DATCP 2022-2

On-farm research and local partnership to reduce nitrogen loading from agriculture in Pepin County

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Project Summary

Title: On-farm research and local partnership to reduce nitrogen loading from agriculture in Pepin County

Project ID: DATCP 2022-2

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Period of Contract: June 2021 – December 2024

Background/Need: Nitrate, which is a critical nutrient for agricultural crop production, has also become Wisconsin's most widespread groundwater contaminant. There is a growing body of research on nitrate leaching dynamics within the Central Sands region of the state, but there is little knowledge of the movement of nitrate beyond the crop rooting zone in other areas of the state. Most research efforts related to nitrogen in agricultural settings have focused on the growing season with an emphasis on nitrogen production inputs and less so, on quantifying the losses below the unsaturated root zone. With elevated nitrate concentrations in groundwater in several areas of the state, there is a need to better understand and quantify the nitrogen leaching dynamics outside of the Central Sands region of the state. Pepin County, WI is one of these areas of the state where nitrate contamination to groundwater is a concern. Equilibrium tension lysimeters can be used to quantify the timing and magnitude of nitrate leaching below the crop root zone. This information will help stakeholders and agricultural producers to understand nitrogen leaching dynamics below the crop root zone and begin to identify agricultural conservation practices and/or management strategies that can be used to reduce nitrogen leaching.

Objectives: Objective 1: Increase documentation of timing and magnitude of nitrate leaching below the root zone in Pepin County. Objective 2: Engage farmers in protecting groundwater from nitrate contamination through implementing and assessing the nitrogen reduction capacity of agricultural practices such as cover crops, reduced nitrogen application rates and diverse crop rotations. Objective 3: Utilize test results from the nearby affected well to demonstrate effects of agricultural management changes. Objective 4: Provide a model for local governments to address agricultural nitrate contribution to groundwater nitrogen management practices with local farmers.

Methods: Objective 1: Eight equilibrium tension lysimeters were installed below the crop root zone of an agricultural production area in Pepin County, WI. Methods for the equilibrium tension lysimeter fabrication and installation were based on Brye et al. (1999). The lysimeters contain a vacuum line to apply a small level of suction to the lysimeter to mimic the natural suction within the soil profile. There is also a sample line that allowed for drainage (volume and concentration collection). The lysimeters were installed in a control/treatment study design to allow for evaluation of the effectiveness of a conservation practice or management strategy to reduce nitrate leaching. Lysimeters were sampled biweekly and were used to inform timing and magnitude of nitrate leaching. A weather station was installed to relate environmental conditions to the observed nitrate leaching. Objective 2: Nitrogen use efficiency (NUE) trials were established on four farms in Pepin County to engage with farmers and assess nitrogen application rates. Sampling efforts included routine soil tests as well as pre-plant and pre-sidedress soil nitrate tests. These soil tests provide context for understanding NUE results. Immediately before harvest, yield was manually measured in the study fields and silage or grain samples were collected for analysis of nitrogen content. Information on nitrogen inputs to the fields and other pertinent management activities

were collected from participating farmers using a survey. Objective 3: A well with high nitrate concentrations at a community church and school was identified for monitoring. Periodic sampling was planned to assess the demonstrate and assess the impact of agricultural management changes on the groundwater nitrate concentrations. Objective 4: As data was collected, the plan was to engage with groundwater modelers and provide data to add to existing or aid in the development, of a model for local governments to use assess and test nitrogen management strategies or conservation practices to reduce nitrogen leaching and their impact on local groundwater sources.

Results and Discussion: Objective 1: From the first two years of monitoring, knowledge and understanding of the timing and magnitude of nitrogen leaching were gained. During the first year of monitoring, the magnitude of nitrate leaching was influenced by the installation of the lysimeters which required high levels of soil disturbance to the soil profile. In the second year of monitoring, 52.2 lbs/ac of nitrate were leached on the east portion of the field while 3.2 lb/ac leached from the west portion of the field. From the first two years of monitoring, nitrate leaching has occurred primarily pre-planting or during early crop establishment as well as post-harvest. Objective 2: Discovery Farms are currently analyzing these data as they are received, but are awaiting the full lab analysis results from nutrient analyses. As full lab analyses are received, we will be completing NUE calculations, and preparing final reports for each farmer. Summarized results from the trials can be provided upon request after the farmers receive their results. Objective 3: Following the lysimeter installation, explorations into the groundwater flow pathway through water-table maps revealed that the drainage and leaching in the area of the lysimeters did not flow to the nearby affected well at the small community church and school. For these reasons, the well was not sampled. Objective 4: The treatment phase of the lysimeter monitoring has not begun yet. More data is needed, particularly for potential practices to reduce nitrogen leaching, before modeling can be completed. Discovery Farms will be able to work with data modelers to prepare models for local governments to use as more data is collected.

Conclusions/Implications/Recommendations: Through the first two years of monitoring, we have gained knowledge of the timing of nitrate leaching and are growing our understanding on the magnitude of nitrate leaching below the crop root zone in this region of the state. Nitrogen Use Efficiency (NUE) trials were also completed in 2024, which allowed for farmer engagement and awareness of nitrogen management considerations. Discovery Farms will continue to monitor the lysimeters in Pepin County with the goal of adding a treatment to the field in 2026. This site, as well as newly added lysimeters in Rock and Calumet Counties, will add to our understanding of the timing and magnitude of nitrogen leaching in Wisconsin. These additional sites will also let us evaluate more practices for their potential to reduce nitrogen leaching. This initial funding allowed for Discovery Farms to also expand our network related to nutrient leaching below the crop rooting zone. We have been able to build a strong relationship and opportunity for collaboration with Dr. Kevin Masarik (Director of Center for Watershed Science and Education, UW-Stevens Point) and Dr. Steven Hall (Assistant Professor of Plant and Agroecosystem Sciences, UW-Madison) for future lysimeter monitoring efforts. Planning is currently underway for further expanding these monitoring efforts in collaboration with both Kevin Masarik and Steven Hall.

Key Words: Nitrate, nitrogen leaching, lysimeters, groundwater, nitrogen use efficiency

Funding: This project was funded through the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP 2022-2)

Final Report: A final report containing more detailed information on this project is available at the Wisconsin Department of Agriculture, Trade, and Consumer Protection. For more information, phone 608-224-4503, or email samuel.brockschmidt@wisconsin.gov.

Introduction

Nitrate, a critical nutrient for agricultural crops, is also Wisconsin's most widespread groundwater contaminant with an estimated 90% of the total nitrate inputs to Wisconsin's groundwater originating from agricultural sources (GWCC, 2024). The nitrate contamination is also increasing in both its extent and severity in Wisconsin's groundwater (GWCC, 2024). In order to make significant reductions in nitrate losses, a need for research-based information on the timing and magnitude of nitrate leaching in agricultural systems as well as the impact of various management practices on nitrate leaching was identified. Several gaps in our knowledge of nitrate leaching in the state of Wisconsin were also identified. Briefly, there is limited data on nitrate leaching dynamics outside the Central Sands area of the state, especially outside the growing season. Additionally, most efforts have focused on nitrogen production inputs and less so on quantifying the losses below the unsaturated root zone.

To begin filling these gaps, Discovery Farms began a nitrogen leaching monitoring study in Pepin County in 2021. This region of the state was identified as having an elevated risk of nitrate contamination in private drinking wells with over 15% of wells tested exceeding the safe drinking standard of 10 mg/L (GWCC, 2024). The monitoring site is located on a dairy farm in the Lima Township in Pepin County, WI. During the planning phase of the project, the Townships of Durand and Lima were both identified as priority areas for monitoring as 33 percent and 45 percent of the wells tested, respectively, exceeded the federal safe drinking water limit of 10 mg/L. A small community church and school in the Lima Township also had to install a treatment system for their well water due to elevated nitrate levels. The neighboring farmers have been engaged in this issue and are eager to identify strategies to reduce nitrogen leaching on their sandy soils.

The field with the monitoring equipment borders the community church and school with the known affected well. This site was selected for monitoring as the farmer is actively engaged in the community and expressed interest in trying to reduce their nitrogen leaching. The field also receives manure, uses cover crops, and has a forage rotation which were practices identified to be a priority to understand in this region for their effect on nitrogen leaching. More specifically, the field has been managed in a corn-soybean rotation. Prior to installation, the field was in corn (grown for grain). The field was in soybeans during the first year of monitoring (2022) and corn silage during the second year of monitoring (2023). A cereal rye cover crop was broadcast after corn silage harvest in 2023. There was also a single reduced tillage pass in spring of 2023 prior to corn silage planting in 2023. Nitrogen nutrient applications were only made during the 2023 growing season and included a pre-plant manure application (72% of total N applied), starter at planting (1% of total N applied), side-dress in June (26% of total N applied), and fertigation (fertilizer applied through irrigation) in July (1% of total N applied).

There were four main objectives for this study: 1) Increase documentation of timing and magnitude of nitrate leaching below the root zone in Pepin County. 2) Engage farmers in protecting groundwater from nitrate contamination through implementing and assessing the nitrogen reduction capacity of agricultural practices such as cover crops, reduced nitrogen

application rates and diverse crop rotations. 3) Utilize test results from the nearby affected well to demonstrate effects of agricultural management changes. 4) Provide a model for local governments to address agricultural nitrate contribution to groundwater nitrogen management practices with local farmers. Results and next steps for each objective are outlined below.

Objective 1. Increase documentation of timing and magnitude of nitrate leaching below the root zone in Pepin County

Methods

In November 2021, eight equilibrium tension lysimeters were installed in Pepin County with the goal of improving our understanding of nitrogen leaching below the crop root zone towards groundwater. Methods for the equilibrium tension lysimeter fabrication and installation were based on Brye et al. (1999). The lysimeter set up (Figure 1) features a metal box buried approximately 4.5 feet below the soil surface, with a porous stainless-steel plate that allows for the drainage to infiltrate into the lysimeter (metal box). Connected to the lysimeter are two lines: a sample line and vacuum line. The sample line allows for the lysimeter to be pumped out to determine the total amount of drainage and to collect water quality samples. The vacuum line is used to apply a small amount of suction to the lysimeter to mimic the natural level of suction within the soil profile. This allows us to accurately measure both the drainage that is naturally occurring below the crop root zone and the amount of nitrate that is leaching.

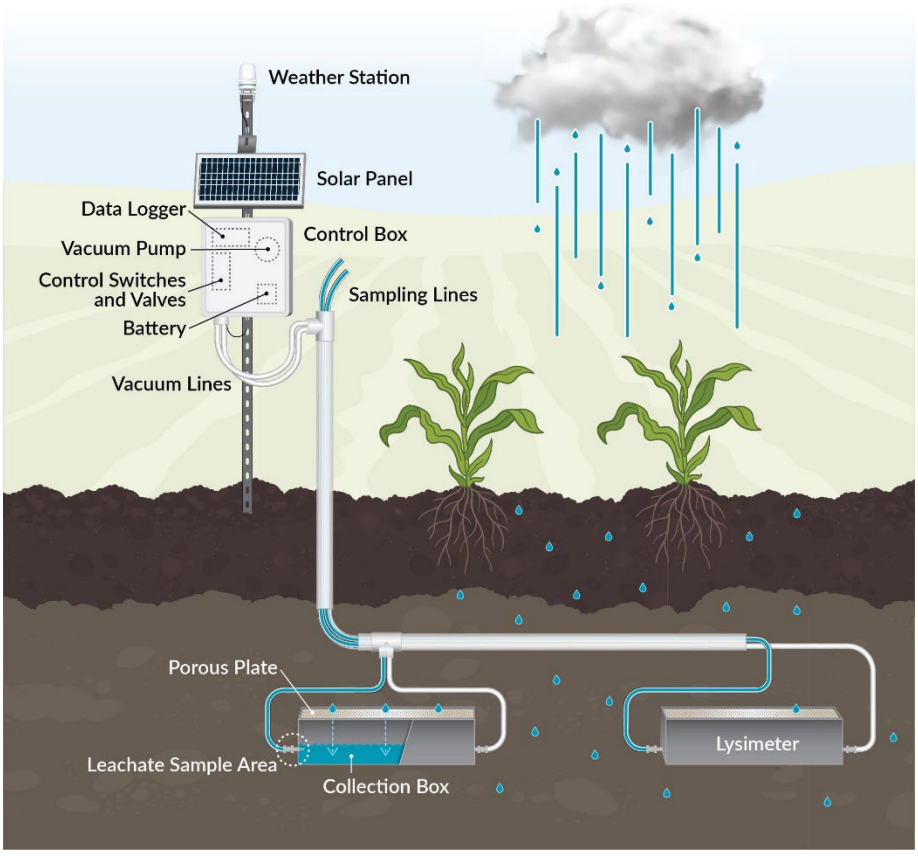

Figure 1. Diagram of the lysimeter set up and components.

The lysimeters are connected to control boxes which contain a data logger system and program that checks and applies suction to the lysimeters as needed. The lysimeters run using solar power.

The site was also equipped with a weather station that collects data including air temperature, soil temperature, soil moisture, precipitation, and more.

Eight lysimeters were installed with a control/treatment study design. With the control/treatment study design, the goal is to evaluate the effectiveness of a practice to reduce nitrogen leaching. For this study design, during the first few years of monitoring, the entire field is managed the same. After a few years of monitoring, a treatment is applied to half of the field (and four of the eight lysimeters). At this point in time, we are still within the initial monitoring period where the entire field is managed the same. This time period is critical for the study design as it is used to build a relationship between the control and treatment areas of the field. This initial monitoring is also useful to inform of the timing and magnitude of nitrogen leaching below the crop rooting zone. The lysimeters are checked roughly biweekly by our project partners, Pepin County Land Conservation and Planning Department.

Results

Thus far, Discovery Farms has collected two full years of monitoring data. A year of data is defined as the period of April 1 - March 31 of the following year to align with crop rotation timing. Nitrogen leaching during the non-growing season is associated with the previous crop, which is why this timeframe was used to define a year of data, rather than the calendar year. The fall after the lysimeters were installed was dry (Fall 2021), and samples were not collected until the following spring (Spring 2022). Therefore, our first data was collected in

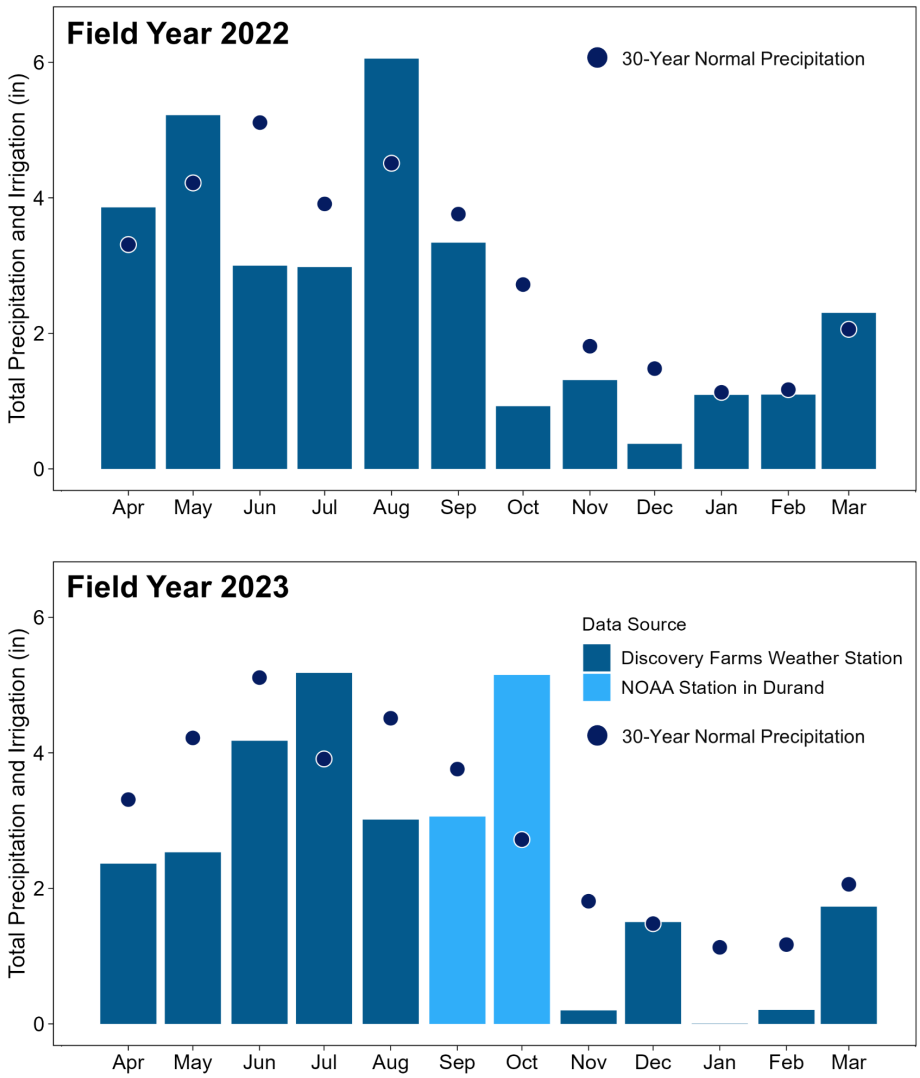

Figure 2. Annual precipitation and irrigation by month for Field Years 2022 and 2023.

Field Year (FY) 2022. Field Year 2024 is still on-going, and is not included in this report. After FY 2024 is completed, the data can be made available upon request.

Precipitation and Irrigation

The timing and magnitude of drainage and nitrogen leaching are influenced by precipitation. The site did experience periods of both above average and below average precipitation during our monitoring. The rain gauge at the Pepin County site collects both precipitation and irrigation data. In general, the trend in the first two years of monitoring (FY22-FY23) has been below average precipitation and irrigation (Figure 2). However, the spring after installation (FY22) was notably wet with above average rainfall. October of FY23 was also above average for precipitation. Note that the rain gauge was temporarily clogged with plant material in part of September and October of FY23. The nearby NOAA weather station in Durand, WI was used to fill in this time period.

Drainage Results and Timing

During the first year of monitoring, there were challenges for Discovery Farms in learning this new monitoring method. There were inconsistencies in the performance of the lysimeters during the first year of monitoring for these reasons. Throughout the first year, much troubleshooting occurred as the equipment and programs that run the lysimeters were sorted out. There was one pair of lysimeters that consistently performed well during the first year. Due to the inconsistencies in performance the first year, Figure 3 only shows the results from the better performing pair of lysimeters on the east portion of the field in FY22 (top) and from lysimeters on both sides of the field in FY23 (bottom), as the consistency of the lysimeter performance improved.

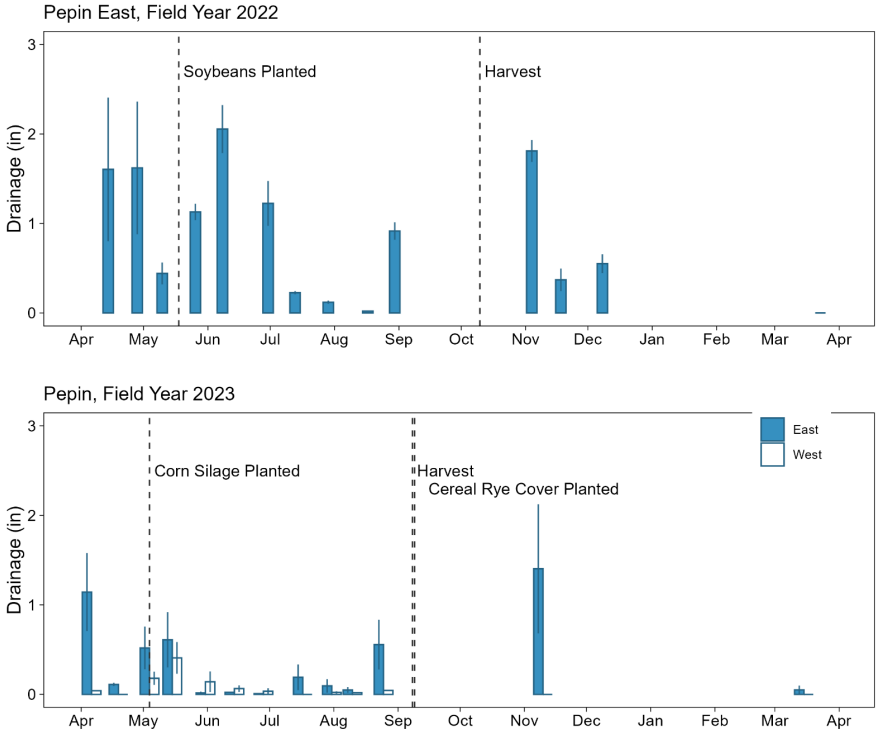

Figure 3. Drainage events by field year.

During the first year of monitoring (FY22), there was 12.1 inches of drainage. Most of the drainage occurred in the spring (April through June) as the new crop became established. Drainage increased again after crop harvest. During the second year of monitoring (FY23), there

was 4.8 inches of drainage on the east side of the field and 0.96 inches of drainage on the west side of the field. Note, the equipment on the west side of the field lost power during the fall of 2023 and missed a large drainage event that the lysimeters on the east portion of the field captured. During the winter months, drainage is less likely due to frozen soil conditions and the sites are often checked monthly during that time period.

Nitrogen Leaching Results and Timing

During the installation of the lysimeters, the soil profile was fully disturbed above the lysimeters. This soil disturbance can stimulate an increased level of mineralization and nutrient cycling. Due to the high level of soil disturbance, the first-year results will be used more to provide information on the timing on leaching in Wisconsin, rather than the magnitude of leaching. The initial leaching events in FY22 were elevated, contributing nearly 60 lbs/ac of leached nitrogen. The range of nitrogen leaching (represented by the bars within the data points in Figure 4) also demonstrates the unnatural levels of nitrate leaching from the installation with highly variable measurements across lysimeters. With time, the soil was able to return to a more normal level of nutrient cycling, also evidenced by the more consistent measurements

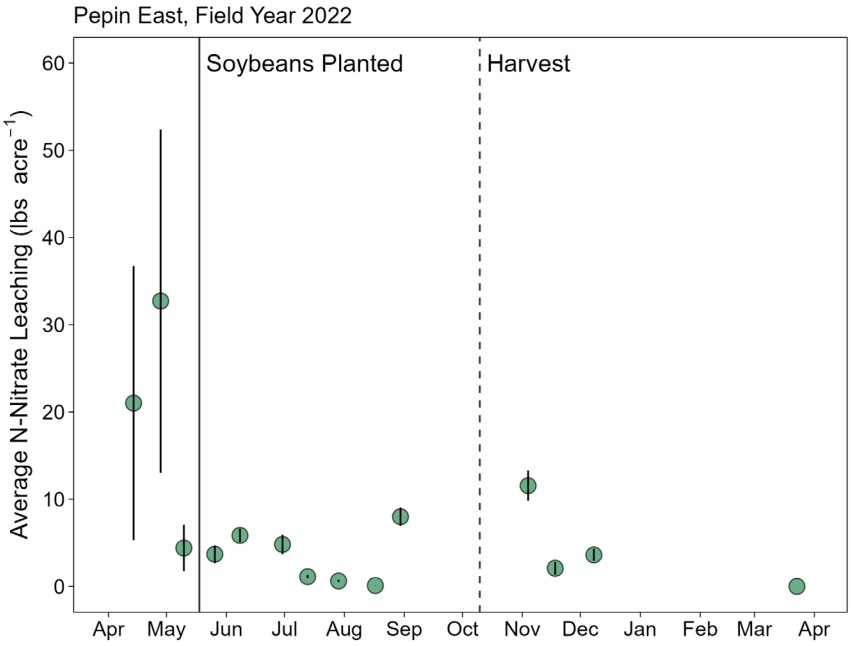

Figure 4. Average nitrate leaching (lbs/ac) by sampling event in FY22.

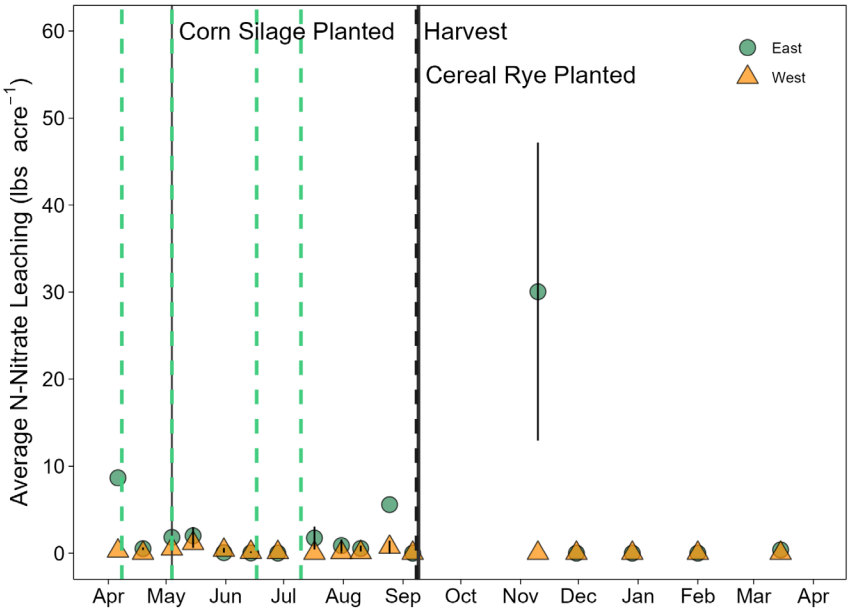

Figure 5. Average nitrate leaching (lbs/ac) by sampling event in FY23.

across the lysimeters (shorter bars in Figure 4). During the second year of monitoring, the nitrogen leaching was consistently low through the spring and growing season. Four nitrogen applications were made: manure in April (72% of total N applied), starter in May (1% of total N applied), side-dress in June (26% of total N applied), and fertigation (fertilizer applied through irrigation) in July (1% of total N applied), each represented as the green dashed lines in Figure 5. There were not any large leaching events following any of these applications (or irrigation). Following crop harvest, there was one larger event. This larger event covers a longer sampling period of time of about two and a half months rather than biweekly sampling as our project partner had staff turnover which delayed sampling. The overall magnitude of leaching is accurate, however, the leaching magnitude may look larger in comparison to the other points when the lysimeters were being sampled biweekly. Most of this leaching likely occurred in October following above average precipitation. The post-harvest leaching does indicate a surplus of nitrogen remaining in the soil following the crop harvest which was flushed out of the soil during above average precipitation in October when there was not a well-established crop using the water.

Nitrogen leaching was also evaluated on a cumulative scale which is used to help identify the timing of any large leaching events. In FY22, the total nitrogen leaching was 99.5 lb/ac which was again, heavily influenced by the soil disturbance required to install the lysimeters. There was an increase in nitrogen leaching after harvest in FY22, which may have been a result of nitrogen leaching from nitrogen fixed by the soybeans (Figure 6).

During FY23, the east side of the field had 52.2 lb/ac of total nitrogen leaching (Figure 7). The largest amount of leaching occurred post-harvest, indicating there was a surplus of nitrogen in the soil following the growing season. There was above average precipitation in October 2023, which helped to flush the surplus nitrogen out of the crop rooting zone. The west side of the field only had 3.2 lb/ac of nitrogen leaching, although the site lost power in the fall of 2023, missing the largest leaching event that was observed on the east portion of the field. From the first two years of monitoring, the emerging trend is that the largest amount of drainage and nitrogen leaching occurs before planting into June when the crop is getting established, and following crop

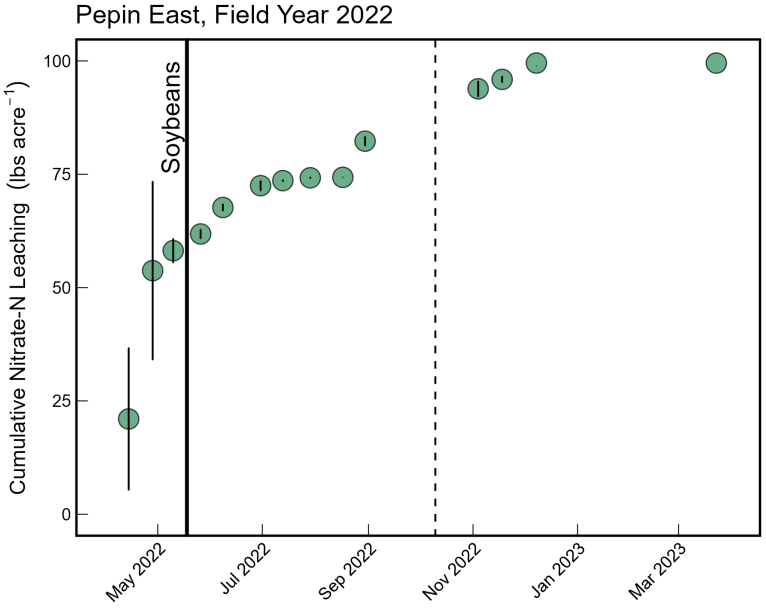

Figure 6. Cumulative nitrate leaching (lbs/ac) in FY22.

harvest. This is the time of the year with lower evapotranspiration, allowing for greater drainage volumes and higher risk for excess nitrogen to be flushed out of the crop rooting zone towards groundwater.

The cumulative annual drainage and leaching data is summarized in Table 1. The data summarizing the sampling events (mean, median, range) is summarized for the east portion of the field in FY22 in Table 2 and FY23 in Table 3. The sampling event-level data is summarized for the west portion of the field in FY23 in Table 4.

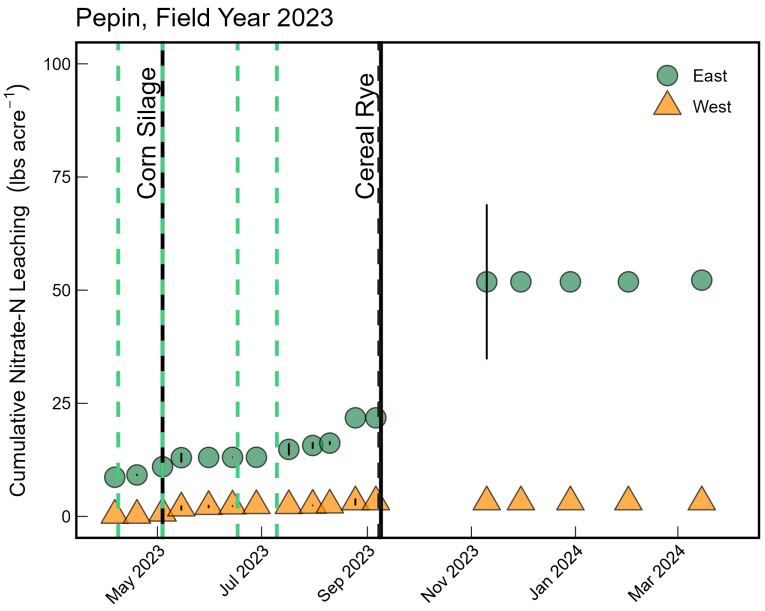

Figure 7. Cumulative nitrate leaching (lbs/ac) in FY23.

Table 1. Cumulative annual drainage and leaching

	2022	**2023**	
	East	***East***	***West***
Total Drainage (in)	12.09	4.77	0.95
Total Nitrate-N Leaching (lbs acre^{-1})	99.53	52.20	3.21
Total Chloride Leaching (lbs acre^{-1})	130.01	26.19	1.82
Sampling events with drainage	13	13	9

Table 2. Field year 2022 “event” summary (east side only).

	Median	Range	Mean (± standard deviation)
Drainage (in)	0.92	0.02 to 2.05	0.93 ± 0.69
Nitrate Concentration (mg L^{-1})	24.75	12.55 to 89.1	32.46 ± 21.18
Nitrate Leaching (lbs acre^{-1})	4.40	0.10 to 32.72	7.66 ± 9.38
Chloride Concentration (mg L^{-1})	14.1	0.25 to 212.0	42.36 ± 67.68
Chloride Leaching (lbs acre^{-1})	1.76	0.001 to 59.34	10.00 ± 16.73

Table 3. Field year 2023 "event" summary, east side of field

	Median	Range	Mean (± standard deviation)
Drainage (in)	0.11	0.01 to 1.4	0.37 ± 0.46
Nitrate Concentration (mg L^{-1})	32.30	3.0 to 94.5	31.31 ± 24.05
Nitrate Leaching (lbs $acre^{-1}$)	0.86	0.01 to 30.05	4.02 ± 8.22
Chloride Concentration (mg L^{-1})	6.20	0.25 to 57.8	14.08 ± 16.49
Chloride Leaching (lbs $acre^{-1}$)	0.34	0.0004 to 18.38	2.01 ± 5.00

Table 4. Field year 2023 "event" summary, west side of field

	Median	Range	Mean (± standard deviation)
Drainage (in)	0.04	0.02 to 0.41	0.11 ± 0.13
Nitrate Concentration (mg L^{-1})	12.27	7.17 to 69.35	19.76 ± 19.42
Nitrate Leaching (lbs $acre^{-1}$)	0.25	0.07 to 1.13	0.36 ± 0.36
Chloride Concentration (mg L^{-1})	1.63	0.92 to 88.25	27.72 ± 38.97
Chloride Leaching (lbs $acre^{-1}$)	0.05	0.01 to 0.88	0.20 ± 0.29

Objective 2. Engage farmers in protecting groundwater from nitrate contamination through implementing and assessing the nitrogen reduction capacity of agricultural practices such as cover crops, reduced nitrogen applications rates, and diverse crop rotations

Methods

Lysimeter Monitoring

Future steps for the lysimeter monitoring in Pepin County include adding a treatment to the field to assess the effectiveness of a practice designed to reduce nitrogen leaching. Discovery Farms is currently in the third year of monitoring at this site. Due to the complications with monitoring equipment on the west side of the field as well as the high level of soil disturbance influencing results in the first year of monitoring, we would like to have one more year of monitoring completed before adding a treatment. The participating farmer already uses a cover crop following corn silage harvest and plans to continue its use across the entire monitoring field as part of their routine management. The treatment at the site will likely be related to manure management (timing and/or placement).

Nitrogen Use Efficiency Trials

In addition to research collaborations with farmers who host lysimeter sites, Discovery Farms is engaging producers across Pepin County in evaluating nitrogen management on their farms, with the goal of reducing groundwater nitrate contamination. Specifically, Discovery Farms offered Nitrogen Use Efficiency (NUE) trials for interested producers in the county during the 2024 growing season. NUE trials measure how much of the nitrogen applied to a field through manure or commercial fertilizer is recovered in the harvested crop. Higher NUE values mean that the crop is able to take up and use more of the applied nitrogen so that less is lost to the environment. Practices to increase NUE include proper crediting of nitrogen supplied from manure or legumes in the rotation, applying nitrogen at the recommended rate, split nitrogen applications, and management of other conditions that can negatively affect crop growth such as soil drainage, moisture availability, pests, and diseases. Increasing NUE can help minimize nitrate losses to surface and groundwater while also supporting farm profitability.

The 2024 Pepin County NUE trials were open to any producer in the county growing grain or silage corn. Four farmers enrolled in the trials, and two of them were first time participants in an Extension NUE trial. The four participating farmers represent a wide range of approaches for nitrogen inputs. One farmer uses only commercial nitrogen fertilizers, two farmers use a combination of commercial products and dairy manure, and one farmer enrolled a field that has been fertilized solely with manure for decades. Participating farmers said that they were interested in the trials in order to learn more about nitrogen dynamics in their fields, evaluate their nitrogen program to see if any adjustments are needed, and better understand the nitrogen supplied from manure. Although not a focus of NUE trials, one producer also commented that they were curious about soil health and wanted to learn more about the effects of cover crops to better hold on to nitrogen in sandy soils.

Across the four farms, a total of five fields were enrolled in the NUE trials. The typical rotation for these fields is either cash gain or dairy forage. During the 2024 growing season, three of the fields were in corn grain while the other two were corn silage. All of the participating farmers were interested in intensive NUE trials, which require maintaining a nitrogen test strip within the field. Two farmers elected to use zero-nitrogen test strips on their enrolled fields. Zero-nitrogen strips receive less than 30 lbs of nitrogen per acre and allow for an evaluation of nitrogen supplied from the soil as well as a more detailed analysis of the effect of additional nitrogen fertilizer on yield. One farmer used a low-nitrogen strip, which receives more than 30 lbs of nitrogen per acre but less nitrogen than they typically apply to the field. This approach allows the farmer to test how a lower nitrogen application rate could influence yield and NUE. The final farmer was interested in zero-nitrogen strips on the two fields he enrolled in the project. Unfortunately, a miscommunication with the custom manure applicator caused one of test strips to be lost completely as it received the same nitrogen application as the rest of the field. The

other test strip was maintained as a low-nitrogen test strip rather than a zero-nitrogen strip. A basic NUE trial was completed for the field in which the test strip was lost.

Sampling efforts for the NUE trials included routine soil tests as well as pre-plant and pre-sidedress soil nitrate tests. These soil tests provide context for understanding NUE results. Two of the farmers provided manure samples for nitrogen testing. Immediately before harvest, yield was manually measured in the study fields and silage or grain samples were collected for analysis of nitrogen content. Information on nitrogen inputs to the fields and other pertinent management activities were collected from participating farmers using a survey.

Results

Lysimeter Monitoring

Discovery Farms has engaged with farmers in the community through two field days/meetings as well as the broader Pepin County community through a public presentation during the Pepin County Land Conservation, Planning/Extension Committee meeting. We have also shared newsletters with the farmer-led watershed group (Farmers 4 Health), to provide updates and information on what we have learned so far from the monitoring. Because of the funding provided for this project, Discovery Farms was able to implement the same monitoring in other locations using the lessons learned here. The result is a larger database of research results more quickly, spurred by these funds. The effectiveness of different practices to reduce nitrogen leaching will also be able to be assessed across the growing network of lysimeter monitoring sites. As the treatment phase of these studies begins, engagement with farmers in protecting groundwater from nitrate contamination through implementing and assessing the nitrogen reduction capacity of agricultural practices will continue.

Nitrogen Use Efficiency Trials

Discovery Farms are currently analyzing these data as they are received, but are awaiting the full lab analysis results from nutrient analyses. As full lab analyses are received, we will be completing NUE calculations, and preparing final reports for each farmer. Summarized results from the trials can be provided upon request after the farmers receive their results.

Objective 3. Utilize test results from the nearby affected well to demonstrate effects of agricultural management changes

The lysimeters were installed in a field that borders the community church and school with the known affected well. This field was selected over other options due to the interest level and community engagement of the farmer as well as the field management which included practices such as manure and cover crops that were identified to be a priority to understand in this region for their effect on nitrogen leaching. It was originally planned that the neighboring church and

school well would be sampled to demonstrate the effects of agricultural management changes. Following the lysimeter installation, explorations into the groundwater flow pathway through water-table maps revealed that the drainage and leaching in the area of the lysimeters did not flow to the nearby affected well at the small community church and school. This made testing of the well to demonstrate the effects of agricultural management changes impractical as the management of the field with the lysimeter monitoring would not be influencing the church/school well identified for testing. Therefore, the well at the small community church and school were not tested. There were not any public wells within the groundwater pathway from the lysimeter monitoring area identified or private wells identified that were interested in the well monitoring.

Objective 4. Provide a model for local governments to address agricultural nitrate contribution to groundwater nitrogen management practices with local farmers.
Discovery Farms is still in the early stages of this monitoring with only two full years of monitoring being completed so far. This information, as well as data from additional lysimeter monitoring sites, will be compiled to better our understanding of the timing and magnitude of nitrogen leaching in Wisconsin. “Treatments” will be added to each of these sites to test the effectiveness of different practices to reduce nitrogen leaching. As these practices are tested, Discovery Farms will be able to work with data modelers to prepare models for local governments to use to demonstrate and address the agricultural contribution to nitrate in groundwater and practices to help reduce nitrogen leaching across the landscape.

Conclusions and Future Work
Discovery Farms began a nitrogen leaching study in 2021 in Pepin County, WI where nitrate contamination of groundwater is a growing concern. Through the first two years of monitoring, we have gained knowledge of the timing of nitrate leaching and are growing our understanding on the magnitude of nitrate leaching below the crop root zone in this region of the state. Nitrogen Use Efficiency (NUE) trials were also completed in 2024, which allowed for farmer engagement and awareness of nitrogen management considerations. Data will be shared with farmers (and will be available upon request to others) to aid their decision-making process for their nitrogen management on their farm. Discovery Farms will continue to monitor the lysimeters in Pepin County with the goal of adding a treatment to the field in 2026. This site, as well as newly added lysimeters in Rock and Calumet Counties, will add to our understanding of the timing and magnitude of nitrogen leaching in Wisconsin. These additional sites will also let us evaluate more practices for their potential to reduce nitrogen leaching. Outreach efforts are also a priority for Discovery Farms and the broader Agriculture Water Quality Program team. We plan to continue hosting field days and meetings with the farming community to share what we are learning and practices that we identify as being effective for reducing nitrogen leaching.

This initial funding allowed for Discovery Farms to also expand our network related to nutrient leaching below the crop rooting zone. We have been able to build a strong relationship and opportunity for collaboration with Dr. Kevin Masarik (Director of Center for Watershed Science

and Education, UW-Stevens Point) and Dr. Steven Hall (Assistant Professor of Plant and Agroecosystem Sciences, UW-Madison) for future lysimeter monitoring efforts. Planning is currently underway for further expanding the Discovery Farms nitrogen leaching monitoring program in collaboration with both Kevin Masarik and Steven Hall.

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