Low-Cost Precision Agriculture Solutions for Advancing Irrigation Efficiency
Project 10-2021

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Background and Objectives

Variable-rate irrigation (VRI) is the precision agriculture practice of customizing irrigation amounts to different areas within a field based on the unique characteristics of each area. VRI can be used to compensate for and minimize problems associated with in-field spatiotemporal variability, especially that of soil moisture. However, the initial and maintenance costs of zone control VRI are often daunting, and the fear of managing these systems discourages farmers from adopting this technology. Sector control VRI systems are less expensive and easier to operate because only the revolution speed of the center pivot is adjusted, and most late-model center pivots can be programmed to travel at a different speed (and thus apply a different irrigation amount) in each of several pie-shaped sectors without additional control panel upgrades. On fields where the distribution of wetter/drier areas match well with the geometry of pie-shaped sectors, the use of sector control VRI is an ideal solution for advancing irrigation efficiency beyond what is possible with conventional uniform irrigation.

We have been working on a production soybean field for the past four years, collecting soil moisture over the field during the growing season. This data shows the spatiotemporal variability over the field and how sector control VRI may help save water. The northwestern region of the field stays relatively wet when the remainder of the field is dry enough to warrant an irrigation application. The producer has given us permission to implement sector control VRI on this field. Specific objectives of this project include: 1) measuring water savings on one production soybean field using sector control VRI, 2) evaluating three additional production fields for potential sector control VRI applications, 3) determining the potential economic benefit from adoption of sector control VRI, 4) conducting a geospatial inventory of OFWS systems to better quantify the extent of irrigation in northeast MS, and 5) sharing results with stakeholders.

Report of Progress/Activity by Objective

Objective 1: Create and apply a sector control VRI prescription on a production soybean field and measure the water savings realized.

A preliminary VRI prescription was developed based on historical soil moisture data and DEM analysis of the area of interest, because previous research on the field showed that elevation/slope appeared to have the greatest influence on soil moisture. Soybeans were planted on April 27, 2021 but experienced uncharacteristic cool, wet conditions soon after planting. This resulted in slug damage to portions of the field (Figure 1). After several rain events, the decision to spot plant damaged areas of the field was made by the producer, and the replanting took place on June 1, 2021. After a strong stand on both the original- and later-planted areas was achieved, soil moisture sensors were installed on June 16 and June 17, 2021 at 12- and 24-inch depths at 44 points over a 55 x 55 m^2 grid. We recorded continuous soil moisture data from installation to when sensors were removed from the field prior to harvest on October 3rd. Plant height was collected at each grid point a total of seven times throughout the growing season (6/23, 7/6, 7/13, 7/28, 8/11, 8/25, 9/9); LAI was also collected on each of these dates except for July 13th, which was lost due to equipment malfunction. On June 23, the majority of the grid points were reading between 0-10 cb, meaning the field was extremely wet. A 2-inch rainfall event occurred on June

29, and the majority of the growing season was unusually wet. We were not able to apply a sector control variable rate irrigation on this field this summer due to adequate rainfall and the general lack of irrigation. There was one irrigation event during this growing season on August 12th consisting of a uniform application of 0.5 inch. In addition, we had aerial imagery flown for the field on June 23 and weekly thereafter. We have readvertised the GRA position to recruit a graduate student for this project.

Objective 2: Develop a simple method for evaluating whether production fields would benefit from sector control VRI.

A new undergraduate student was hired to help advance progress on this objective, and he started in January. Soil and elevation data for the other two larger fields at our study farm are being downloaded and analyzed, and flow meters for all three pivots at the study site were repaired and are now working.

Objective 3: Evaluate the economic benefit from VRI adoption.

Work on this objective is being shifted to Years 3 and 4 of the project, since the 2021 growing season was so wet that we were unable to apply the VRI prescription. Therefore, data collection for this objective will begin in 2022.

Objective 4: Perform a geospatial inventory of surface water storage systems used for irrigation in Northeast Mississippi, to assess the potential for VRI adoption.

An undergraduate student was hired in January to work on this objective. Images collected through the USDA-Farm Service Agency's (FSA) National Agriculture Imagery Program (NAIP) were downloaded from the Mississippi Automated Resource Information System (MARIS) website for all 22 counties in Northeast Mississippi. MARIS serves as the state's geospatial data clearinghouse. The NAIP images were used in combination with Google Earth images to delineate on-farm water storage systems (OFWS) and center pivot locations in these counties. When performing the inventory for each county, a grid was placed on top of the NAIP imagery. This allowed the student to look at each section of the grid individually to determine the presence of an OFWS or center pivot. Of the 22 counties, three have been completed to date (Figs. 2 and 3).

Objective 5: Share project results with producers and other stakeholders, especially those in Northeast Mississippi.

Dr. Tagert organized two "Turnrow Talk" events where she shared our current findings and continued research with local farmers and stakeholders. The first event on June 29, 2021 took place in Noxubee County at our field of research in Brooksville, Mississippi, and the second event occurred on June 30 at Holloway Farms in Monroe County. Flyers were emailed to all county Extension offices in Northeast Mississippi. Dr. Tagert attended the ASABE/Irrigation Association (IA) 6th Decennial National Irrigation Symposium, which was held in conjunction with the annual Irrigation Association Trade Show on Dec. 6-8, 2021 in San Diego, CA. She gave an oral presentation on this project titled "Factors Affecting In-Field Soil Water Variability and Irrigation" and published a related conference paper.

Impacts and Benefits to Mississippi Soybean Producers

We are in the early stages of this project, but the results will benefit soybean producers using center pivot irrigation who implement sector control VRI, which can help save water and energy through a more efficient application of water. Benefits could be even greater in drought years where fields are irrigated with on-farm reservoirs and could allow more land to be irrigated by the same reservoir. The

geospatial inventory will be useful in many ways, including helping justify cost assistance programs related to irrigation in the northeastern region of the state and helping better target education and outreach programs.

End Products – Completed and Forthcoming

- Two "Turnrow Talk" events in Noxubee (June 29) and Monroe (June 30) counties and presentation at the ASABE/Irrigation Association 6th Decennial National Irrigation Symposium with conference paper (completed)
- At least one Extension publication and/or fact sheet summarizing project results (forthcoming)
- A thesis produced by an AETB M.S. student and a thesis produced by an Ag Econ M.S. student (forthcoming)
- At least one peer-reviewed journal article (forthcoming)
- Power Point presentation describing the project and project results (forthcoming)

Graphics/Tables

Figure 1. Slug damage experienced by soybeans prior to sensor installation.

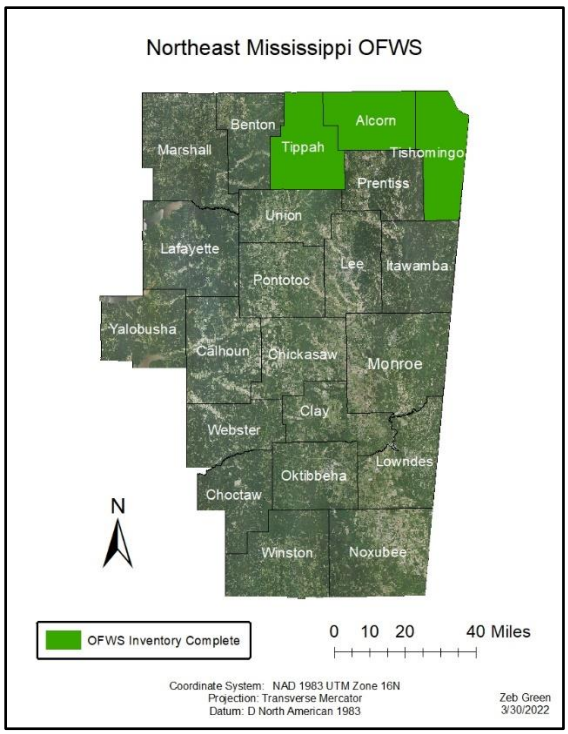

Figure 2. Progress on geospatial irrigation inventory.

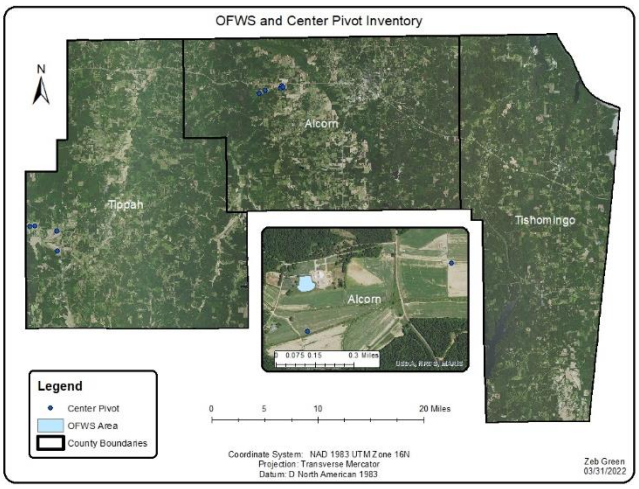

Figure 3. Completed counties in irrigation inventory.