completed was twice as many as our target in objective 1 of our proposal.
- Four of the farmers participating in the project have purchased the sensors and adopted them in their crop management systems. Three of these four have also been hired by nearby farmers to use the sensors in applying nitrogen fertilizer on their fields. One other participant has purchased the sensors and uses them on part of his farm. Three other participants have adopted crop sensors into their management systems on a limited basis. One farmer and one service provider who did not participate in the field demonstrations have purchased the crop sensors at least partly due to their exposure to this project.

3) Lessons Learned

- Crop sensors to guide nitrogen applications were effective as a conservation practice relative to normal producer rates applied at the same time.
- Few corn producers in the midwest apply nitrogen fertilizer to the growing crop. Traditionally, all nitrogen fertilizer is applied before planting corn. Use of crop sensors to guide nitrogen rates requires that the fertilizer is applied to the growing crop. This turned out to be a key to successful corn production during the project years. Several lines of evidence suggest that during the very wet growing seasons of 2009 and 2010, traditional pre-plant nitrogen applications suffered heavy losses to water and air, resulting in nitrogen-deficient corn over large areas. Sensor-based nitrogen applications 6 to 10 weeks after planting were much less vulnerable to these losses, and often produced much better yields than neighboring fields.
- Our practical experience in conducting these field demonstrations taught us many lessons that could be of value to others attempting to use crop sensors to manage nitrogen fertilizer. These lessons are summarized in the publication "Managing nitrogen with crop

sensors: WHY and HOW". This publication is available online at **http://plantsci.missouri.edu/nutrientmanagement/nitrogen/sensor%20manual.pdf**

4) Dissemination

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5) Project Documents

a) Include with your report 2-10 representative photos from the project. Photos need to have a minimum resolution of 300 dpi.

b) Include with your report publications, GIS data, brochures, videos, outreach tools, press releases, media coverage, and any project deliverables per the terms of your grant agreement.