2021 Final Report Summary Sheet

Grantee Information

Project Title: The effect of cover crops on surface water quality: A paired watershed experiment in the Lake Bloomington watershed

Institution: Purdue University

Primary Investigator: Dr. Shalamar Armstrong

NREC Project #

[redacted]

Is your project on target from an IMPLEMENTATION standpoint? ☒ **Yes** ☐ **No**

If you answered "no" please explain:

Is your project on target from a BUDGET standpoint? ☐ **Yes** ☒ **No**

If you answered "no" please explain: We received the contracts late causing there to be a delay in spending, but a NCE has been approved.

Based on what you know today, will you meet the objectives of your project on-time and on-budget? **Yes** X **No**

If you answered "no" please explain: See above and below explanations

Have you encountered any issues related to this project? **Yes** **x** **No**

If you answered "yes" please explain:

Have you reached any conclusions related to this project that you would like to highlight? X **Yes** **No**

If you answered "yes" please explain:

Significant reductions in nitrate-N concentration and load due to partial cover crop adoption (50%) on a watershed scale.

Have you completed any outreach activities related this project? Or do you have any activities planned? x **Yes** **No**

If you answered "yes" please explain and provide details for any upcoming outreach:

Midwest Cover Crop Council 2021, NREC TEDTALK Research Summit 2021, Indiana CCA Conference 2021, Kentuckiana Crop Production Conference 2021, IL Soybean Summit 2021 WI Agribusiness Classic 2021, Ohio State University, Agronomy Society of America 2021,

The effect of cover crops on surface water quality: A paired watershed experiment in the Lake Bloomington watershed

Research Objectives

1. To determine the impact of mass adoption of cover crops on nitrogen in tile drainage water.
2. To investigate the impact of mass adoption of cover crops on surface runoff P loss.
3. To quantify the spatial and temporal variation in cover crop growth and N uptake.
4. To relate patterns in nutrient loss to cover crop biomass, nutrient uptake and soil nitrogen.
5. To include a final report at the conclusion of this project to address each of the objectives stated above.

Significant Agronomic Findings of 2021

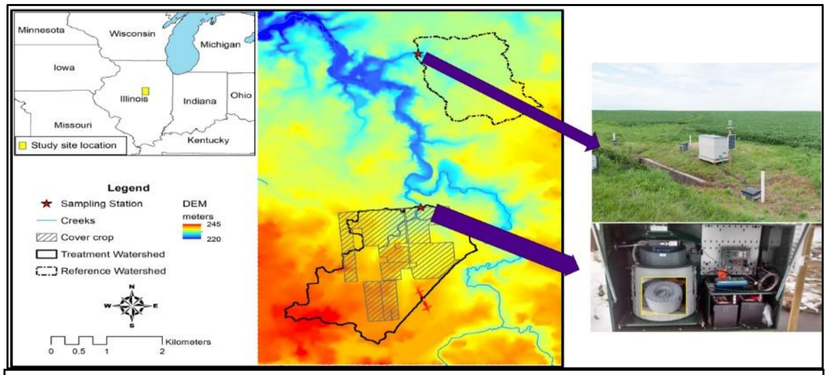


Figure 1. Sub-watershed (treatment and reference) locations within the Lake Bloomington Cover Crop Watershed study.

Cover crops impact on nitrate loss via tile-drainage is scalable to the watershed level. After a successful aerial application of cover crops in the fall of 2020 on 449 acres (49% of the treatment watershed), we observed a reduction in tile-drainage water NO_3-N concentration for the cover crop watershed relative to the reference (control) watershed. This reduction in tile-drainage water NO_3-N concentration is consistent with our observation from previous years of 2018-2020. Furthermore, when considering NO_3-N load, the total mass of NO3-N per 1000 gallons of drainage water, cover crop adoption resulted in a 33% reduction relative to the reference watershed in 2021, which is consistent with the 39% reduction of the previous 3 years. These observations demonstrate the ability of cover crops to interact and scavenge soil nitrate from the residual and legacy N pools that would otherwise be susceptible to being lost via tile-drainage. Once soil nitrate is scavenged, the cover crop assimilates the nitrate into its organic structure securing it from possibility of leaching and denitrification.

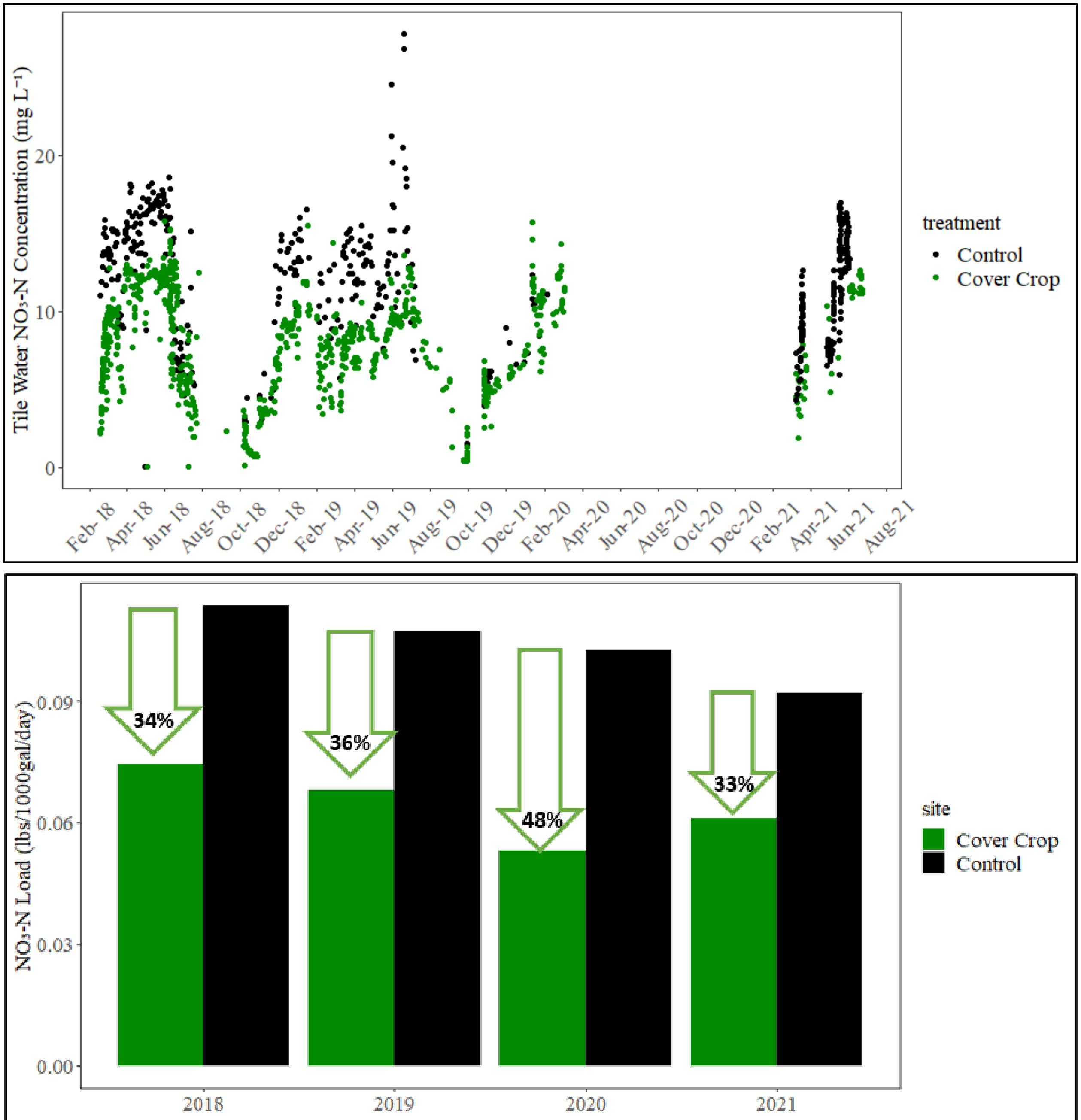


Figure 2. Tile water NO_3-N concentration in tile water over time within the reference and cover crop watersheds (top). Tile water NO_3-N load from 2018-2021 within the reference and cover crop watersheds (bottom). Note: data points in 2020 was limited to the cover crop growing season.

Significant Accomplishments

<u>Upgrade of the water quality monitoring systems in both the reference and treatment watershed to quantify Surface water runoff quality and quantity</u>

To better understand the impact of cover crops on nutrient loading on a watershed scale, we designed an in-situ water monitoring and sampling system to evaluate the impact of surface water in addition to the tile water previously being monitored. In both the treatment and reference watersheds, a concrete culvert located near the existing water sampling stations (Figure 3 and 4) was used as a flume to capture the surface water flow and to provide us with a defined shape to determine the volume of water leaving each watershed. In the treatment watershed, the culvert was located such that it was capturing only surface water and in the reference watershed it was located such that it was capturing a combination of surface and tile water (Figure 3 and 4).

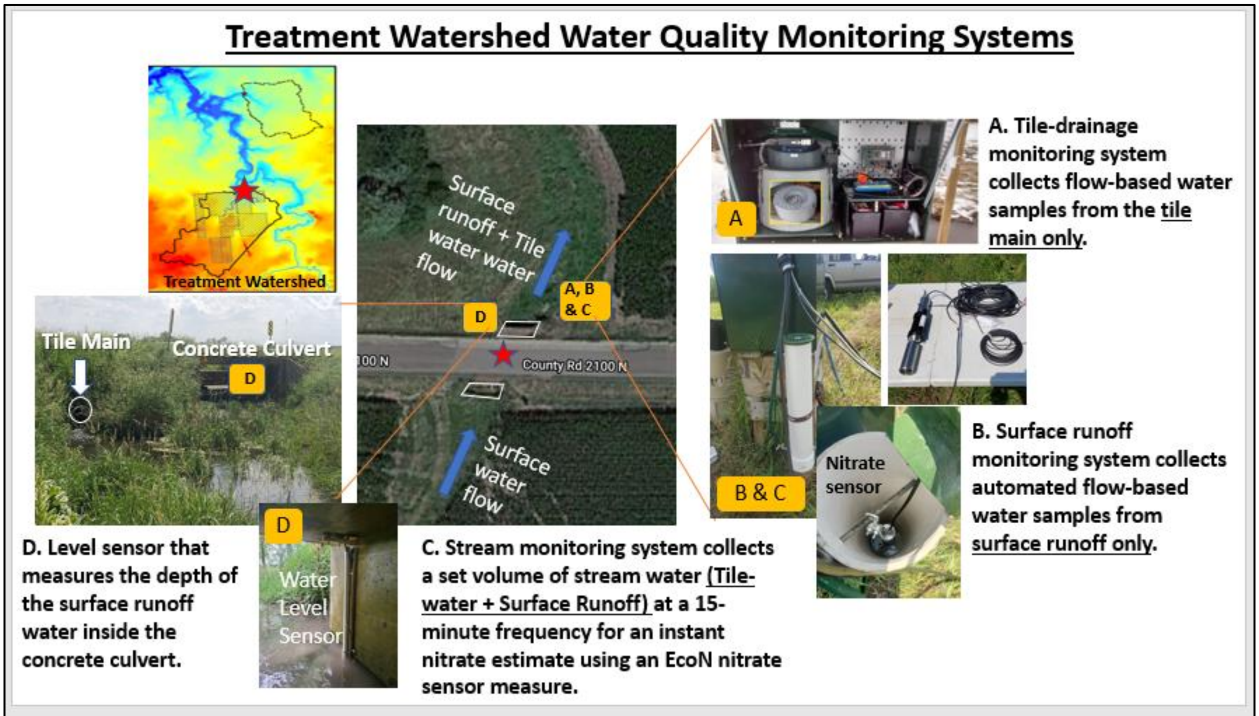


Figure 3. Schematic of the treatment (cover crop) watershed water quality sampling systems.

In the treatment watershed, we installed a level sensor (pressure transducer) and water sampling line inside the culvert (Figure 2, letter D) to monitor the level of the water and to collect water samples using an automated water sampler whenever surface flow occurs (Figure 2 letter B and D). In addition, we also installed an in-situ nitrate sensor to monitor the nitrate concentration in the stream water (both surface and tile water). This sensor was originally installed in the stream at a point after the tile water and surface water mixed; however, we experienced recurring problems with stream debris and vegetation obscuring the optic lens of the sensor. As a result, we designed and built a sampling well to house the nitrate sensor on the bank of the stream (Figure x letter C). The sampling well uses a battery power water pump connected to a relay timer to pump water every 15 minutes from the stream up to the sampling well. This allowed us to protect the nitrate sensor from debris in the stream while still measuring the real time nitrate concentration of the stream.

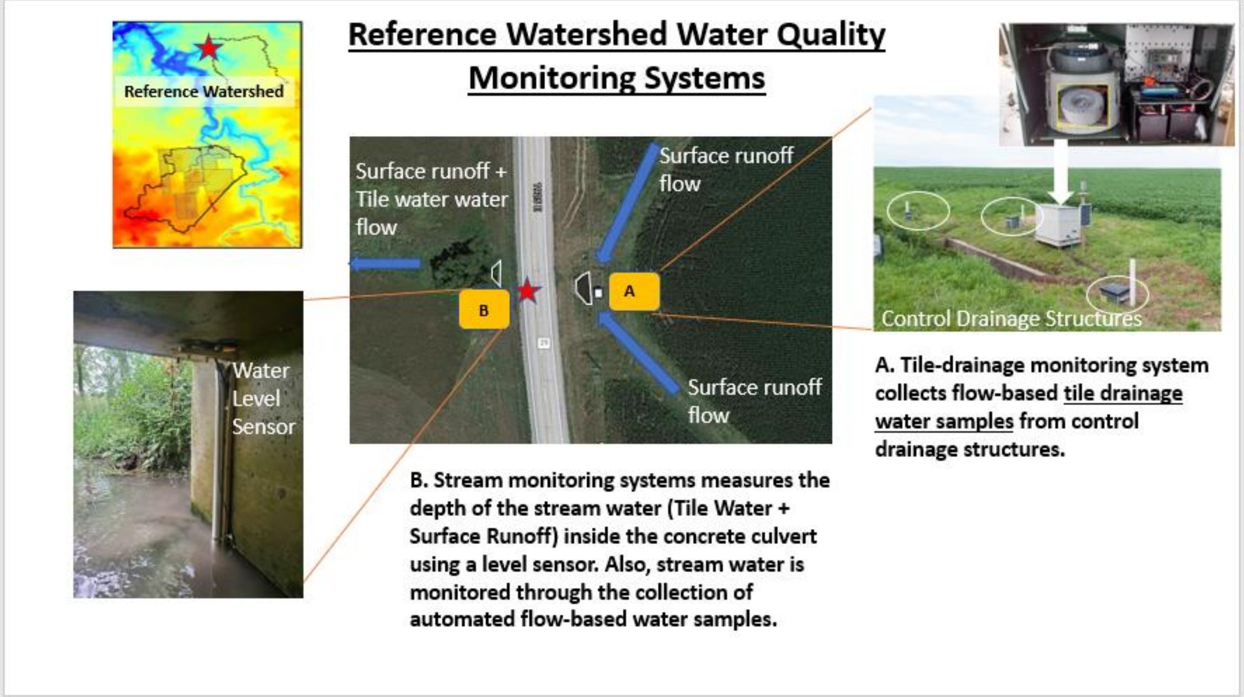


Figure 4. Schematic of the reference (control) watershed water quality sampling systems.

In the reference watershed, we installed a level sensor (pressure transducer) and water sampling line inside the culvert to monitor the level and to collect stream water samples (surface and tile water) using an automated water sampler (Figure 3, letter B). Since the water in the reference watershed culvert is a mixture of surface and tile water, samples were only collected with this system when both surface and tile water flow was occurring. An end member mixed model defined below will be used to determine the impact of cover crops on the total nutrient load leaving each watershed and the load contribution from surface and subsurface flow.

End Member Mixed Model

TwTc + SwSc = TwTc

T= Tile water, S= Surface/rainwater, T= Total/stream, w= Water, and c = Nutrient Concentration

Preliminary data from the new surface and subsurface water monitoring systems.

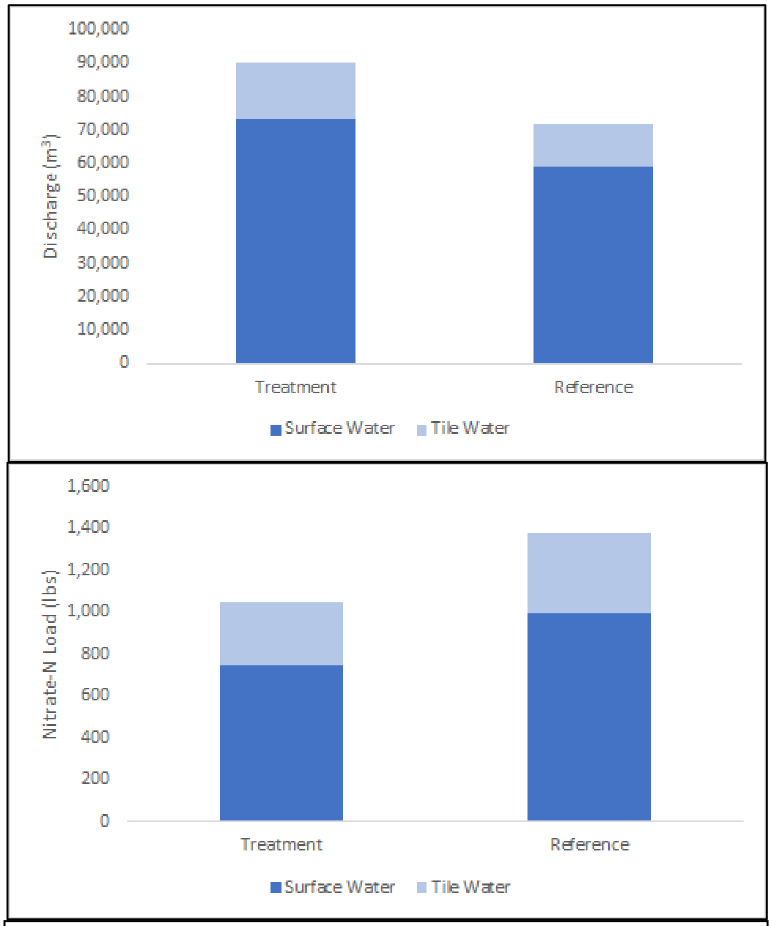


Figure 5. Discharge and nitrate-N load for surface and subsurface drainage within both reference and treatment watershed on July 9-12th.

After the installation of the surface water monitoring systems within each watershed (reference and treatment), significant rainfall events occurred between the days of July 9-12th that generated peak surface and subsurface flow. Throughout the drainage event, the quantity of surface and subsurface drainage water exported from the watersheds was estimated. Additionally, water samples from both sources of drainage water were collected and analyzed for inorganic nitrogen to determine water quality and the distribution of nitrogen load across surface of subsurface drainage paths. Results from the drainage event analysis determined that an average of 76% of drainage occurs through surface drainage and only 24% from tile-drainage (Figure 5). Due to the treatment watershed being larger, its total drainage was 28% greater relative to the reference watershed. However, during the drainage event we observed 40% greater nitrate loading form the reference watershed relative to the larger treatment watershed (Figure 5). This reduction in total nitrate load demonstrated that the presence of cover crops reduced nitrate load from both surface and subsurface drainage. The ability to quantify the distribution of drainage volume and nitrate load across surface and subsurface drainage paths give greater insight on potential conservation needs.

Crop Planting

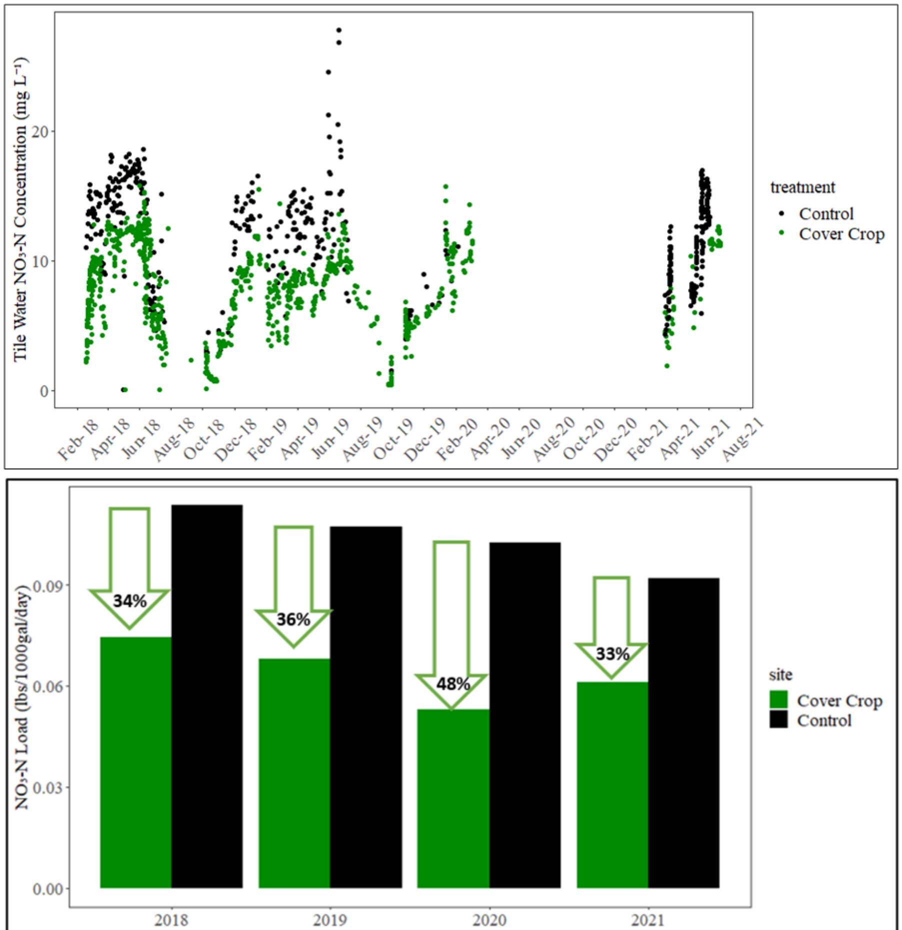
In the fall of 2020, on September 8th we aerially planted cereal rye/radish and radish/oats mixtures on 397 acres. The following day (September 9th) annual rye/radish was planted on 437 acres (figure 6). Cover crop planting in the fall of 2020 resulted in treatment effects on water quality over the fallow period and into the following spring of 2021.

Figure 6. As applied maps from the ariel planting of cover crops in the fall of 2020,

Farmer Engagement

During the summer and early fall of 2020, the Armstrong Lab engaged each farmer of the watershed project individually and in-person. Our farmer visits consisted of two major goals (1) to update the farmers of the data collected and data trends and (2) recommitment of the farmer for another three years in the project. Thus, we created a factsheet that we shared with each farmer and facilitated a personal question and answer session with each farmer. Furthermore, in March of 2022 we are planning a farmer/watershed meeting to inform the watershed and surrounding area about current results and future research plans.

<u>Summary Figures</u>



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