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NREC annual project report

February 15, 2017

Project	Assessing synergies and tradeoffs of recommended BMPs to reduce nutrient losses
Participants	Cameron Pittelkow, Laura Christianson, Rabin Bhattarai, Gary Letterly
Length	4 years (January 1, 2016 – December 31, 2019)
Summary	This project completed its first year of funding. Tile installation at the Dudley Smith research site was delayed until Sep/Oct 2016 due to a lengthy university procurement process. However, after identifying a successful bid, the experimental site and tile drainage research infrastructure were successfully established with financial assistance from the ACES Office of Research. After consultation with NREC and other researchers, it was determined that a baseline year of data collection was still necessary to meet the long-term goals of the project. Thus, baseline data collection will occur in 2017 with the first cover crop and N treatments being applied after harvest in 2017. The bioreactor was successfully installed and bioreactor research is ongoing. Tile drainage water quality and soil N_2O sampling will start in Spring 2017. Automatic water samplers have been purchased and gas chambers are currently being constructed. All project activities are otherwise occurring as proposed. An updated timeline and budget is included below.

1. Objectives

The overall goal of this project is to evaluate whether current BMPs for reducing nitrate loss may also result in agronomic and environmental tradeoffs that have not been previously considered (e.g. negative impacts on crop productivity, nutrient utilization, tile drainage P losses, and/or N_2O emissions). A replicated tile drainage research site combining in-field and edge-of-field practices is currently being established at the UIUC Dudley Smith Research Farm near Pana, IL to address the following objectives:

1. Determine the effects of combining recommended water quality BMPs on tile drainage nutrient losses, field N and P balances, and fertilizer use efficiencies.

2. Considering a best case scenario (e.g. 4R nutrient stewardship + cover crops + bioreactor), assess whether synergies are occurring among practices, and/or there is an upper limit to nutrient loss reductions.

3. Using plots without fertilizer inputs as a baseline, assess the relative contribution of soil vs. fertilizer sources to annual N and P losses for continuous corn production systems.

4. Evaluate whether recommended BMPs reduce nitrate losses but increase N_2O emissions.

5. Evaluate whether cover crops and bioreactors reduce nitrate losses but increase tile drainage P losses under certain conditions.

6. Assess crop yields and relative cost efficiencies of recommended BMPs.

7. Evaluate (through modeling) how environmental tradeoffs can be managed at the landscape and/or watershed-scale using different combinations of BMPs.

8. Communicate results to agricultural community stakeholders through field days and extension events.

9. Include a final written report at the conclusion of this project to address each of the objectives stated above.

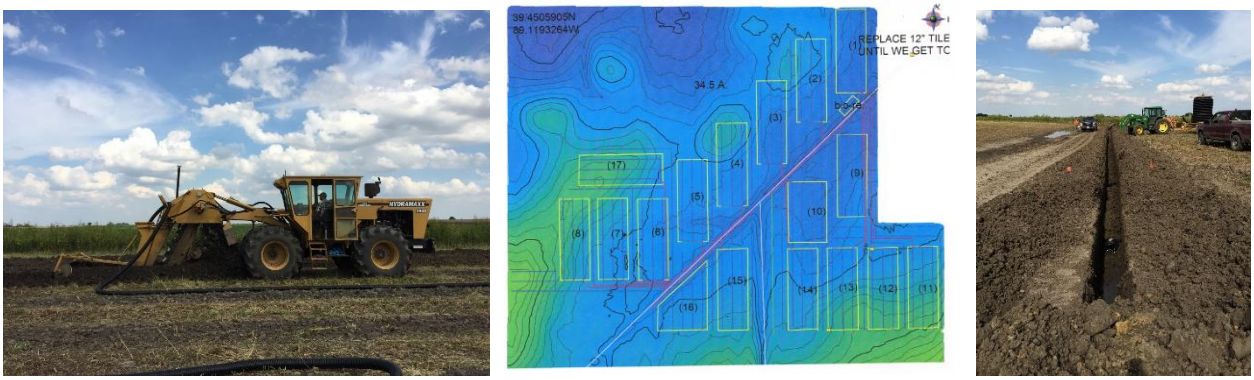

Figure 1. Dudley Smith experimental site showing tile drainage being installed and layout of individually drained research plots approximately 2 acres in size.

2. Accomplishments

Research infrastructure at the site including the individually replicated tile drainage research plots and a bioreactor were successfully installed at the Dudley Smith farm in Sept/Oct 2016 (Fig. 1). This represented a delay in the project compared to the original timeline, which was largely caused by purchasing logistics at UIUC. Tile installation costs were covered by the College of ACES, and the cost estimate was large enough that the contract had to go out for public bid. The ACES Office of Research remained very dedicated to this project throughout this process, particularly through the leadership of Dr. Vickie Jarrell. With their support, the bid/procurement steps were successfully navigated, and tile drainage and bioreactor installation occurred rapidly in Fall 2016 following bid approval at the institutional level (Fig. 2).

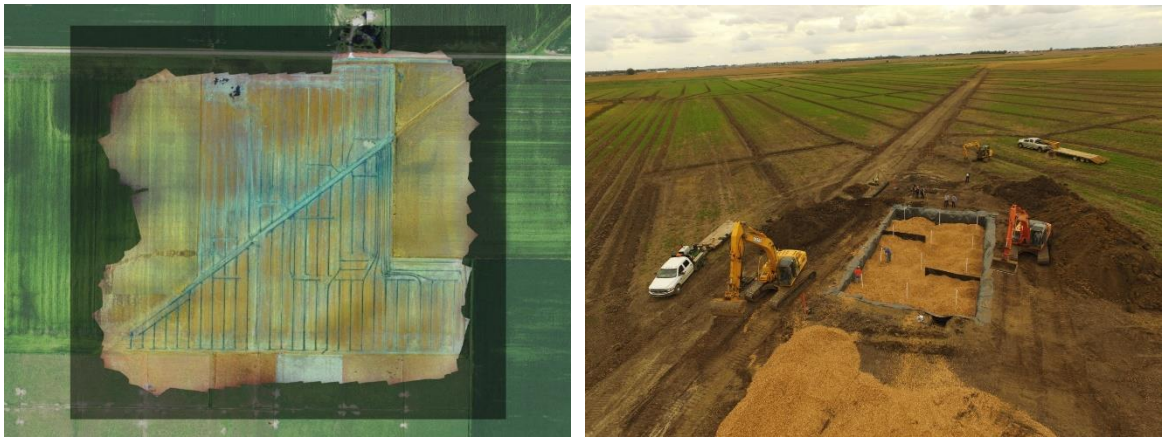

Figure 2. Aerial photographs of Dudley Smith experimental site showing individually replicated tile drainage plots approximately 2 acres in size (left) and bioreactor installation (right).

The original proposal indicated that a baseline year of data collection would occur in 2016 to assess potential inherent differences in drainage discharge and nutrient losses at the experimental site. Due to the delay in establishing the site, it was considered to eliminate this baseline year of monitoring to adhere to the original project timeline. However, after extensive discussion with all involved parties (other researchers, NREC, ACES office of research, etc.), it was agreed that a year of baseline data collection is necessary to maintain the scientific quality and integrity of the project, particularly because monitoring is anticipated to occur over the long-term. An understanding of initial conditions could help explain variation in tile discharge observed in later years, without the confounding effect of treatments already in place. Thus, the project timeline has shifted one year, and cover crops and N management treatments will now be imposed in Fall 2017, with the 2018 growing season representing the first full year of data collection assessing treatment impacts.

An updated timeline reflecting this change is shown in Fig. 3. Otherwise, project setup and implementation has been consistent with the originally proposed plan, with the following accomplishments:

- In Feb 2016 a meeting was held between UIUC administrators and extension, the faculty research team, the tenant farmers operating the DS farm, and a potential tile drainage contractor to discuss long-term project goals and logistics of tile installation and crop management.
- A working relationship with the researchers and tenant farmers (the Curtin family) who will be responsible for planting, weed and pest management, and harvesting the experiment each year was established, and the lease between the tenants and the University was updated to meet the project goals.
- An initial tile drainage and bioreactor design was created and approved by project researchers in March/April 2016.
- A **field day** introducing the new project was conducted at the site on June 15th in combination with a cow-calf meeting. All four project participants presented and received good questions and feedback (Fig. 4).

- A **field day** was conducted on Aug 19th in combination with the Soil Health Partnership as well as the NREC Council, again with the goal of introducing the project and gaining feedback from local stakeholders.
- Additional proposals have been submitted to leverage the research infrastructure and make additional measurements at the site. **One proposal collaborating with the Christian County Farm Bureau was successful** (2017 Illinois Farm Bureau Nutrient Stewardship Grant), and another is in progress as part of a larger 4R nutrient management project covering multiple tile drainage research sites in the Midwest.
- The novel bioreactor design was **featured in the Spring 2017 AdvanCES in Research magazine**: "*Bioreactors are ready for the big time*" (Quinn, L.; pp. 48-49), available at: http://research.aces.illinois.edu/sites/research.aces.illinois.edu/files/reports/2017_AdvanCES_in_Research.pdf.
- Several meetings have occurred with different stakeholder to define representative 4R nutrient stewardship and cover crop practices that are recommended for reducing nutrient losses while maintaining or increasing yield in continuous corn systems. A tentative description of the four treatments to be imposed in this study starting in Fall 2017 is included in Table 1.

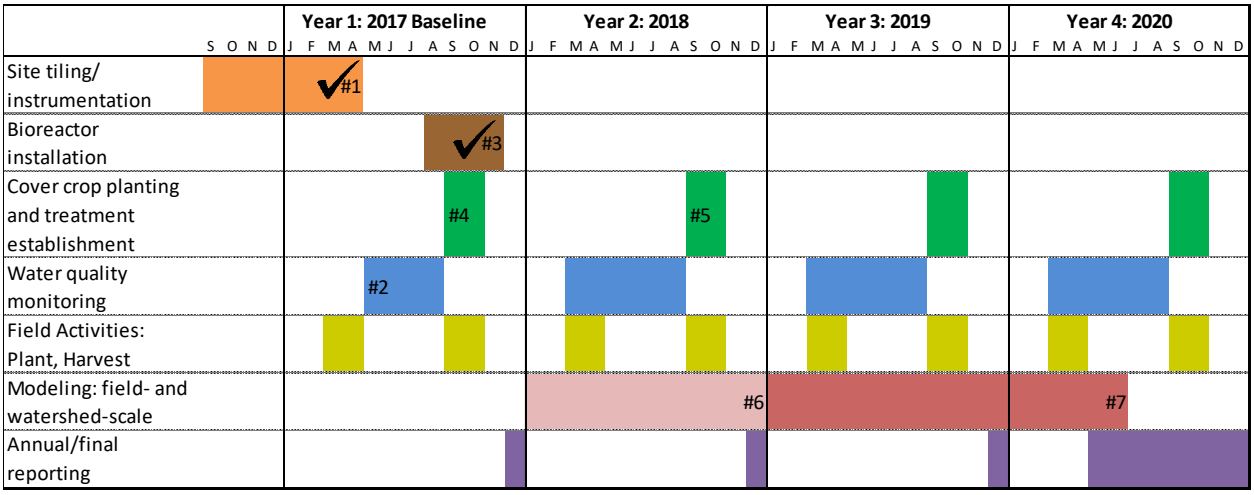

Figure 3. Four year project timeline detailing site installation, field agronomic and monitoring, and modeling activities. While 2020 is not included in the current budget, unused funds for 2016 will be allocated towards data collection in 2020 by applying for a no-cost extension at the conclusion of the project. Numbers in the figure indicate the following milestones, #2 growing season for baseline water quality and soil N2O monitoring, #4 cover crop and N treatments first imposed, #5 first annual assessment of N and P losses under different treatments, #6 first annual assessment of N2O emissions under different treatments, #7 modeling portion with calibration and validation of field- and watershed- scale models.

Figure 4. Photos from the June 15th, 2016 field day at the site. Dr. Laura Christianson discussing the IL NLRS (left), poster describing overall goals of the experiment (middle), and Dr. Rabin Bhattarai discussing how models can be used to upscale results (right).

3. Benefits to environment, crop production, and economics of Illinois Agriculture

Results from this project will provide much-needed information on the potential positive and negative impacts of water quality BMPs that growers are being encouraged to adopt as part of the IL NLRS. This experiment is the first of its kind spanning in-field nutrient management, in-field cover crop management, edge-of-field remedial practices, and modeling to provide a holistic assessment of promising pathways for reducing nutrient losses while maintaining crop production goals and economic profitability in Illinois agriculture.

Treatment	N rate	P and K mgmt.	Cover crop	Strip till	Fall N	N at planting	Sidedress N
Unfertilized control				X			
Conventional	MRTN	Broadcast		X	140 lb N (NH_3)	60 lb N (UAN)[1]	
4R management	MRTN	Broadcast		X		60 lb N (UAN)[2]	140 lb N (UAN)[2]
4R + cover crop	MRTN	Broadcast	Cereal rye	X		60 lb N (UAN)[2]	140 lb N (UAN)[2]

Table 1. Description of N fertilizer and cover crop treatments to be implemented in Fall 2017. The MRTN rate for continuous corn in central Illinois is 200 lb N/acre. All plots will be strip tilled in the fall. [1]For the conventional treatment, UAN will be applied at planting as an herbicide carrier or 2x2 with the planter. [2]For the 4R treatments, a portion of N applied at planting or sidedress may either be UAN or a stabilized N source such as Agrotain.

4. Budget analysis

As discussed above, tile drainage was installed at the experimental site in Fall 2016 which represented a delay in the project. While expenditures in the Materials and Supplies category have occurred to purchase the automatic water quality monitoring stations, there have been limited expenditures in terms of technician labor and travel to the site. This is because water and gas samples were not collected in 2016. In addition, trial management costs were not incurred in 2016.

Significant work will occur starting in Spring and Fall 2017 in terms of trial management, baseline and archive soil sampling, water quality monitoring in the bioreactor and tile drainage, and soil gas sampling. Therefore, it is anticipated that funds for 2017 will be allocated as proposed in the budget. Because this is a long-term experiment, it is anticipated that a no-cost extension will be applied for at the end of the project to apply the remaining funds from 2016 (primarily labor and trial management) to data collection and trial management efforts in 2020.

A preliminary budget analysis is provided below, but a finalized budget for 2016 will be sent from the UIUC Grants & Contracts Office to Julie Armstrong later in Feb 2017 when charges are finalized in the University accounting system.

Project Budget				
Line Description	**Budget**	**Expenditures**	**Encumbrances**	**Balance**
Salaries and Wages	51,000	18,874.24	1,515.57	30,610.19
Fringe Benefits	20,601	8,201.96	646.08	11,752.96
Equipment	0	0	0	0
Travel	5,000	69.66	0	4,930.34
Materials and Supplies	78,002	68,324.77	522.71	9,154.52
Publications and Printing	0	0	0	0
Services	8,500	246.21	0	8,253.79
Total Indirect Costs	18,121	10,100.87	298.22	7,721.91
Total	181,224	105,817.71	2,982.58	72,423.71