Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2018 ENRTF Work Plan (Main Document)

Today's Date: 4-16-18

Date of Next Status Update Report: 01-31-2019

Date of Work Plan Approval: 06/05/2018

Project Completion Date: 06-30-2020

Does this submission include an amendment request? No

PROJECT TITLE: Using Perennial Grain Crops in Wellhead Protection Areas to Protect Groundwater

Project Manager: Margaret Wagner

Organization: Minnesota Department of Agriculture

College/Department/Division: Pesticide and Fertilizer Management Division

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Location: Lincoln, Olmsted, and Wadena Counties

Total Project Budget: $250,000

Amount Spent: $0

Balance: $250,000

Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 04j

Appropriation Language: $250,000 the second year is from the trust fund to the commissioner of agriculture to establish demonstration plots of Kernza, a new intermediate perennial grain crop, to evaluate the potential to profitably reduce nitrate contamination of groundwater in vulnerable wellhead protection regions of Minnesota. Any income generated as part of this appropriation may be used to expand the project.

I. PROJECT STATEMENT:

Annual row-crop production on coarse textured soils above shallow aquifers contributes to nitrate leaching and drinking water contamination. Preventing nitrate contamination through innovative land-use practices could be a cost-effective method to protecting groundwater. Converting row-crop agriculture to perennial cover is known to reduce nitrate leaching; however, converting annual crops to perennials is rarely an economically viable solution to improve water quality, until now. Almost two decades of traditional plant breeding (non-GMO) has resulted in a new perennial grain crop from intermediate wheatgrass (IWG) called Kernza®. The University of Minnesota has partnered with The Land Institute (a non-profit from Kansas) to develop IWG into a new perennial grain crop, which requires fewer pesticides since it is resistant to most wheat diseases and crop pests. IWG has a deep, dense root system that filters nitrate from soil water before it pollutes groundwater. **This project will establish production-scale fields of IWG to demonstrate and confirm that reductions in nitrate leaching below the perennial crop can reduce nitrate in groundwater compared to annual row crops in vulnerable wellhead catchment areas**.

This project will be Phase 1 (2 years) of a long-term (6-10 years) study to reduce groundwater nitrate contamination in high-risk, wellhead protection areas using IWG. Phase 1 will establish a network of instrumented IWG demonstration and research fields at three diverse locations to measure water and soil quality improvements compared to an annual row-crop. The three locations and partnering entities are:

- **Lincoln-Pipestone Rural Water** (LPRW) 54 acres planted in a highly vulnerable wellhead protection area (pumps 1.8 billion gallons of water annually to 36 municipalities and rural residents in a 10 county region). These are not lands protected with a conservation easement through a previous ENRTF-funded project because that project was not completed when planting began with in-kind funds for this project. Instead, we will plant on lands owned by Lincoln-Pipestone that were previously rented to farmers planting corn and soybean. This land will be made available for use rent free during the project period by Lincoln-Pipestone.
- **City of Chatfield** (Olmsted and Fillmore counties) 10 acres planted on land with karst soil owned by the city and a private party. Seven acres are planted on private land within a wellhead protection acre and three acres planted on public land directly adjacent to the wellhead protection area. Rental payment will be based on current market value.
- **Central Lakes College** Four acres planted at the Ag and Energy Center operated by Central Lakes College (Staples, Wadena County) in the Central Sands Region with coarse-textured soil that would be typical of land in a wellhead protection area and is vulnerable to nitrate leaching. This land typically has low annual crop yield unless irrigated. Rental payment will be based on current market value.

II. OVERALL PROJECT STATUS UPDATES:

First Update January 31, 2019

Second Update June 30, 2019

Third Update January 31, 2020

Final Update June 30, 2020

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: ***Establish and maintain IWG fields for demonstration and research***
Description: Establish approximately 68 acres of IWG. Fifty-seven acres will be located within two wellhead protection areas considered high priority for protection by the Minnesota Department of Health (MDH) and Minnesota Department of Agriculture (MDA). The remaining acres will be on land typical of soils present on wellhead protection areas in that region. Activity includes securing land, preparing land for planting, and seeding

IWG. All lands will be planted in order to evaluate the ability of IWG to reduce nitrogen from reaching groundwater. Two of the three sites will also be used for an IWG field day in 2019. One of these field days will be held in conjunction with *Green Lands Blue Waters* (a regional consortium of Mississippi River watershed partners) and will leverage technical and financial resources.

ENRTF BUDGET: $57,466

Outcome	Completion Date
1. Establish stands of IWG	July 1, 2018
2. Host IWG field day at two of three sites and develop outreach materials	October 30, 2019

First Update January 31, 2019

Second Update June 30, 2019

Third Update January 31, 2020

Final Update June 30, 2020

ACTIVITY 2: ***Initiate field instrumentation and data collection of IWG water studies***

Description: Install and execute a replicated experiment at the Central Lakes College location to measure nitrogen use dynamics beneath IWG and annual row crops. This sites will includes detailed soil nutrient analyses, lysimeters for soil water analyses, and soil moisture sensors. Project partners will collect soil nitrate data at various depths, measure root growth and turnover, measure crop yields, and report baseline data. Partners will also install lysimeters to monitor soil water nitrogen and measure soil nitrogen throughout the growing at the two IWG plantings in Lincoln and Olmstead Counties. The focus of the latter two plantings will be on evaluating nitrogen and water movement below the root zone of IWG (4‘), which is deeper than has been previously studied.

ENRTF BUDGET: $160,061

Outcome	Completion Date
1. Report soil water nitrate vulnerable to leaching below IWG and annual crops	June 30, 2020
2. Monitor changes in nitrate leaching parameters below IWG in Lincoln & Olmstead Counties	June 30, 2020
3. Report IWG grain and biomass yields for economic comparisons	June 30, 2020

First Update January 31, 2019

Second Update June 30, 2019

Third Update January 31, 2020

Final Update June 30, 2020

ACTIVITY 3: ***Grain testing to determine optimal end-use for IWG***

Description: Measure IWG grain quality for nutritional, storage, and processing information. Report grain quality measures including protein, carbohydrate, and gluten content. Measure food safety metrics including mycotoxin and ergot levels. Identify potential commercial processors and end-users for Minnesota markets.

Some grain testing on Kernza has been done, but most of the food science research was conducted on very early germplasm (e.g. populations that were not nearly as advanced as those that we have now). As breeding has

increased seed size and yield, this alters the composition of nutrients, fatty acids, and other characteristics related to food quality.

The initial work by UMN food scientists was to generally characterize Kernza grain. They determined protein and carbohydrate content, fatty acid profiles, and characterized gluten composition. Depending on what type of product Kernza will be used in, there are other metrics of concern that should be tested (e.g. gelatinization temperature for brewing).

Our project will characterize composition of nutrients, fatty acids, and other characteristics related to food quality in the newest germplasm and also look at specific metrics related to use in a variety of products. The metrics will be determined based on the target market for the grain (bread, beer, cereal, etc.). The target market(s) and metrics will be decided at the beginning of the project, based on discussion with project partners.

ENRTF BUDGET: $31,744

Outcome	Completion Date
1. Report of IWG grain quality for nutritional, storage, and processing information	June 30, 2020
2. Report indicating potential processors and end-users of IWG grain	June 30, 2020

First Update January 31, 2019

Second Update June 30, 2019

Third Update January 31, 2020

Final Update June 30, 2020

IV. DISSEMINATION: ***Dissemination of project results will be done through reports and a field day.***

Description: Research results will be summarized and presented in the LCCMR final report document. Data and information from the final report will be divided into three categories: 1) experimental results, 2) field monitoring data, and 3) grain quality and end-use; each organized into a separate report. A field day will be held in 2019 that will showcase the LCCMR funded research and provide a broad overview of the growing Kernza enterprise in Minnesota. Outreach materials, designed for a public audience, will be developed and disseminated.

First Update January 31, 2019

Second Update June 30, 2019

Third Update January 31, 2020

Final Update June 30, 2020

V. PROJECT BUDGET SUMMARY:

A. **Preliminary ENRTF Budget Overview:** Grant dollars will be administered by the Minnesota Department of Agriculture and managed through a contract with the University of Minnesota.

See attached budget spreadsheet

Explanation of Capital Expenditures Greater Than $5,000:

Explanation of Use of Classified Staff: NA

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: NA, all in-kind	Divide by 2,080 = TOTAL FTE: None

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 5,408	Divide by 2,080 = TOTAL FTE: 2.6

B. Other Funds:

SOURCE OF AND USE OF OTHER FUNDS	Amount Proposed	Amount Spent	Status and Timeframe
Other Non-State $ To Be Applied To Project During Project Period: None			
	$	$	
Other State $ To Be Applied To Project During Project Period: None			
	$	$	
Past and Current ENRTF Appropriation*:* None			
	$	$	
Other Funding History: ***Awarded to project team at the University of Minnesota:*** UMN Institute for Renewable Energy and the Environment - $600,000: Funded the preliminary, plot-scale lysimeter study showing that intermediate wheatgrass has less nitrate in the soil water compared to corn. MDA + Forever Green - $98,405: Funding to study agronomic aspects of intermediate wheatgrass grain production. Perennial Agriculture Project - $100,712: Funded additional environmental and agronomic studies on intermediate wheatgrass. In kind provided by the University of Minnesota, Lincoln-Pipestone Rural Water, and the City of Chatfield to plant sites already seeded in Chatfield and Lincoln-Pipestone as well as for Lincoln-Pipestone to provide land for research and demonstration sites.			
	$ 799,117	$	Secured

VI. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Drs. Jacob Jungers, Craig Sheaffer and Jessica Gutknecht	Research Scientists	University of Minnesota	Oversee the experiments including crop agronomics, plant and soil sampling, and data analysis
Michael Sparby and Al Doering	Research Scientists	Agricultural Utilization Research Initiative (AURI)	Conduct lab analysis of crop biomass and grain samples related gluten quality
Keith Olander and student worker	Dean of Agricultural Studies	Central Lakes College (CLC)	Lab analysis of water quality samples, manage

			field research in Wadena County, and oversee student worker
Brian Burkholder	Superintendent of City Services	City of Chatfield	Coordinate land arrangements in Fillmore and Olmstead counties, project advisory role and review outreach materials
Jason Overby	General Manager	Lincoln Pipestone Rural Water (LPRW)	Coordinate farmer involvement and land-use through LPRW, project advisory role and review outreach materials

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Margaret Wagner	Supervisor, Clean Water Technical Assitance Unit	Minnesota Department of Agriculture (MDA)	Serve as project manager: manage budgets, oversee experimental design and coordinate MDA staff providing in-kind support
Randy Ellingboe	Manager, Drinking Water Protection	Minnesota Department of Health (MDH)	Advise on project objectives and deliverables, review reports
Aaron Meyer and Scott Hanson	Source Water Specialists	Minnesota Rural Water Association (MRWA)	Advise on project objectives and deliverables, review reports and outreach materials

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

Four million Minnesotans depend on groundwater for drinking water. This two-year project will initiate the framework and establishment of an IWG research, production, and education network to allow the project team an opportunity to secure federal and private funds for an additional four to six year project. It balances the need for implementation and continued research on a new perennial grain crop in Minnesota. In the short-term, citizens of the project communities will directly benefit through reduced nitrate leaching to their drinking water source; long-term impacts could be statewide as this project will support our understanding of the environmental benefits and economic viability of IWG to Minnesota's farmers and landowners. This unique opportunity is timely because General Mills, Inc. has recently committed to using IWG as a food ingredient[1], which will catalyzed the market. IWG fields established for this project will be used to demonstrate production and to introduce this new crop into rural Minnesota communities during an educational field day. Fields will be managed as full-scale production fields; from which we will collect both water quality and economic data (e.g. cost savings from reduced chemical inputs, tillage, and annual reseeding), which will be made available for future use to produce enterprise budgets for IWG profitability.

VIII. REPORTING REQUIREMENTS:

- **The project is for 2 years, will begin on July 1, 2018, and end on June 30, 2020.**
- **Periodic project status update reports will be submitted January 31 and June 30 of each year.**
- **A final report and associated products will be submitted October 31, 2020.**

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet
B. Visual Component or Map
C. Parcel List Spreadsheet- N/A
D. Acquisition, Easements, and Restoration Requirements- N/A
E. Research Addendum- N/A

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2018 Budget Spreadsheet

Project Title: Using perennial grain crops in wellhead protection areas to protect groundwater
Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 04j
Project Manager: Margaret Wagner
Organization: Minnesota Department of Agriculture
College/Department/Division: Pesticide and Fertilizer Manage
M.L. 2018 ENRTF Appropriation:
Project Length and Completion Date: 2 years, 06/30/2020
Date of Report: April 16, 2018

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	TOTAL BUDGET	TOTAL SPENT	TOTAL BALANCE
BUDGET ITEM			
Professional/Technical/Service Contracts: Central Lakes College	$29,952	$0	$29,952
Personnel: Field Technician - 0.6 FTE per year for 2 years, 100% salary and no fringe. (*Total - $29,952*)			
Professional/Technical/Service Contracts: Agricultural Utilization Research Institute	$31,744	$0	$31,744
Personnel: Process Scientist - 0.1 FTE per year for 2 years, 80% salary and 20% fringe. (*Total - $22,880*)			
Personnel: Process Scientist - 0.03 FTE per year for 2 years, 80% salary and 20% fringe. (*Total - $6,864*)			
Travel: AURI personnel to travel from Marshall office to St. Paul for three project meetings per year for two years (Mileage: 6 trips @ ~315 miles trip @ $0.545 per mile = $1030; M&IE @ $64 per day = $384). AURI personnel travel from Marshall location to Crookston location for microbial analysis of grain, two trips per year for two years (Mileage: 4 trips @ ~270 miles per trip @ $0.545 per mile = $586 (*Total - $2,000*)			
Professional/Technical/Service Contracts: University of Minnesota	$98,453	$0	$98,453
Personnel: Postdoctoral Researcher - 0.5 FTE per year for 2 years, 78.6% salary and 21.4% fringe to oversee field and lab research and produce deliverables. (*Total - $61,307*)			
Personnel: Technician - 0.2 FTE per year for 2 years, 73.8% salary and 27.2% fringe conduct field research tasks such as planting, weeding, and harvesting research plots. Oversee processing of research samples. (*Total - $24,666*)			
Personnel: Hourly undergraduate interns - 0.25 FTE per year year for two years, 100% salary 0% fringe to collect soil water samples from the demonstration fields. (*Total - $12,480*)			
Equipment/Tools/Supplies			
Lysimeters to collect soil water samples from research fields and demonstration plots - 80 lysimeters @ $80/lysimeter	$6,400	$0	$6,400
Soil moisture sensors to determine soil moisture content at various depths to determine soil perculation rates - 120 sensors @ $150/sensor	$18,000	$0	$18,000
Analysis	$38,704	$0	$38,704
Soil carbon and nitrogen - Combustion analysis of soil samples to determine carbon and nitrogen - 336 samples per year for 2 years at $4/samples (*Total - $2,688*)			

Soil P, K, pH, OM - Baseline soil characteristics to determine nitrogen cycling and leaching - 72 samples per year for 2 years @ $14 per sample (*Total - $2,016*)			
Soil texture (%sand, silt, and clay) - Baseline soil texture to determine soil water perculation rates - 72 samples per year for 1 year @ $20 per sample (*Total - $1,440*)			
Soil nitrate - Analysis to determine changes in soil nitrate through time 504 samples per year for 2 years @ $5 per sample (*Total - $5,040*)			
Plant carbon and nitrogen - Combustion analysis of plant tissue to determine carbon and nitrogen - 128 samples per year for 2 years @ $4 per sample (*Total - $1,024*)			
Soil water nitrate - Analysis of lysimeter soil water samples to determine nitrate content - 1,472 samples per year for 2 years @ $9 per sample (*Total - $26,496*)			
Travel expenses in Minnesota			
Funds for 2 UMN personnel to make 13 trips per year from St. Paul to Verdi (400 miles round trip) to collect soil water samples. Expenses include M&IE each day and lodging for 10 nights. Travel expenses for 2 UMN personnel to make 13 trips per year from St. Paul to Chatfield (225 miles roundtrip) to collect soil water samples. Expenses include M&IE each day and no lodging.	$18,000	$0	$18,000
Professional/Technical/Service Contracts: Unknown - Contract for services to hire a custom harvester to combine grain from IWG demonstration plots and cut, bale, and remove residue from fields.	$8,747	0	$8,747
COLUMN TOTAL	**$250,000**	**$0**	**$250,000**