Project Number:	
Project Title:	**LADDER (Large Agricultural Database that Drives Extension and Research)**
Organization:	**Mississippi Water Resources Research Institute (MWRRI); Mississippi State University**
Project Lead Name:	**Dave Spencer**
Reporting Period: *Please select the appropriate reporting period for this report.*	☐ December ☒ March ☐ June ☐ September ☐ Final

The information included in this detailed report should reflect quantifiable results that can be used to evaluate and measure project success.
If Progress Report – What key activities were undertaken and what were the key accomplishments during this reporting period? List each key deliverable from the proposal and describe progress made (or not made) toward achieving it, including metrics were appropriate.
If Final Report – What were the key accomplishments during the life of the project? List each deliverable from the proposal and describe progress made (or not made) toward achieving it, including metrics where appropriate.

Objective 1: Determine the effects of environment, i.e., CEC, pH, slope, climatic data, and agronomic practices including irrigation, precision ag technology, nutrient management, planting systems, and tillage systems on soybean productivity and profitability at the farm scale.

LADDER now has added functionality to allow users to build a data model, predict yields and ideal nutrient levels, and use these ideal nutrient levels to automatically generate nutrient prescriptions. To do this, LADDER allows a user to upload a sample, LADDER finds the difference in ideal nutrients and the samples nutrients, then LADDER predicts the yield and appends rows for the rate of nutrients to be added in PPM. Using the equation 1 PPM = 2 Lbs./Acre and accounting for molecular weight of said nutrient, we can generate recommended prescriptions in Lbs./Acre. As users build a larger dataset over time, the model can be retrained to improve accuracy. During testing, LADDER was able to predict soybean yields with an average error rate of +- 8 Bushels while being trained on a relatively small dataset of ~15 harvest files.

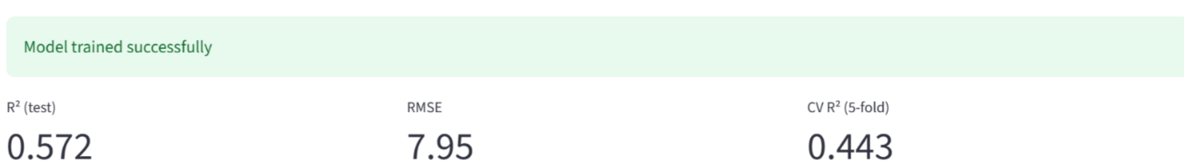

Figure 1: Root Mean Square Error for Soybean Yield

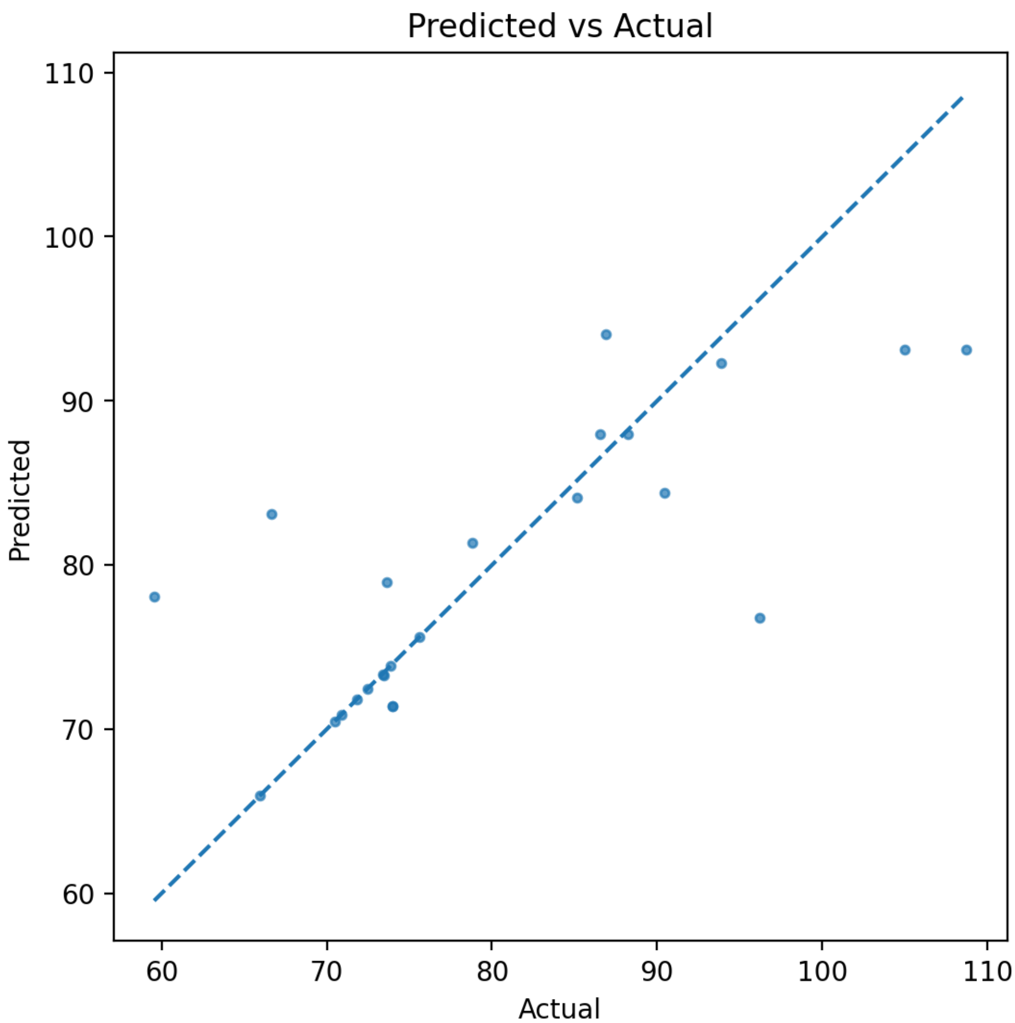

Figure 2: Predicted Soybean Yield vs Actual Yield

Best Predicted Outcome

Predicted best VRYIELDVOL: 94.08

	pH (1_2)	S (M3)	Zn (M3)
26	6.6	7	4.4

Figure 3: Best Predicted Outcome and Associated Nutrient Levels

Prescription Preview

	predicted_yield	Zn (M3)_rate	S (M3)_rate	pH (1_2)_rate	P (M3)_rat
0	75.8823	0.4	0	0	
1	69.5591	0.4	0	0	
2	74.0013	2.8	0	0	
3	75.6194	1	0	0	
4	81.9927	0	0	0	
5	73.9575	0.8	0	0	
6	72.8952	2.6	0	0	
7	73.312	1.6	0	0	
8	71.8171	2	0	0	
9	75.3763	2.6	0	0	

Download Prescription CSV

Figure 4: Prescription Preview for Users' Soil Sample

$$2Lbs/Acre = 1ppm$$
$$Target_K = 125ppm$$
$$Actual_K = 90ppm$$
$$\Delta K(Lbs/Acre) = 2 * (Target_K - Actual_K)$$
$$\Delta K = 2 * (125ppm - 90ppm) = 70(Lbs/Acre)$$

$$AtomicWeight_K = 39.1$$
$$AtomicWeight_O = 16$$

$$AtomicWeight_{K_2O} = (2 * AtomicWeight_K) + AtomicWeight_O$$
$$AtomicWeight_{K_2O} = (2 * 39.1) + 16.0 = 94.2$$
$$K_{percent} = (2 * 39.1)/94.2 = 83\%$$
$$Potash \quad 0 - 0 - 60\%$$
$$Potash \quad to \quad apply = 70(Lbs/Acre)/(83\% * 60\%) = 140Lbs/Acre$$

Figure 5: Formula Used to Determine Fertilizer Application rate

Furthermore, when training the data model, the user can choose multiple columns to be "features" (not just nutrients) and a single column to be a "target" (usually yield). This allows LADDER to generate data models by using any numeric columns at hand such as elevation, harvest speed, seeding application rate, dates in julian format, etc.

Objective 2: Deliver research-based Extension programing to soybean producers in the Mid-South to stimulate the adoption and proper implementation of geospatially specific agronomic practices that improve grain yield, net returns, and sustainability.

LADDER's report generation features are currently being written. These auto-generated reports paired with LADDER's prescription generation features will give farmers deep, actionable insights on yield performance, parameter deficits, and estimated yield improvements. Combining recommended prescriptions and predicted yields with historical yields as well as nutrient price will enable farmers to approximate the potential return on investment (ROI) from implementing recommended prescriptions.

Figure 6: PDF Report Generation Functions

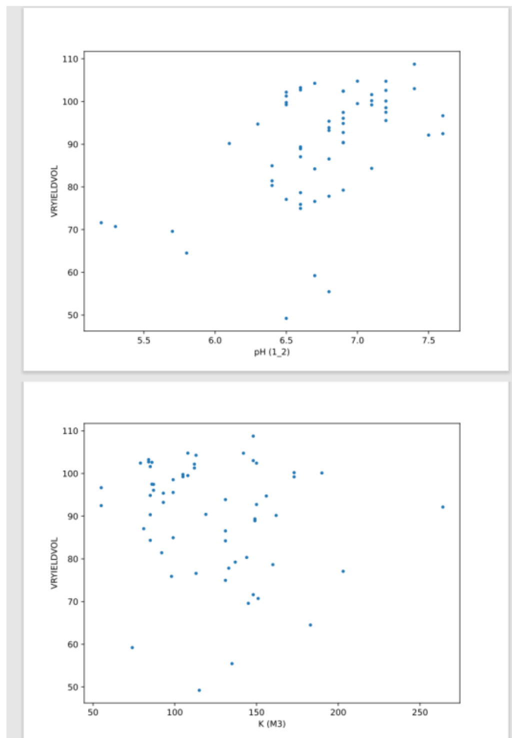

Figure 7: PDF Report

LADDER is in the final stages of development. The main spatial analysis techniques have been developed as well as LADDER's data ingestion techniques, data rasterization techniques, data model generation, and data plotting techniques. The final steps in moving LADDER towards a production ready format will be packaging it as an executable, creating documentation covering LADDER's architecture and use cases, and creating example projects the user can use as a starting point for their own data analysis operations. Furthermore, there will be a docker image included in the deliverable that will allow LADDER to be hosted on a web server so that multiple clients can use LADDER in parallel.