Environment and Natural Resources Trust Fund

M.L. 2020 Approved Work Plan

General Information

ID Number: 2020-031

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: August 13, 2021

Project Title: Implementing Hemp Crop Rotation To Improve Water Quality

Project Budget: $700,000

Project Manager Information

Name: Keith Olander

Organization: Minnesota State Colleges and Universities - Central Lakes College

Office Telephone: (218) 894-5163

Email: keith.olander@clcmn.edu

Web Address: http://www.clcmn.edu/

Project Reporting

Date Work Plan Approved by LCCMR: August 13, 2021

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2025

Final Report Due Date: August 14, 2025

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 08d

Appropriation Language: $700,000 the second year is from the trust fund to the Minnesota State Colleges and Universities System for Central Lakes College to evaluate how hemp crops reduce nitrogen contamination of surface water and groundwater in conventional crop rotations and demonstrate the environmental and economic benefits of hemp production. This appropriation is available until June 30, 2025, by which time the project must be completed and final products delivered.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: We will evaluate how hemp crops may reduce nitrogen contamination of surface and groundwater in conventional crop rotations while demonstrating the environmental and economic benefits of hemp grain production.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Establishing industrial hemp (Cannabis sativa) as an oilseed grain crop has potential to improve surface and ground water quality and restore soil integrity within the conventional crop rotation systems that are major environmental concern in Minnesota. Deep rooted hemp has the potential to scavenge, prevent runoff and reduce leaching of agricultural nutrient inputs, especially nitrogen, while further contributing organic matter to the soil horizon.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

We will experimentally test the effectiveness of hemp grain crops to scavenge excess nitrogen and prevent leaching in crop rotation systems. In parallel, we will demonstrate on a production scale how the incorporation of hemp grain into conventional crop rotation systems can achieve desired water quality and soil health outcomes. Finally, we will communicate the viable economic potential of hemp oilseed/grain cropping as discovered, refined and facilitated by market pathway and supply-chain development analyses.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Communication of study results and best practices through field days, farm demonstrations, and presentations will support adoption of hemp crops to achieve water quality, soil improvement and other environmental benefits in Minnesota.

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Corn vs. hemp comparison of nitrogen movement & corn-soybean-hemp integration

Activity Budget: $418,000

Activity Description:
Changes to the 2014 and 2018 federal Farm Bills have piqued the interest of growers in adding industrial hemp to their crop rotations. Unlike corn, hemp produces a robust tap root that has the potential to recover nitrate leached deep into the soil profile before it enters the water table. (1) This three-year experiment will use experimental blocks sited at four locations to quantify nitrate in leachate collected under experimental hemp plots and corn plots and thereby assess the potential for hemp to mitigate nitrate contamination of water resources if included in typical crop rotations. (2) We will also conduct production scale trials at two locations to demonstrate the integration of hemp into conventional corn-soybean rotations and to assess leaching and scavenging of nitrogen.

Outcome 1: Investigate the potential of hemp to mitigate groundwater nitrate contamination. (Milestones 1a - 1e)
Outcome 2: Demonstrate benefits of nitrate recovery from hemp in production-scale demonstration rotation to farmers. (Milestones 2a - 2c)

Activity Milestones:

Description	Completion Date
1c) Compare crops following corn/hemp for percent nitrate leachate collected periodically under experimental plots.	December 31, 2023
1d) Compare crops following corn/hemp for season-wide quantity of N leached under experimental plots.	December 31, 2023
1a) Compare crops following corn for percent nitrate in leachate collected periodically under experimental plots.	December 31, 2024
1b) Compare crops following corn for the season-wide quantity of N leached under experimental plots.	December 31, 2024
1e) Plot mean nitrate percentage and quantity by sampling date vs. rainfall and irrigation data.	December 31, 2024
2a) Record/summarize economic impact each year of adding hemp to production scale corn-soybean rotation.	December 31, 2024
2b) Record/summarize logistical considerations each year growing and harvesting hemp grain and/or fiber.	December 31, 2024
2c) Provide best management guide to hemp production economics/logistics based on 2a) and 2b).	December 31, 2024

Activity 2: Economic impact with business development for industrial hemp in Minnesota

Activity Budget: $181,000

Activity Description:
Ameliorating the impact of agriculture on water quality requires economically viable alternatives to current crop rotation systems. We will gather information on crop yield and economic data to deliver economic benefits that are aligned with environmental quality in connection with Activity 3. This activity will examine the economics of adding industrial hemp to a conventional crop rotation, supply chain and identify the market potential for feed, food, fuel, and fiber from industrial hemp. Due to public safety concerns as well as market volatility, we will not investigate the economics of cannabidiol (CBD) production in hemp.

Activity Milestones:

Description	Completion Date
Compile economic findings on industrial hemp in a corn-soybean rotation. Communicate annually at field days.	September 30, 2024

Identify markets for industrial hemp by reviewing supply chain availability. Communicate annually at field days.	September 30, 2024
Report Minnesota market and supply chain findings of industrial hemp for feed, food, and fiber.	December 31, 2024
Produce environmental benefits and provide advice for profitable production of industrial hemp in corn-soybean rotation.	March 31, 2025

Activity 3: Education and outreach on growing hemp in a conventional cropping systems

Activity Budget: $101,000

Activity Description:
We will host annual field days and demonstrations to showcase the production of industrial hemp in a rotation to farmers, government officials, local businesses, educators, and students. This activity will showcase a farmer with industrial hemp as part of a corn and soy crop rotation. We will also communicate the results obtained from Activities 1 and 2 so farmers can be informed on requirements to implement hemp in a rotation, economic considerations, market availability, and water quality improvement.

Activity Milestones:

Description	Completion Date
Organize and host annual hemp field days to educate about growing hemp in crop rotations.	October 31, 2024
Demonstrate/discuss the variable markets of hemp from a cropping rotation during annual field days.	October 31, 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Tom Michaels	University of Minnesota - Department of Horticultural Science	Professor Tom Michaels is the lead researcher of Activity 1: "Corn vs. hemp comparison of nitrogen movement" experiment described in the project research addendum.	Yes
George Weiblen	University of Minnesota - Department of Plant & Microbial Biology	Professor George Weiblen is an industrial hemp researcher and subject expert consulting on the project design. The industrial hemp research project manager in Weiblen's lab at the University of Minnesota, Dr. Jonathan Wenger, is the project coordinator working closely with the Project Manager.	Yes
Michael Stutelberg	Agricultural Utilization Research Institute	Michael Stutelberg leads and manages AURI's Analytical and Bioproducts laboratories in Marshall. He will coordinate among three AURI functional project teams: Technical, Business Development, and Outreach and Innovation Network.	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
Dissemination efforts include multiple field days, farmer program presentations in the off-season, and fellow academic audiences to inform them of research progress and outcome. We will host annual field days and demonstrations to showcase the production of industrial hemp in a rotation to farmers, government officials, local businesses, educators, and students. This activity will showcase a farmer with industrial hemp as part of a corn and soy crop rotation. We will also communicate the results obtained from Activities 1 and 2 so farmers can be informed on requirements to implement hemp in a rotation, economic considerations, market availability, and water quality improvement. Communication of study results and best practices through field days, farm demonstrations, and presentations will support adoption of hemp crops to achieve water quality, soil improvement and other environmental benefits in Minnesota.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?
The three-year span of this project coincides with the initial licensing of and expansion of commercial industrial hemp production in Minnesota as authorized under the 2018 Federal Farm Bill. Evidence-based guidance from this study on how hemp crops can mitigate water quality impacts of conventional corn-soybean agriculture by reducing excess input nitrogen runoff and leaching will help maximize environmental benefits through farmer adoption of this emerging agricultural economic opportunity.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Farm-Ready Cover Crops for Protecting Water Quality	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04l	$741,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
CLC farm operations manager		Manages technical operations of the CLC research facility.			29.6%	0.45		$27,994
CLC research coordinator		Coordinates administrative tasks of the CLC research facility.			29.6%	0.75		$44,712
CLC ag technician		Conducts technical tasks of the CLC research facility.			29.6%	0.45		$20,995
CLC Ag & Energy Center Director - PI - Keith Olander		Supervises and provides overall management of project.			29.6%	0.84		$109,973
UMN project manager		Provides coordination and logistical management across project activities.			36.5%	1.26		$93,836
UMN nitrate experiment technical manager		Oversees, conducts, collects and analyzes data of the Activity 1 nitrate scavenging experiment.			31.8%	2.49		$143,638
UMN undergraduate student		Provides technical assistance conducting and collecting data from the Activity 1 nitrogen scavenging experiment.			0%	0.75		$22,848
UMN graduate student		Assists conducting, collecting and analyzing data of Activity 1 nitrogen scavenging experiment.			19.9%	0.4		$15,124
CLC student intern		Provides technical assistance to Activity 1 experiment block and rotation demonstration at CLC Ag & Energy Center			0%	3		$23,040
							Sub Total	**$502,160**
Contracts and Services								
Agricultural Utilization Research Institute	Sub award	AURI Business Development team will establish supply chain opportunities and investigate new markets with private businesses with industrial hemp products. AURI Technical team (comprising of Process Engineer, food scientist, and analytical scientist)will work on assessing grains for proximate				1.02		$150,960

		analysis, nitrogen, and provide economic impact of hemp.						
U of MN	Internal services or fees (uncommon)	500 consumable plot maintenance supplies/year x 3 years =$1500; $500 soil sampling supplies/year x 3 year = $1500; 96 soil water samplers x $100 each = $9,600; soil water analysis lab supplies @ $725/location/year x 4 locations x 3 year = $8700; seed = $2433				0		$23,732
							Sub Total	**$174,692**
Equipment, Tools, and Supplies								
	Tools and Supplies	Land costs: six acres/yr + four acres/yr = 10 acres/yr x 3yrs x $275/acre, this cost is for College lease land access for length of project.	Activity 1: Production-scale demonstration (six acres/yr); nitrogen scavenging experiment (four acres/yr)					$8,250
	Tools and Supplies	CLC machinery operations: $165/acre x 6 acres x 3 yrs	Cultivation, planting, maintenance, harvest, cleanup of Activity 1 production-scale demonstration.					$2,970
	Tools and Supplies	CLC Field day costs (material and supplies): (5 days total over 3 yrs), 300 total attendance x $10/participant	On-site demonstration and immersion of farmers to foster adoption of emerging practices.					$3,000
							Sub Total	**$14,220**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	UMN Plot management	St. Paul to Waconia, Lamberton, Morris, Staples, St. Paul 500 mi Minivan rental $56/day x 2 days = $112. Hotel $120/night x 2 rooms = $240. Total $352/trip Year 1 - 2 trips = $704 (minivan rental hotel room)					$4,928

			Year 2 – 6 trips = $2,112 (minivan rental + hotel) year 3 - 6 trips = $2,112 (minivan rental + hotel)					
							Sub Total	**$4,928**
Travel Outside Minnesota								
	Conference Registration Miles/ Meals/ Lodging	UMN Presentation of results	Annual Conference of American Society for Horticultural Science) $2000 in year 2 and $2000 in year 3	X				$4,000
							Sub Total	**$4,000**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$700,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside Minnesota	Conference Registration Miles/Meals/Lodging	UMN Presentation of results	This is a national conference with annual venue at various locations: For example: 2022: 30 July - 3 August Hyatt Regency O'Hare Chicago, Chicago, Illinois 2023: TBD 2024: TBD

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	University of Minnesota	Unrecovered ICR (55% of UMN costs)	Pending	$170,000
In-Kind	Minnesota State Colleges and Universities: Central Lakes College	Unrecovered ICR (29.4% of salary+fringe)	Pending	$65,000
			State Sub Total	**$235,000**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**$235,000**

Attachments

Required Attachments

Visual Component

File: 1352c195-4d7.pdf

Alternate Text for Visual Component

Five panes: Question – hemp planting, seedlings, combining;
Experiment– corn and hemp crop and grain and 3-year rotation tables
Outcomes – hemp grain and plant with bee with pollen.
Site location map....

Optional Attachments

Support Letter or Other

Title	File
Peer-reviewed Research Addendum	b9706182-d82.docx
Background Check confirmation	d6d1e64f-130.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

None

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the Commissioner's Plan.

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

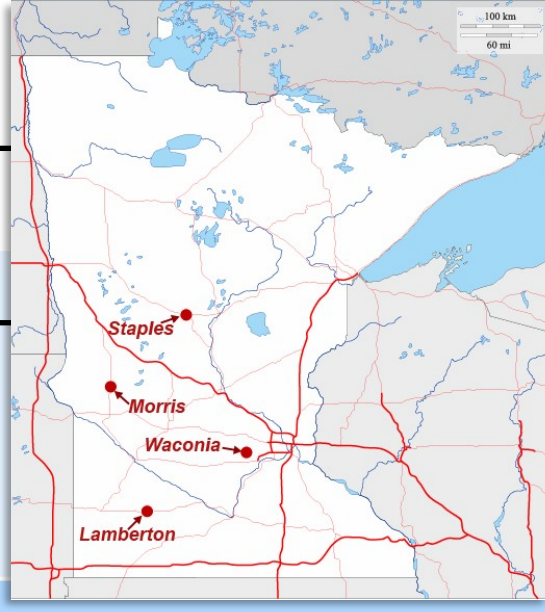
No

Implementing Hemp Crop Rotation to Improve Water Quality

CLC CENTRAL LAKES COLLEGE

UNIVERSITY OF MINNESOTA Driven to Discover℠

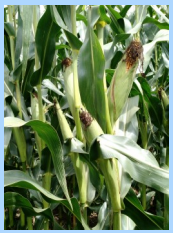
Agricultural Utilization Research Institute auri

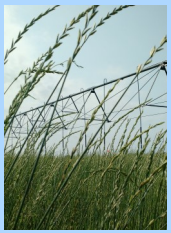


Question: Does hemp affect water quality?

- Seeding
- Best Management Practices
- Fertilizer requirements
- Harvest

Experiment: Crop rotation and water quality comparisons





Year	2022	2023	2024
Crop Rotation	Corn	Soybeans	Small Grain
	Hemp	Corn	Soybeans
	Small Grain	Hemp	Corn
	Soybeans	Small Grain	Hemp

Year	2022	2023	2024
Crop Comparisons	Corn	Hemp	Corn
	Hemp	Corn	Hemp

Outcomes

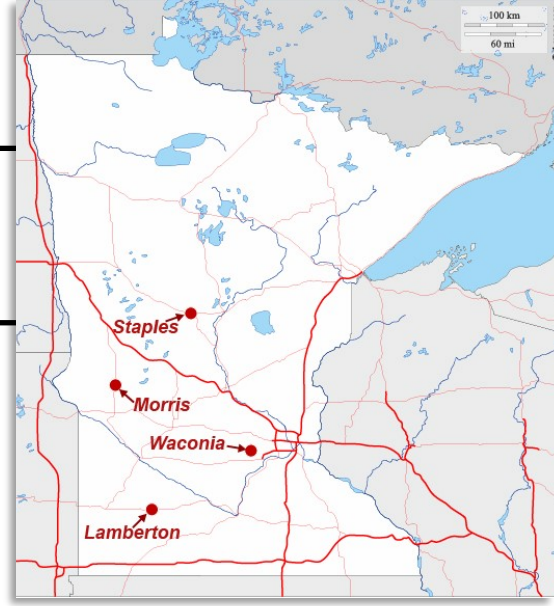
- Determine water quality impacts
- Maximize nitrogen scavenging in clay soils
- Minimize nitrogen leaching in sandy soils
- Yield production for both seed and fiber

Implementing Hemp Crop Rotation to Improve Water Quality

CLC CENTRAL LAKES COLLEGE

UNIVERSITY OF MINNESOTA Driven to Discover℠

Agricultural Utilization Research Institute auri



Question: Does hemp affect water quality?

- Seeding
- Best Management Practices
- Fertilizer requirements
- Harvest



Experiment: Crop rotation and water quality comparisons




Year	2022	2023	2024
Crop Rotation	Corn	Soybeans	Small Grain
	Hemp	Corn	Soybeans
	Small Grain	Hemp	Corn
	Soybeans	Small Grain	Hemp


Year	2022	2023	2024
Crop Comparisons	Corn	Hemp	Corn
	Hemp	Corn	Hemp

Outcomes

- Determine water quality impacts
- Maximize nitrogen scavenging in clay soils
- Minimize nitrogen leaching in sandy soils
- Yield production for both seed and fiber