Illinois State University Nitrogen Management Research Farm: A Field Scale Comparison of Nitrogen Efficiency within Conventional and Alternative Nitrogen Management Systems

I. Investigators

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Co-Investigator: Catherine O'Reilly, Associate Professor of Hydrogeology, Department of Geography-Geology, at Illinois State University.

II. Cooperators and Locations

Location: Lexington, IL is the location of the Illinois State University Nitrogen Management Research Farm. The site has been secured for a minimum of 8 years through a lease agreement with the landowners.

III. Objectives

The Research and Demonstration of the Illinois State University Nitrogen Management Research Farm, Lexington, IL is designed to produce long term analyses of conventional and alternative nitrogen (N) management practices. The consist of two phases, applied agriculture research and demonstration. The demonstration phase will be executed by engaging farmers and the agriculture community in applied research to educate them on the agronomic and economic benefits of best management practices on a field scale and the integration of cover crops. Thus, the goals Illinois State University Nitrogen Management Research Farm are **(i)** to evaluate the efficacy of conventional and systematic N management practices to reduce nitrate leaching from tile drained cropping systems, **(ii)** to investigate the impact of cover crop inclusion on the vulnerability of fall and spring applied N, and **(iii)** to utilize the experimental site and research finding to educate and equip the farming community to make sound management decisions concerning N management.

Specific objectives:

1. Monitor the nitrate content of the tile drainage flow to determine the impacts of N application timing on nitrate losses from fields with a corn and soybean rotation.
2. Investigate the impact of cover crops on the distribution of soil N and the vulnerability of fall and spring applied N.
3. Quantify the N uptake and yield response of corn and soybean to the addition of cover crops and N application timing.
4. Execute novel demonstration, outreach, and education strategies to impact the N management practices of farmers through the region.

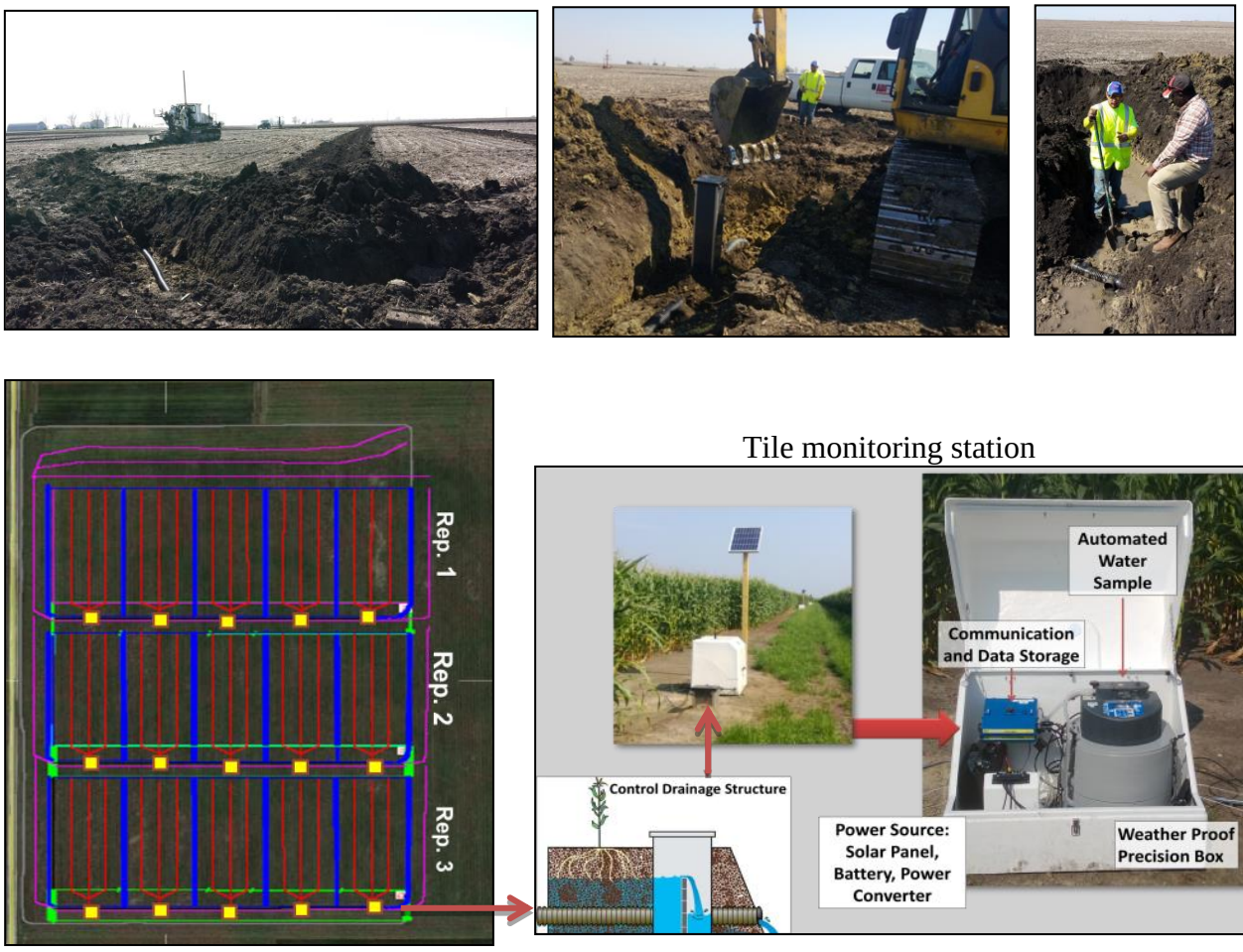
The primary goals of year 1 of the study were to establish base line data that would describe (i) the quantity of water and nitrate nitrogen loss via tile drainage, (ii) corn nitrogen uptake and yield, (iii) the hydrology of field under the current nitrogen management of the farmer, prior to

the implementation of the research treatments. Furthermore, we aimed to inform the farmers, state and federal conservation agents, and the general public of the research goals and educate them on alternative nitrogen management practices through annually planned outreach events.

IV. **Installation of tile drainage and monitoring equipment**

Tile drainage for each plot was successfully installed on April 18, 2014 and the installation of the monitoring site occurred on June 23-27 (Figure 1). Since the installation of the tile monitoring instrumentation to date, we have monitored 7 rainfall events and analyzed 5 rainfall events that produced measurable tile drainage flow from 1.5 acre fields that are individually tiled and monitored (Figure 2).

Figure 1.

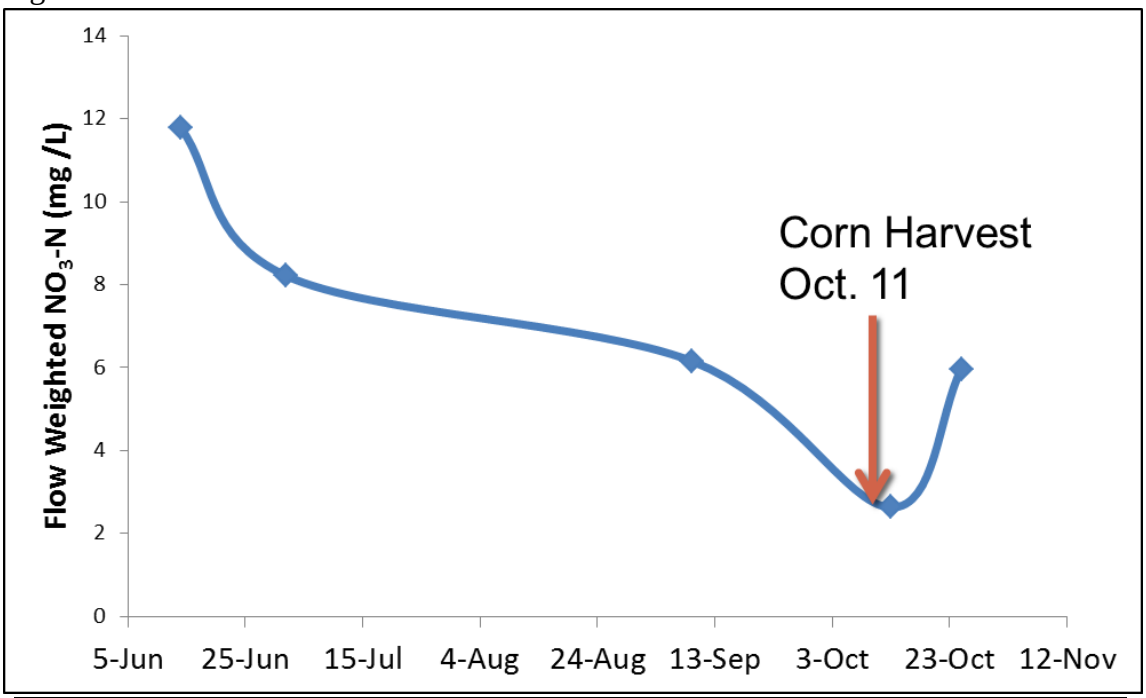


V. Environmental, Agronomic, and Soil Measures

Tile Water Measures

As a result of the 5 rainfall events (Figure 2), the average total nitrate loading via tile flow was 16.12 lb NO_3-N A^{-1} and the range was 9.76 to 29.01 lb NO_3-N A^{-1}. As expected, the flow weighted tile water concentrations decreased linearly as the crop growth progressed throughout the growing season. However after harvesting the corn on October 11, 2014, we observed a sharp increase in the flow weighted NO_3-N concentration in tile water flow from a subsequent rainfall event on October 13, 2014. After monitoring 5 rainfall events that produced dynamic quantities, distributions, and intensity of precipitation, the data produced from our monitored tile systems give strong indications that we will be able to discern differences in tile water quantity and quality after the implementation of our research treatments. The distribution of flow across the field is not equal, but similar as expected. To account for flow differences, flow weighted calculations will be employed to normalize flow and to discern treatment differences.

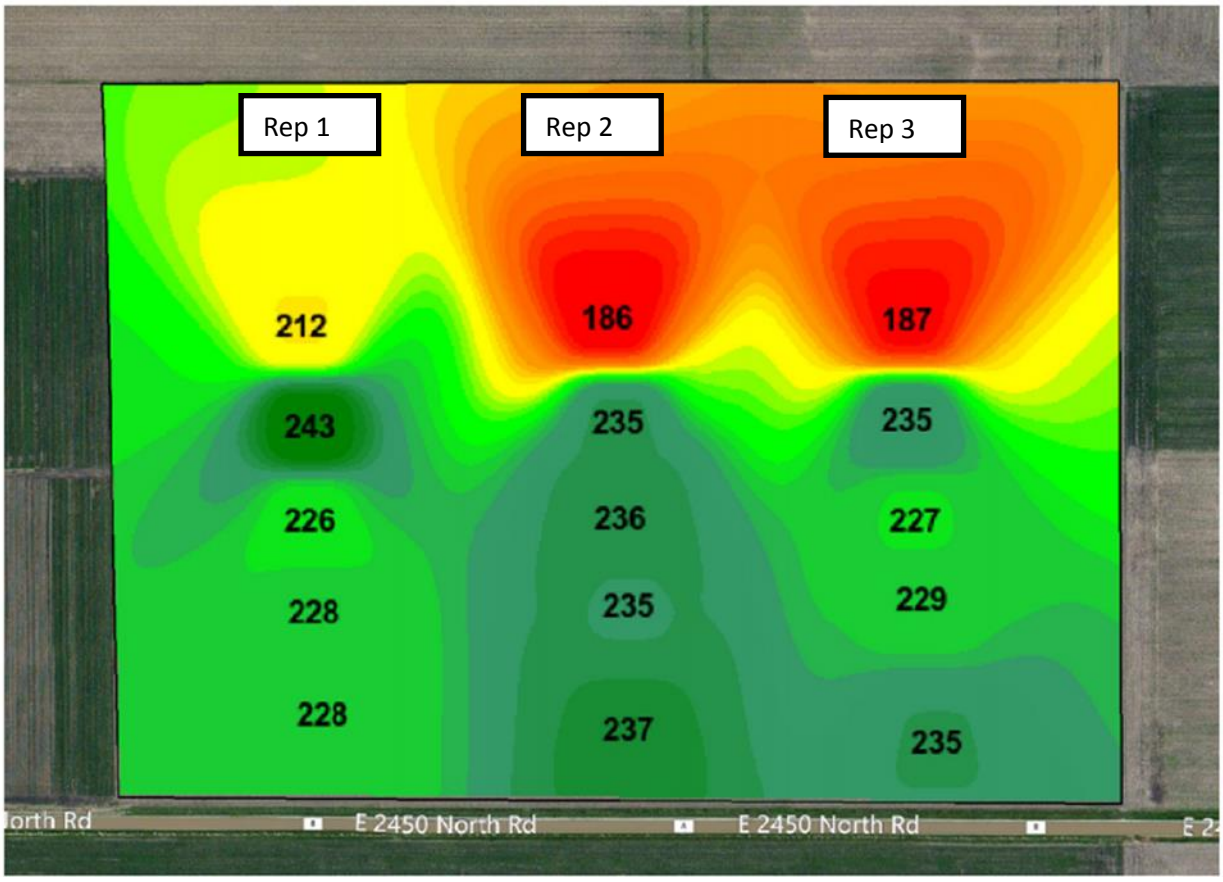
Figure 2.



Date	Rainfall Event	Rainfall (inches)	Average Nitrate Loss (lb/A)	Flow Weighted Concentration (mg NO3-N/L)
30-Jun-14	1	2.73	3.48	11.78
2-Jul-14	2	2.80	6.67	8.21
9-Sep-14	3	3.23	3.42	6.16
13-Oct-14	4	1.83	1.11	2.63
25-Oct-14	5	1.06	1.44	5.97

Agronomic Measures

Under the current Nitrogen management system of the farmer (60% Fall applied N and 40% Spring applied N; Strip-till before corn and No-till before beans), the average N uptake at the V6 corn growth stage was 27.23 lb A^{-1} and by V12 average uptake was N uptake was 117.29 lb A^{-1} (Figure 3). The average corn yield for the field was 225 bu A^{-1} at an adjusted moisture content of 15.5%. After harvest, the analysis of the corn grain suggested that 112.94 lb N A^{-1} was removed from the field. A Cereal Rye and Daikon Radish mixture was planted on September 4, 2014 in standing corn using a Hagie high clearance applicator. On November 13, 2014 cover crop biomass was collected and analyzed to determine N uptake. The data indicated that on average the cover crops scavenged 23.31 lb N A^{-1} residual N.



Corn Yield @ 15.5% moisture	225.24 bu A^{-1}
Corn Plant N uptake at V6 growth stage	27.23 lb A^{-1}
Corn Plant N uptake at V12 growth stage	117.29 lb A^{-1}
Corn Grain Nitrogen Analysis	112.94 lb A^{-1}

Figure 3. Resultant average grain distribution and nitrogen uptake from the current nitrogen management of the participating farmer prior to the installation of research treatment.

Figure 4. The progression of the 2014 cover crop growth

A mixture of Cereal Rye and Daikon Radish was planted on September 12, 2014 using a Hagie high clearance applicator (Figure 4). The high clearance applicator broadcasted the cover crop seed below the canopy of standing corn during the dry down period of the corn canopy. One week after planting we observed significant growth of the cover beneath the canopy of the standing corn. After 51 days of growth, we sampled the cover crop for biomass form three random places with the cover crop plots, before the radish in the mixture winter killed. The analysis of the sampled biomass suggested an average biomass production of 598 lb A^{-1} and 23.3 lb A^{-1} of nitrogen was absorbed by the cover crop.

Fall soil samples were collected on October 25, 2014, using a 3 point hitch hydraulic probe, after corn grain harvest that allowed us to take undisturbed core down to 2.5 from the soil surface. The soil cores were divided into 4 sections 0-5 cm, 5-20cm, 20-50cm, and 50-80cm depths to determine the distribution of available nitrogen soil from the surface to 2.5 ft near the tile drainage. The soil analysis determine that samples collect from plots with no cover contained 41% greater available nitrogen within the entire 2.5 ft profile and 50% greater nitrogen at the lower depth within the profile. Although the cover crop had only 43 days of growth to time of

soil sampling, they impacted the distribution of residual nitrogen in the soil profile through nitrogen scavenging.

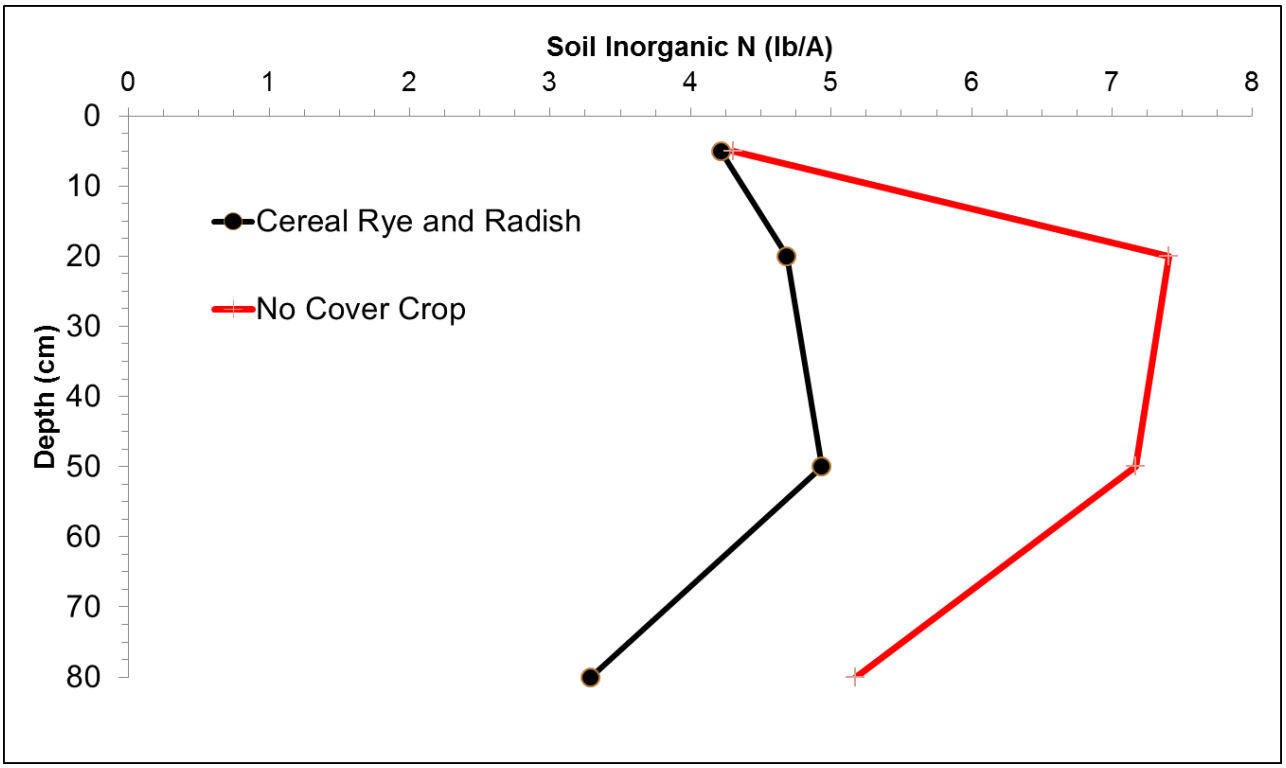


Figure 5. The impact of cover crops on the distribution of soil available nitrogen, after only 43 days of growth.

2015-2015 Research Treatments

1. **Control-No fertilizer-No Cover crop**
2. **Spring Split Application of Nitrogen (20% -DAP and 80% sidedress-UAN)**
3. **Spring Split Application of Nitrogen (20% DAP and 80% sidedress-UAN) + Cover Crops**
4. ***Fall Split Application of Nitrogen (75% Fall and 25% sidedress-UAN)**
5. ***Fall Split Application of Nitrogen (75% Fall and 25% sidedress-UAN) + Cover crops**

*Treatments 4 and 5 were installed on December 4, 2014, where fall anhydrous ammonia was strip tilled into a living stand of Cereal and Radish mixture. The fall portion of treatments 2 and 3 were applied on November 13, 2014. The spring nitrogen application will occur in the spring at the appropriate time for sidedressed nitrogen in the form of urea ammonium nitrate.

VI. Outreach Activities

Outreach Activities, where data was presented or the ISU Tile Drainage Research Site was introduced to the public	Dates
ISU Winter Outreach Meeting: Integration of Cover Crops within Nitrogen Management to Improve Aspects of Soil Health and Water Quality	February
Illinois Conservation Cropping Seminar, Douglas County	February
2015 IFCA Trade Show	January
Illinois Conservation Cropping Seminar, Dekalb County	January
Pro harvest Salesman Training	January
Indiana Certified Crop Adviser Program, Indianapolis, IN	December
Corn Board Presentation	August
NREC Field Day Tour Featured in FarmWeek News Paper Link: http://issuu.com/farmweek/docs/farmweek_september_1_2014	August
Brandt Consolidated Agronomy Day	August
Lady Landowners Educational Tour	August
McLean County Soil and Water Conservation District, Conservation Cropping Seminars, Normal, IL	March


ISU Winter Outreach Meeting

Throughout 2014 to date, we have made an intentional effort to inform the agricultural industry and general public of the fact that we were conducting a field scaled nitrogen management study that provide side-by-side comparisons of conventional and alternative nitrogen management practices. Thus, our outreach efforts consisted of multiple invited presentations across the state, a host of site tours, a winter outreach meeting in Lexington, IL, and the establishment of a website. Our most impactful outreach effort within the region surrounding the study site was the outreach winter meeting. The goals of this outreach meeting were to (1) inform regional farmers and agricultural industry leaders of the rationale, objectives, and results of the study and other related studies of within our research program, (2) educate farmers on the influence of cover crops on soil health and water quality, (3) expose farmers to cost share conservation programs and results from other regional watershed water quality projects. The agenda for the meeting consist of seminar on soil

health, the integration of cover crop within conventional and alternative N management, the Dynamics of nitrogen management within IL, conservation cost share programs and special initiatives within IL, a farmer panel that discussed cover crops and other soil conservation practices that impact nitrogen loading and soil health. Total attendance was 33 people and the representation of the agricultural industry in the audience were 12 farmers from the region, 6 agribusiness reps, 3 agriculture federal and state conservation agency staff, 4 graduate students, and 2 professors. The exit survey indicated that 4 of the 12 farmers decided to try cover crops in 2016 and that all participants found the program highly informative and look forward to next year.

Another effective outreach was the NREC site tour held in August of 2014. NREC board members, representatives from the ILEPA, CBMP, professors from U of I and others visited the ISU Nitrogen management and tile drainage site and experienced an informative tour given by Mike Kelly, one of the participating farmers, Dr. Catherine O'Reilly, and myself. The counsel was brief on the installation, research design, and preliminary data. The group also engaged in discussion on projected research outcomes and broader impacts, cover crop management, and the integration of cover crops within alternative and conventional nitrogen management. The tour was highly successful and the progress of the research was commended my many that attended. A similar tour was given the Lady Landowners of IL during that same week, where graduate students and my self-educated the women on the design of the tile study, the justification for the study, and the potential impacts of the study on nitrogen management. We also education the women why nitrate leach and the dead zone of the Gulf of Mexico. Total number of women that experience the tour was 18.

Figure 6. NREC Site Tour of the ISU Nitrogen Management and Tile Drainage site

VII. Budget Report

	Allocated Cost	Actual
1. Indirect Costs	8,439	3,358
2. Personal Services	65,156	23,746
3. Lab Commodities	23,708	7,251
4. Travel	8,050	1,586
4. Equipment	3,550	------
5. Grant Fringes Benefits	4,910	2,222

The unexpended funds within the budget can be explained by the following factors

1. The funds in the budget were proposed for a 12 month period; however, we gained access to the funds on the 25th of March. This delay in access to the funds resulted in unexpended funds within each category of the budget.

2. The delay in the accessibility of the awarded funds also delayed the hiring of our lab technician and graduate students, purchasing of laboratory consumables, and the purchasing of equipment.

3. Finally, with the permission from NREC, ILEPA, and University Grants Accounting the budget of this research project, the NREC and ILEPA funds for the ISU Lake Bloomington watershed were adjusted to (1) support a research technician that was hired to facilitate the research of both projects and (2) to extend the ISU Lake Bloomington watershed study to from a 2 year study to a 3 year study. Therefore, a portion of the funds unexpended in this grant are allocated to the watershed study in which I am a Co–principle investigator with Dr. Catherine O'Reilly of ISU Geology Department.

Based upon the above factor, we are requesting that all of the unexpended funds from the 2014 budget be rolled over or be assessable in addition to the proposed 2015 budget.