Illinois Nutrient Research & Education Council

2017 NREC Funded Research Projects
Project Objectives

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
A comprehensive corn nitrogen research program for Illinois	UI	Nafziger	2014-2018	$114,234
The effect of cover crops on surface water quality: A paired watershed experiment in the Lake Bloomington Watershed	ISU	O'Reilly	2014-2019	$172,159
Multifunctional buffers on marginal farmland to improve the environmental profile of agriculture and diversify production opportunities	UI	Lovell	2014-2018	$120,667
Updating P and K response and crop removal numbers for Illinois	UI	Villamil	2014-2017	$56,542
Nitrogen management systems in tile-drained fields: Optimizing yields while minimizing losses	UI	David/Gentry	2014-2019	$245,573
Nitrate leaching in cover crops and corn/soybean systems in Southern Illinois With N15	SIU	Schoonover	2015-2019	$95,907
An agronomic assessment of soil nitrous oxide emissions in Illinois: increasing nutrient utilization while reducing impacts on air quality	UI	Pittelkow	2015-2017	$84,482
tracking soil nitrogen loss and availability	UI	Nafziger	2015-2017	$187,572
Demonstration and monitoring of nutrient-removal wetlands in the Big Bureau Creek watershed (Northern/Central Illinois)	The Wetlands Initiative	Kostel	2015-2018	$140,000
Evaluating nutrient loss reduction strategies: longer rotation with cover crops and bioreactor	UI	Gentry	2015-2019	$160,973
Industry and University Partnership & KIC 4R Programs	IFCA	Schaefer	2016-2018	$447,002
Dissimilatory nitrate reduction to ammonium: An unexplored microbial	UI	Kent	2016-2017	$28,035

pathway for nitrate retention in agricultural soils				
The two-stage saturated buffer: Integrating the use of cover crops into saturated buffer designs for nitrogen mitigation	SIU	Schoonover	2016-2018	$82,453
Assessing synergies and tradeoffs of recommended BMPs to reduce nutrient loss	UI	Pittelkow	2016-2019	$131,640
Dissolving uncertainty: A comprehensive evaluation of dissolved P in tile drainage	UI	Christianson	2016-2018	$42,153
Understanding mechanisms and processes of dissolved reactive phosphate (DRP) loss in Illinois tile-drained fields	UI	Arai	2016-2019	$167,151
Cereal Rye Ahead of Corn: N Catch and Release	UI	Gentry	2017-2019	$58,653
Cereal Rye Ahead of Corn: N Catch and Release	IFCA	Schaefer	2017-2019	$22,635
Web-based Decision Support Tool for Cover Crop Management	UI	Coppess	2017-2019	$135,589
A Long-term Evaluation of Nitrogen Application Timing and Cover Crops Impacts on the Fate and Availability of Nitrogen Fertilizer and Crop Production on Tile Drained Fields	ISU	Armstrong	2017-2019	$210,095
Drainage water management and saturated buffers for achieving NLRS goals	UI	Christianson	2017-2020	$115,749
Bioreactors for Illinois: Smaller, Better, Faster	UI	Christianson	2017-2020	$158,992

ONGOING PROJECTS:

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
A comprehensive corn nitrogen research program for Illinois	UI	Nafziger	2014-2018	$114,234

Objectives

1. To gather data on the response of corn grain yield to N fertilizer rates when corn follows soybean in rotation and when corn follows corn, with replicated, field-scale, N rate trials at numerous on-farm locations throughout Illinois, representing the large diversity of soils and weather in the State. Some of these will include treatments comparing fall-applied and spring-applied fertilizer N rates.
2. To compare combinations of fertilizer N rate, form, inhibitor treatments, and application timing on corn yield and economic return using smaller-plot approaches on UI research centers.
3. Beginning in 2016, to address the NREC priority on late N application using UAN injected preplant and Y-drop method for late application.
4. To continue trials to address testing nitrification inhibitors. We already have several inhibitor treatments in our trials. We will also do some lab testing of inhibitor effects, if this information does not already exist, by adding the inhibitor along with fertilizer N to soil in containers and taking periodic samples to measure the rate of conversion of ammonium to nitrate.
5. To continue trials that began in 2016, to address the NREC priority of evaluating the utilization of N from DAP and/or MAP in comparison to TSP to determine degree of loss or utilization of nitrogen in DAP or MAP for both fall and spring application. We have such studies in 2016 at two sites (Urbana and Monmouth) and will continue these for two more years. These trials are designed to compare fall-applied DAP, spring-applied DAP, and spring-applied UAN as N sources at different N rates.
6. To include a final written report at the conclusion of this project to address each of the objectives listed above.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
The effect of cover crops on surface water quality: A paired watershed experiment in the Lake Bloomington watershed	ISU	O'Reilly	2014-2019	$172,159

Objectives:

The goal of this project is to understand how cover cropping at large spatial scales affects nutrient loss, without altering other farming practices.

Our objectives are as follows:

1. To determine nitrogen and phosphorous losses by comparing tile drainage water quality from two watersheds, one of which is cover cropped.
2. To relate patterns in nutrient loss to cover crop biomass, nutrient uptake and soil nitrogen.
3. To compare differences in the effectiveness of cover cropping after soybeans relative to

after corn.

4. To develop a hydrologic model of the cover cropped watershed that can be used to explore alternative farming practices and climate change impacts.
5. To conduct an economic assessment of large-scale cover crop implementation.
6. To provide information and outreach for local farmers on the use and effectiveness of cover crops.
7. A final objective is to include a final report at the conclusion of this project to address each of the objectives stated above.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Multifunctional buffers on marginal farmland to improve the environmental profile of agriculture and diversify production opportunities	UI	Lovell	2014-2018	$120,667

Objectives:

The long-term goal of our research is to develop and evaluate strategies for our Illinois agricultural landscape that optimize nutrient recovery and reduce greenhouse gas emissions, while maximizing profitability for the farmer. Our goal in this proposal is to establish and evaluate different multifunctional perennial systems appropriate for marginal or sensitive areas (e.g. sloped land, floodplains, etc.) on Illinois farms.

1. Establish replicated long-term studies to compare different multifunctional buffer systems at three of the University of Illinois Research Stations.
2. Evaluate the environmental benefits of multifunctional buffer treatments related to nitrogen recovery through the analysis of soil nutrient factions over time, leaching of nutrients in the subsurface zone, and abundance of key nitrogen-cycling microorganisms.
3. Conduct Life Cycle Assessment to study Greenhouse Gas (GHG) emissions and eutrophication impact for the eight multifunctional buffer systems, using data from field plots to supplement values from the literature.
4. Compare the profitability of the eight multifunctional buffer treatments including labor and resource requirements and develop a prototype farm planning tool for optimizing profitability and environmental benefits of multifunctional buffers.
5. Include a final report at the conclusion of this project to address each of the objectives stated above.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Updating P and K response and crop removal numbers for Illinois	UI	Villamil	2014-2017	$56,542

Objectives:

Profitable yet environmentally responsible crop production requires a better understanding of P and K fertilizer applications for improved nutrient efficiency in our current cropping systems. The ultimate goal of this project is to work with producers to improve P K fertilizer recommendations for Illinois. Specific objectives are:

1) **To modernize P and K removal rates by analyzing P and K concentrations in corn and soybean grain samples collected from producers across Illinois.** Only by collecting grain samples from producer fields throughout Illinois can we modify (or confirm) how much P and K modern corn and soybean varieties remove in harvested grain. This information is

essential for nutrient replacement as it is practiced today.

2) **To include a final report** at the conclusion of this project to address each of the objectives stated above.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Nitrogen management systems in tile-drained fields: Optimizing yields while minimizing losses	UI	David/Gentry	2014-2019	$245,573

Objectives:

The overall goal of this project is to more fully understand current and new nitrogen management systems on corn yields and nitrate losses from tile-drained fields in Illinois.

The objectives are to:

1. To develop on-farm field trials of current and new nitrogen management systems for typical corn/soybean rotations, evaluating both the yield response and the tile losses of nitrate.
2. To determine when and why tile nitrate losses occur in these management systems, during both corn and soybean rotations.
3. Include a final report at the conclusion of this project to address each of the objectives stated above.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Nitrate leaching in cover crops and corn/soybean systems in Southern Illinois With N15	SIU	Schoonover	2015-2019	$95,907

Objectives:

1. Evaluate nitrate-N leaching under legume/non-legume cover crops at field scale.
2. Evaluate nitrate-N Leaching due to the interactions with tillage.
3. Estimate nitrate-N load losses based on location conditions.
4. Evaluate the influence of cover crops (Hairy vetch and cereal rye) on nutrient dynamics and leaching at different topographic positions on a watershed scale.
5. Evaluate the contribution of cover crops in building soil carbon pools (total carbon, active carbon or potassium permanganate oxidizable carbon and water extractable carbon.
6. Evaluate the influence of cover crops in improving soil water holding capacity.
7. Include a final report at the conclusion of this project to address each of the objectives stated above.

Our goal is to gain critical knowledge about how long-term cover cropping, tillage practices and topography contribute to nitrate leaching. This knowledge will enable us to optimize crop yields, maximize nutrient utilization and minimize the environmental impact due to N leaching. An addendum to this project was added in 2015 to study 15N on micro-plot scale and trace N in three different pools including plant, soil and water for better understanding of the N cycling within the system. This research blends replicated micro-scale 15N study with field-scale experiments up to watershed-scale research.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
An agronomic assessment of soil nitrous oxide emissions in Illinois: increasing	UI	Pittelkow	2015-2017	$84,482

nutrient utilization while reducing impacts on air quality				

Objectives:
The overall goal of this project is to assess nitrogen (N), tillage, and residue management strategies for minimizing yield-scaled nitrous oxide (N2O) emissions while increasing nutrient utilization and crop productivity in IL corn production systems. Specific objectives are as follows:

1. Evaluate N2O emissions, crop N uptake, and crop yields in response to N fertilizer management practices aimed at increasing N use efficiency.
2. In a separate experiment, quantify the effects of tillage and residue management practices on N2O emissions, crop yield, and N use efficiency.
3. In both experiments, evaluate N2O emissions as a function of crop yield to identify practices that minimize air quality impacts per unit of crop production.
4. In both experiments, assess soil N availability and environmental factors that regulate soil N2O emissions, particularly early in the growing season, to better understand crop management options for minimizing nutrient losses to the atmosphere.
5. Include a final written report at the conclusion of this project to address each of the objectives listed above

Project Title	**Institution**	**Primary Investigator**	**Proposed Project Period**	**2017 Project Budget**
Tracking soil nitrogen loss and availability	UI	Nafziger	2015-2017	$187,572

Objectives:
1. To use soil N data that might be available from the N-Watch program that started in fall 2012 to supplement data gathered under this proposed project to produce a predictive model of how soil N amount in the soil at any point during the growing season is affected by the form and timing of N fertilizer applications and by weather conditions that follow N fertilizer application.
2. To apply different N timing and form treatments in replicated studies at twelve sites in Illinois, beginning in the fall of 2014, and to sample soils periodically following N application in order to monitor soil nitrate and ammonium into and through the cropping season in order to see how much N remains in the soil, and by subtraction how much has moved out of the soil.
3. To include at each of the twelve monitoring sites an N rate trial next to the N-monitoring site in order to match soil N observations with N responses.
4. To use both the model and the results from soil sampling in real time to develop estimates of the fate of N applied on the amount of N left as the season progresses.
5. To combine modeled estimates and actual soil N amounts into a publicly-available website and a smartphone App that will enable the user to input N form and time of application, and to receive, for that soil type and region, an estimate of how much N remains in the soil and in what form.
6. To include a final written report at the conclusion of this project to address each of the objectives listed above.

Project Title	**Institution**	**Primary Investigator**	**Proposed Project Period**	**2017 Project Budget**

Demonstration and monitoring of nutrient-removal wetlands in the Big Bureau Creek watershed (Northern/Central Illinois)	The Wetlands Initiative	Kostel	2015-2018	$140,000

Objectives:
The project goal is to advance the use of small, precisely placed constructed wetlands on farm properties along or within ditches or headwater streams to capture nutrient runoff from tile drainage. Pairing nutrient management practices with innovative nitrogen-removal practices such as wetlands is essential to achieving nutrient reduction goals, but farm-based wetlands have been severely underutilized in Illinois to date as part of the toolkit of conservation practices to improve water quality.

1) To provide technical assistance to at least four farmers in installing a constructed wetland "demonstration site" on their properties;
2) With project partner Dr. Karl Rockne of UIC, to conduct water quality monitoring of a wetland demonstration site to better understand the exact processes of nutrient removal and to develop a cost-effective monitoring protocol for the wetlands;
3) To promote replication of the wetland practice by peer landowners via field demonstration days and other outreach; and
4) To include a final report at the conclusion of this project to address each of the objectives stated above.

Project Title	**Institution**	**Primary Investigator**	**Proposed Project Period**	**2017 Project Budget**
Evaluating nutrient loss reduction strategies: longer rotation with cover crops and bioreactor	UI	Gentry	2015-2019	$160,973

Objectives:
The main objective of this study will be to test the effectiveness of a longer rotation with cover crops in combination with a bioreactor to decrease tile nitrate loss and directly examine this potential nutrient loss reduction scenario on a field-scale production system.

Project Title	**Institution**	**Primary Investigator**	**Proposed Project Period**	**2017 Project Budget**
Industry and University Partnership & KIC 4R Programs	IFCA	Schaefer	2016-2018	$447,002

Objectives:
There are four on-going NREC projects that this proposal will support as outlined below. The University of Illinois project investigators will provide details of the specific project work plan and objectives in their proposal; this proposal defines how we help coordinate those projects with farmer and ag retail cooperators and an outreach component. **The goal of this proposal** is to facilitate professional, consistent and reliable implementation of the treatments at these NREC research sites to produce viable, useful data to the researchers to achieve their goals of analyzing, publishing and communicating results that can be applied across many acres in Illinois to improve nutrient utilization and reduce nutrient losses.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Dissimilatory nitrate reduction to ammonium: An unexplored microbial pathway for nitrate retention in agricultural soils	UI	Kent	2016-2017	$28,035

Objectives:
The *overall goal* of the proposed research is to improve understanding about the importance of and controls on DNRA in Illinois agricultural soil. This goal will be achieved through the following *specific objectives*:
Objective 1: Quantify rates of DNRA and denitrification in Illinois agricultural soils,
Objective 2: Characterize the abundance and diversity of microbial communities capable of DNRA and denitrification in Illinois agricultural soils, and
Objective 3: Determine drivers of DNRA rates and microbial community composition.
Objective 4: We will produce a final report at the conclusion of this project to address each of the objectives stated above. In this report, we will outline the prospects for future investigations that can capitalize on our results.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
The two-stage saturated buffer: Integrating the use of cover crops into saturated buffer designs for nitrogen mitigation	SIU	Schoonover	2016-2018	$82,453

Objectives:

1. Compare nitrate leaching among drainage tiles managed with a grass strip (control), a saturated buffer with a grass strip (treatment 1), and a saturated buffer with a grass strip coupled with a cover crop strip (treatment 2). 2.
2. Estimate runoff volumes reaching the tile outlet among the three aforementioned drainage scenarios.
3. Quantify the economic costs and benefits associated with the control and two saturated buffer treatments.
4. Include a final report at the conclusion of this project addressing the objectives above.

The overarching goal of this research is to provide farmers and land managers with data pertaining to multiple best management practices designed to mitigate nitrogen in tile-drained systems. These data will illustrate the quantity of nitrogen that can be retained on a site and will offer insight into economic savings through the reduction of the environmental loss of fertilizers (i.e., assimilation by the cover crop).

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Assessing synergies and tradeoffs of recommended BMPs to reduce nutrient loss	UI	Pittelkow	2016-2019	$131,640

Objectives:
The overall goal of this project is to generate and communicate new information about best practices for balancing nutrient management, water quality, and corn production goals in

Illinois. This experiment is the first of its kind to ask the question: are current recommendations primarily minimizing environmental impacts with respect to nitrate losses, but having negative impacts on crop productivity, nutrient utilization, tile drainage P losses, and/or N2O emissions?

This project has 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 N2O 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/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.

Project Title	**Institution**	**Primary Investigator**	**Proposed Project Period**	**2017 Project Budget**
Dissolving uncertainty: A comprehensive evaluation of dissolved P in tile drainage	UI	Christianson	2016-2018	$42,153

Objectives:

The major goal of this work is to improve understanding of factors impacting the occurrence of dissolved reactive phosphorus (P) in Midwestern subsurface drainage waters.

The specific assessable objectives are to:

1. Further develop the Measured Annual Nutrients for Agricultural Environments (MANAGE) database through addition of drainage nutrient concentration data, specifically dissolved reactive P but also including other forms of P and N.
2. Statistically analyze the newly assembled nutrient concentration database to determine the effect of controllable factors (e.g., precipitation, soil drainage class) upon P concentrations in drainage water
3. Per the RFP, the final objective is "*to include a final report at the conclusion of this project to address each of the objectives stated above."*

Project Title	**Institution**	**Primary Investigator**	**Proposed Project Period**	**2017 Project Budget**
Understanding mechanisms and processes of dissolved reactive phosphate (DRP) loss in Illinois tile-drained fields	UI	Arai	2016-2019	$167,151

Objectives:

The overall goal of this project is to evaluate physicochemical factors (e.g., soil test P, landscape topography, infiltration rate, and soil chemistry) influencing the seasonal distribution and movement of DRP in tile drainage systems. We will more fully understand the fate of DRP in relation to soil test P in current P management systems at long term tile-drained experimental fields in Illinois.

The objectives are to:

1. fully understand tile DRP losses in relation to soil test P (i.e., labile P in surface soils) for fields in east-central Illinois under typical corn and soybean production;
2. assess tile DRP losses in relation to spatial variability (i.e., fine scale topography) across fields and landscapes;
3. determine the relationship between land surface topography and tile DRP losses, examining soil physical properties (e.g., infiltration rate, hydraulic conductivity, soil P extraction relevant to soil test P);
4. examine the processes responsible for seasonal DRP release to tile lines, including physicochemical properties (e.g., depth sequence distribution of DRP and agronomic P soil test P) of subsurface soils; and
5. include a final report at the conclusion of this project that will address each of the objectives stated above and evaluate both the yield response and the tile losses of DRP/changes in soil test P.

NEW PROJECTS

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Cereal Rye Ahead of Corn: N Catch and Release	UI	Gentry	2017-2019	$58,653

Objectives:
The main objective of this study is to learn how to best manage cereal rye as a winter cover crop before corn in either a corn/soybean rotation or in continuous corn. Our experimental design will accommodate three corn N fertilizer treatments (fall vs. spring vs. side-dress) with and without cereal rye and three spring cover crop termination dates (approximately 2 weeks apart). This design will allow us to investigate N release from the cover crop under various N fertilizer regimes and to evaluate N immobilization vs. allelopathy in regard to negative cover crop effects on the subsequent corn crop.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Cereal Rye Ahead of Corn: N Catch and Release	IFCA	Schaefer	2017-2019	$22,635

Objectives:
This proposal is to provide agronomic and technical assistance at the two on-farm sites for this project. Dan Schaefer will be responsible for working directly with Lowell Gentry at the University of Illinois and with the two cooperating farmers to ensure the cover crop plantings, fertilizer treatments and termination are performed in accordance with the work plan to assure quality data collection.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Web-based Decision Support Tool for Cover Crop Management	UI	Coppess	2017-2019	$135,589

Objectives:

The ultimate objective of this proposal is to provide farmers with a practical decision support tool that they can use in their fields to manage cover crops effectively. It will put to use existing and future research to demonstrate the potential of cover crops and increase adoption of this important practice. The final tool will be a web-based software application that can provide farmers, researchers, extension educators and others in the industry with data and information about cover crops in a practical, visualized format. Initial seed funding has produced a proof-of concept web interface that was the first step in the overall project (see, Part VIII, page 8).

This proposal to NREC is to advance the overall project through the initial developmental stage. The tool will provide information about cover crop growth integrated into common cropping systems, starting with cereal rye added to a corn-soybean rotation. When completed, the tool will:

- simulate growth of the cover crop, including termination scenarios across multiple fields in the farm operation;
- estimate biomass in the field;
- estimate the carbon-to-nitrogen ratio;
- estimate the amount of carbon, nitrogen and water stored in the cover crop; and
- provide estimates of the impact on soil moisture and field conditions, nutrient loss and water quality from the cover crop in each individual field.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
A Long-term Evaluation of Nitrogen Application Timing and Cover Crops Impacts on the Fate and Availability of Nitrogen Fertilizer and Crop Production on Tile Drained Fields	ISU	Armstrong	2017-2019	$210,095

Objectives:

1. Quantify the impact of N application timing (fall and spring) and cover crop inclusion on corn and soybean N uptake and yield, distribution of soil N, and nitrate loss through tile drainage.
2. Investigate the impact of N application timing and cover crop inclusion on N2O release during the year.
3. Utilize 15N methods to identify whether cover crops primarily take up soil or fertilizer N.
4. Determine the impact of cover crops on the fate and availability of fall and spring applied fertilizer N (mineralization, immobilization, nitrification, conversion to soil OM, leaching, and plant uptake) using 15N methodology.
5. Utilize 15N methods to determine the synchrony of the timing and quantity of cover crop residue N release and corn and soybean N demand.
6. Develop an economic model to evaluate the value/risk of cover crops based on 5 years of agronomic and environmental data.
7. Include a final report at the conclusion of this project to address each of the objectives stated above.

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Drainage water management and saturated buffers for achieving NLRS goals	UI	Christianson	2017-2020	$115,749

Objectives:
The goal of this work is to evaluate N loss reduction provided by drainage water management and saturated buffers to assess their potential inclusion as recommended practices in the NLRS.

The specific assessable objectives are to:

1. Monitor drainage water management and saturated buffer sites for nutrient loss reduction and crop yield impacts.
2. Develop a water balance at the drainage water management sites to better quantify lateral seepage impacts upon the overall nutrient loss reduction.
3. Perform an economic evaluation of these two practices ($ per acre treated and $ per pound of nitrogen removed).
4. Evaluate if these practices should be added to the IL NLRS. And if so,
    a. Develop an appropriate N loss reduction value to add to the NLRS tables.
    b. Develop a procedure and seek approval for adding drainage water management and/or saturated buffers to the NLRS.
5. Per the RFP, the final objective is *"to include a final report at the conclusion of this project to address each of the objectives stated above."*

Project Title	Institution	Primary Investigator	Proposed Project Period	2017 Project Budget
Bioreactors for Illinois: Smaller, Better, Faster	UI	Christianson	2017-2020	$158,992

Objectives:
The major goal of this work is to test novel full-size bioreactors intended to maximize nitrogen removal from drainage water while limiting land removed from production.

The specific assessable objectives are to:

1. Design and build four new types of denitrifying bioreactors in Illinois:
    a. Two Ditch Bioreactors
    b. One High-Flow Booster Bioreactor
    c. One Heat-enhanced Bioreactor
2. Compare the nutrient removal efficiency and hydraulic performance of these novel bioreactors to existing conventional bioreactors.
3. Perform an economic evaluation of these novel bioreactors ($ per acre treated and $ per pound of nitrogen removed).
4. Per the RFP, the final objective is *"to include a final report at the conclusion of this project to address each of the objectives stated above."*