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Progress Report

2022 South Dakota Nutrient Research and Education Council Invited Proposals

Progress Report Title:	Interim Report - Due July 1, 2022
Applicant Name:	John McMaine
Application Title:	Precision Controlled Drainage for Reducing Nutrient Loss through Tile Drainage and Improving Yield
Application ID:	1843
Review Deadline:	07/1/2022 11:59 PM

Interim Report - Due July 1, 2022

Project

	Start Date	End Date
Start and End Dates of Funding:	01/1/2022	12/31/2022

Title of Project: Precision Controlled Drainage for Reducing Nutrient Loss through Tile Drainage and Improving Yield

Project Description: Nutrient loss contributes to economic loss for producers and potential negative downstream water quality impacts. One path of soluble nutrient loss (nitrate) from fields is through subsurface drainage. Controlled drainage (CD) has the potential to reduce nitrate loss by more than 50%. Unlike other conservation drainage practices, by holding more water in the field when needed, CD has also shown potential to increase yield by up to 10% (Helmers et al., in preparation). While all conservation drainage practices are tools in a farmer's toolbox to reduce nutrient loading downstream, CD has the potential to pay for itself over time, making it an attractive option for farmers and drainage contractors. Current CD management recommends adding or removing stop logs two-three times per year without regard to field conditions. Commercially available systems allow for remote control through a smart phone but management still does not account for field, crop, or future weather conditions. As part of this project, SDSU faculty and staff will develop a precision controlled drainage prototype, deploy the prototype into the field and evaluate field performance (nutrient load and yield) of precision controlled drainage compared to conventional free drainage. The Year 1 project cost is $54,285. Preliminary data from this project will be leveraged to competitively apply for a USDA grant for further development and widespread impact. If a different source of funding is not secured then the project team will apply to the SD Nutrient Research and Education Council to complete additional phases.

Publications

Publication Title:	Thesis - Morghan Hurst
Publication Date:	05/6/2022
Status:	published on open prairie
Publication Description:	MS thesis

Title: Precision Controlled Drainage for Reducing Nutrient Loss through Tile Drainage and Improving Yield

PI and collaborators:

PI – John McMaine, Agricultural and Biosystems Engineering, SDSU. John.mcmaine@sdstate.edu. 859-229-6669.

Objectives

1. Develop and test a bench-scale precision controlled drainage system that optimizes water retention and release as a function of soil moisture dynamics (water holding capacity and drainage rate), in-field soil moisture, current and projected crop water demand, and weather forecasting.
2. Deploy a field-scale precision controlled drainage system.
3. Evaluate performance of a field-scale precision controlled drainage system.

Progress and Updated Plans

After discussion with the project team and Agri Drain Corporation, it was decided to utilize upon existing technology as a base and improve upon existing technology rather than start from scratch. PI McMaine had an in-person meeting with Agri Drain president, Charlie Schaffer and discussed collaboration opportunities for the project. The project team agreed to move forward with using an Agri Drain remote controlled drainage system as a foundation and doing additional development and testing with that system. Details for design and installation are in progress for setup and installation of the pilot system in South Dakota.

To provide additional preliminary data to support the proposal for USDA, two additional analyses were performed using a field-scale hydrologic model (DRAINMOD) and historic crop insurance data. The model was set up and run for a location in Clay County, SD for a 63-year period. A water balance was performed under drained conditions and opportunities for controlled drainage were identified if water was present in the soil profile and ET (crop use) occurred at the same time. It was determined that in 18 of 31 average years, water could have been held back that would be used by the crop.

The second additional analysis determined instances that crop loss occurred from both moisture extremes in the same county and same year. For 120 county years (four counties and 30 years), both moisture extremes caused crop damage for corn in 89 county years and 100 county years for soybeans. This demonstrates that it is not just the total amount of water that causes crop loss but the timing. Both of these analyses indicate potential for automated controlled drainage.

Impact

The two additional analyses were published in a MS thesis in April, 2022. Concepts from this project were presented during Crop Hour with around 40 participants. This project is expected to reach an additional 500 participants through booths at Ag PhD Field Day and Dakota Fest. It is anticipated that the pilot project will also be installed in time for the Eastern South Dakota Water Conference and South Dakota Student Water Conference and will be included on tours at these events.

Changes in Project Personnel

As with seemingly every project the last two years, one of the primary boots-on-the-ground personnel, Kristen Almen resigned her position this spring. Kristen was on the project team and assisted in project coordination. This created a challenge for building momentum to get the pilot project installed at SDSU. A temporary technical staff has been hired and steps are being taken to hold regular project meetings in Kristen's absence to keep the project moving forward.

Budget

Due to the delays in installing the pilot project, much of the materials and supplies budget has not been spent down. It is anticipated that this will be spent in the coming months. In addition, personnel costs (PhD student) were tied to work on the pilot project, so have not been initiated yet. A PhD student is in place that is interested in working on the project, so when the pilot project is installed it is anticipated that they can start work immediately.