MISSISSIPPI SOYBEAN PROMOTION BOARD

Low-Cost Precision Agriculture Solutions for Advancing Irrigation Efficiency, Project 10-2022 Annual Report

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Rationale and Justification

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.

After analyzing the soil moisture and elevation data from previous years, two sectors under the pivot were identified for a VRI prescription – a ‘wet sector’ and a ‘dry sector.’ These sectors were identified by further analyzing the soil moisture data on multiple dates throughout the growing season. Once these sectors were identified, they were each broken into six individual “slices” for a total of twelve “slices”. Plots were delineated in the outer span of the pivot, allowing a 30-ft. border on the side of each plot and a 20-ft. border on the inner and outer perimeter of each plot (Figure 1). Centroids were calculated for each plot and then uploaded to a Trimble Yuma GPS. Corn was planted in this field on April 25, 2022 and the centroids and plot boundaries were then flagged in the field using the GPS. Watermark granular matrix soil moisture sensors were installed on June 1, 2022 at 12- and 24-inch depths. The angles for the VRI prescription were calculated using ArcMap (Table 1), and these angles were then placed into Feildnet by the producer on June 14. Also, a Sentek Sensor was installed at eight of the twelve centroids. The producer first irrigated on June 16 and then again on June 22 and 27 due to the extremely dry conditions experienced during the month of June. In the month of July the field was irrigated on July 3rd and 9th. Each of these irrigation events applied 0.75 inches to the full rate plots and 0.6 inches (20% reduction) to the reduced rate plots. After the crops were irrigated on July 9th, the producer had to make the call to no longer irrigate the corn crop due to the lack of water remaining in their on farm water storage systems (Figure 2). After very little rain for the rest of July and August, the sensors were pulled on August 19th so that they could begin harvesting. All the soil moisture data that was collected this growing season was organized by plot (ex. Low 1 and Full 1). Also, all irrigation applications and rainfall events that occurred throughout the growing season have been compiled along with the soil moisture data. The soil water tension, precipitation, and irrigation data were analyzed. The results showed that the dry full and wet low plots were similar in soil water tension values throughout the growing season (Figure 3).

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

Data such as soil type and elevation maps from the three larger fields at our study farm have been downloaded and formatted. All of this data was then overlaid and evaluated to determine if these production fields would benefit from sector control VRI (Figure 4). Next, shapefiles of the irrigated areas were created to later be divided into sections, and proposed management zones were created for each center pivot (Figure 5). This allowed us to determine the placement of soil moisture sensors in each management zone. Dataloggers for each new field were ordered and received. New Watermark 200ss granular matrix soil moisture sensors were ordered, assembled, and installed in the three larger fields being evaluated.

Objective 3: Evaluate the economic benefit from VRI adoption.

Work on this objective will be conducted over the next two years, and the monitoring data we are collecting will be shared with the ag economics team. The economic benefits evaluation will be conducted by using partial budgeting and net present value. The team will identify changes in benefits and costs that result from implementing the new irrigation practice of sector control VRI, including water and energy bill savings, improved yield sale, and extra equipment, software, and labor costs, while all other aspects of farming budgets that are unchanged by the implementation can be safely ignored. The benefits and costs of VRI are also a multiple-year issue, which requires us to account for cross-year weather variations and the long-term cash flows. To correctly evaluate the multi-year economic impact, the net present value approach is used to discount the dollar amounts in future years over the useful life of the equipment.

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

To perform a geospatial inventory of surface water storage systems used for irrigation in Northeast Mississippi, USDA National Agriculture Imagery Program (NAIP) imagery for this region that was collected in 2020 was downloaded from MARIS and then uploaded into ArcMap. A 1 km^2 grid was then overlaid onto the imagery to analyze the imagery for on-farm water storage (OFWS) systems in an organized fashion. Google Earth was also used as a secondary data source because of its high resolution as compared to the NAIP imagery. This helps to reinforce system components that might not be easily identifiable from the NAIP imagery. To date, 18 of the 22 counties have been completed. There have been 79 possible on-farm water storage (OFWS) systems identified, providing 414 hectares of surface water storage area. In addition, 160 center pivots have been mapped, and these pivots irrigate 6,657 hectares (Figure 6 & 7). Ground-truthing of these systems has begun, and at least 50% will be ground truthed over the next year.

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

Dr. Tagert organized a “Turnrow Talk” Event where she and Zeb Green shared the benefits of VRI, the current VRI Prescription, and how it was formulated with local farmers and stakeholders. This event took place on June 30, 2022 in Noxubee County at our field of research in Brooksville, Mississippi, and 35 participants were in attendance (Figure 8). Dr. Tagert shared project information during the South Central US Drought Update and Winter Outlook: Impacts to Agriculture, Ongoing and Future Issues on November 14. She was one of seven invited speakers, and the webinar was sponsored by the National Oceanic and Atmospheric Administration (NOAA)'s National Integrated Drought Information System and the Southern Regional Climate Center. A poster showing preliminary project results was created and displayed at the North Mississippi Producer Advisory Council meeting in Verona on February 16 and also at the Farm and Gin show on February 24-25 (Figure 9). In addition, Zeb Green gave a presentation on the project at the Mississippi Water Resources Conference on March 29th, 2023 (Figure 10).

Impacts and Benefits to Mississippi Soybean Producers

We are mid-way through the 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 related to irrigation.

End Products – Completed and Forthcoming

- One “Turnrow Talk” events in Noxubee county (June 30) and a presentation at the South Central US Drought Update and Winter Outlook: Impacts to Agriculture, Ongoing and Future Issues (November 14). A poster showing preliminary project results was created and displayed at the North Mississippi Producer Advisory Council meeting in Verona (February 16) and also at the Farm and Gin show (February 24-25). (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

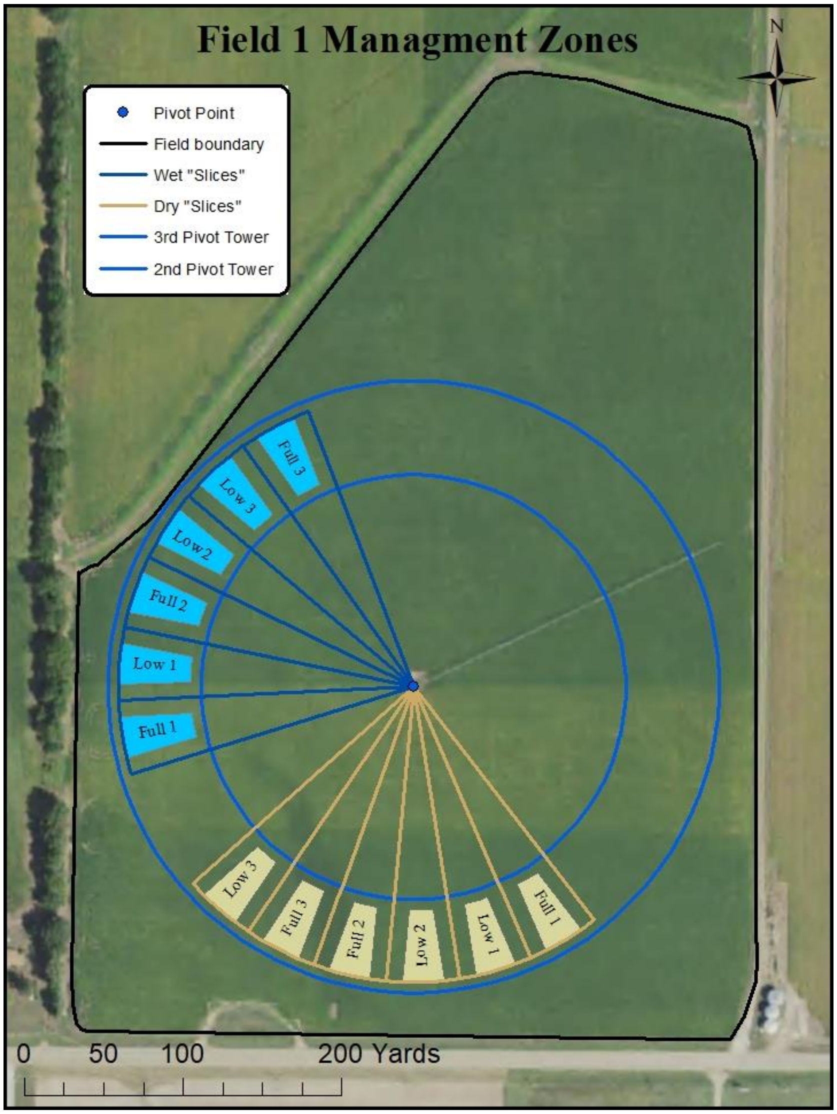

Figure 1. VRI map showing wet and dry zones with plots and irrigation rates.

Area	Start angle	End Angle	Pivot Speed(%)	Application Rate (in)
1	335	167	26.2	0.75
2	167	196	32.8	0.6
3	196	225	26.2	0.75
4	225	239	32.8	0.6
5	239	278	26.2	0.75
6	278	292	32.8	0.6
7	292	307	26.2	0.75
8	307	335	32.8	0.6

Table 1. VRI prescription calculated using ArcMap.

Figure 2. On Farm Water Storage System that is used to irrigate the field of study in July 2022.

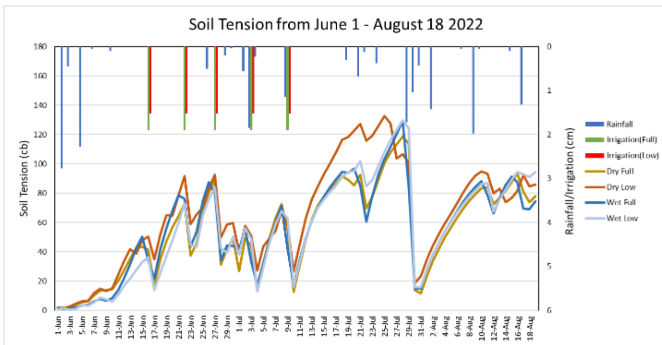

Figure 3. Daily average soil water tension from June 1st to August 18th, 2022.

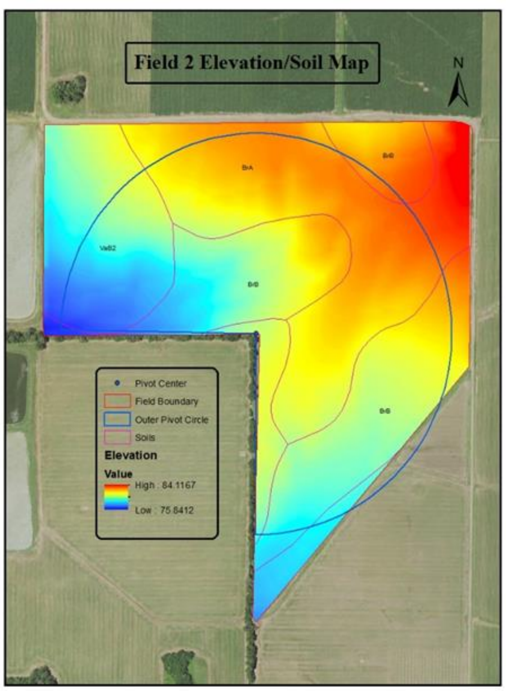

Figure 4. Elevation and soil map of field 2.

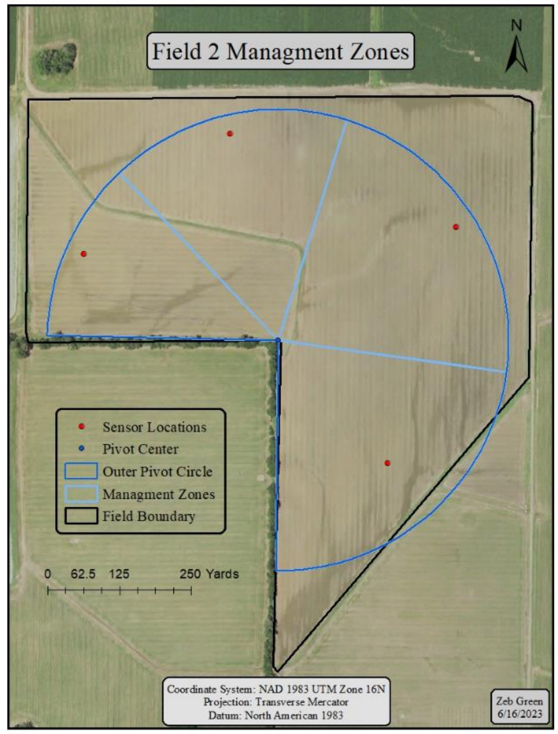

Figure 5. Field 2 management zones and sensor locations for the 2023 growing season.

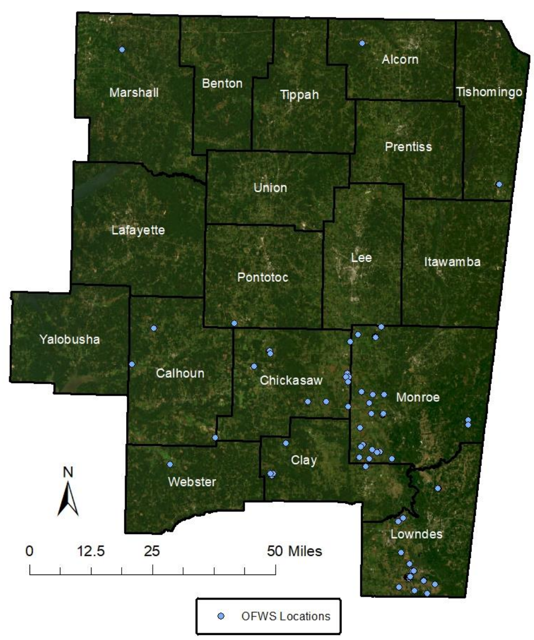

Figure 6. OFWS system inventory map.

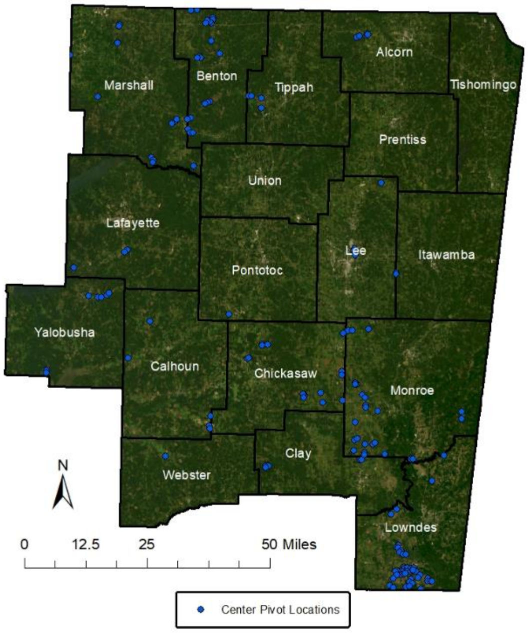

Figure 7. Center Pivot Inventory map.

Figure 8. Dr. Tagert speaks to local farmers and stakeholders at Noxubee County Turnrow Talk.

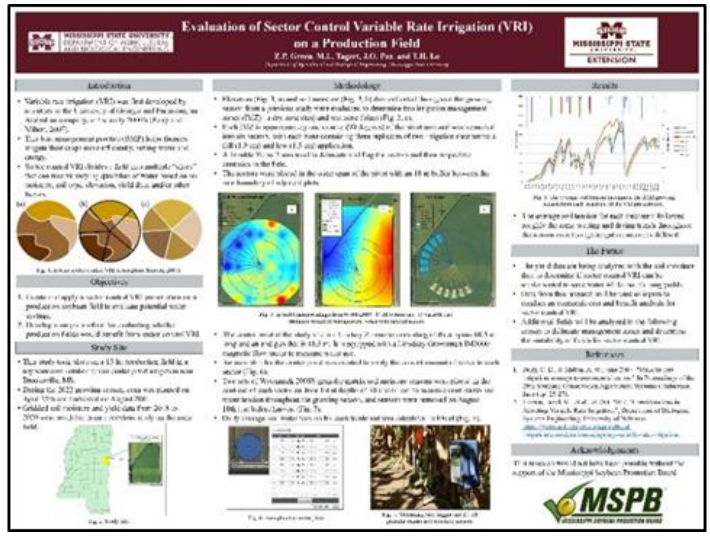

Figure 11. Poster that was presented at the North MS Producer Advisory Council and Farm and Gin Show.

Figure 10. Presentation at the Mississippi Water Resources Conference.