



# Environment and Natural Resources Trust Fund

2021 Request for Proposal

## General Information

**Proposal ID:** 2021-409

**Proposal Title:** Implementing Hemp Crop Rotation to Improve Water Quality

## Project Manager Information

**Name:** Jonathan Wenger

**Organization:** Minnesota State Colleges and Universities - Central Lakes College

**Office Telephone:** (218) 894-5163

**Email:** keith.olander@clcmn.edu

## Project Basic Information

**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.

**Funds Requested:** \$700,000

**Proposed Project Completion:** 2024-12-31

**LCCMR Funding Category:** Water Resources (B)

## 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

## Narrative

**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.

## 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)

First Update April 1, 2022

Second Update November 1, 2022

Third Update April 1, 2023

Fourth Update November 1, 2023

Fifth Update April 1, 2024

Sixth Update November 1, 2024

Final Report between December 31, 2024 and March 31, 2025

#### Activity Milestones:

Description	Completion Date
1b) Compare crops following corn for the season-wide quantity of N leached under experimental plots.	2023-04-30
1a) Compare crops following corn for percent nitrate in leachate collected periodically under experimental plots.	2023-04-30
1d) Compare crops following corn/hemp for season-wide quantity of N leached under experimental plots.	2024-04-30
1e) Plot mean nitrate percentage and quantity by sampling date vs. rainfall and irrigation data.	2024-04-30
1c) Compare crops following corn/hemp for percent nitrate leachate collected periodically under experimental plots.	2024-04-30
2b) Record/summarize logistical considerations each year growing and harvesting hemp grain and/or fiber.	2024-12-31
2a) Record/summarize economic impact each year of adding hemp to production scale corn-soybean rotation.	2024-12-31
2c) Provide best management guide to hemp production economics/logistics based on 2a) and 2b).	2024-12-31

### 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.

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Fifth Update April 1, 2024

Sixth Update November 1, 2024

Final Report between December 31, 2024 and March 31, 2025

**Activity Milestones:**

Description	Completion Date
Produce environmental benefits and provide advice for profitable production of industrial hemp in corn-soybean rotation.	2024-06-30
Identify markets for industrial hemp by reviewing supply chain availability. Communicate annually at field days.	2024-09-30
Compile economic findings on industrial hemp in a corn-soybean rotation. Communicate annually at field days.	2024-09-30
Report Minnesota market and supply chain findings of industrial hemp for feed, food, and fiber.	2024-12-31

**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.

First Update April 1, 2022

Second Update November 1, 2022

Third Update April 1, 2023

Fourth Update November 1, 2023

Fifth Update April 1, 2024

Sixth Update November 1, 2024

Final Report between December 31, 2024 and March 31, 2025

**Activity Milestones:**

Description	Completion Date
Demonstrate/discuss the variable markets of hemp from a cropping rotation during annual field days.	2024-10-31
Organize and host annual hemp field days to educate about growing hemp in crop rotations.	2024-10-31

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
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
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
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

## 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

## Project Manager and Organization Qualifications

**Project Manager Name:** Jonathan Wenger

**Job Title:** Dean of Agricultural Studies

**Provide description of the project manager's qualifications to manage the proposed project.**

Olander is a Dean of Agricultural Studies for Minnesota State, Central Lakes College. His undergraduate and advanced education is in Agricultural Education (B.S., 1994, M.Ed. 2006). Currently, he directs a large research and demonstration farm focused on cropping on coarse sandy soils under irrigation. Aside from this experience over the past six years, he has owned and operated a 300 acre crop farm for nearly two decades. Complementing this experience in the field, he has taught agricultural education at the secondary and post-secondary levels for 21 years. Finally, he is well versed in leading teams in completing research projects to support farmer viability.

**Organization:** Minnesota State Colleges and Universities - Central Lakes College

**Organization Description:**

Central Lakes College – Brainerd and Staples is one of 37 Minnesota State Colleges and Universities ([www.minnstate.edu](http://www.minnstate.edu)), offering excellent, affordable education in 54 communities across the state. We are a comprehensive community and technical college serving about 5,500 students per year. With a knowledgeable, caring faculty and modern, results-oriented programs in comfortable facilities, CLC is the college of choice for seekers of success.

**CLC Ag & Energy Center**

Originally started as a research and demonstration farm for irrigation named CMDRIF, Central Minnesota Demonstration and Research Irrigation Farm, the Ag and Energy Center strives to be a catalyst for agriculture research and demonstration in the coarse, sandy plains of Minnesota. Currently, the Ag and Energy Center operates around 2,000 acres under research and crop production. The main crops include corn (522), soybeans (859), barley (321), and edible beans (238). Many of these acres include research tied into fields such as cover crops, water management, and nutrient/fertilization management. There are 87 acres that are dedicated solely to research plots located at the farm site across from the main Staples college campus. Research projects are conducted in partnership with many industry and public educational institutes.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
CLC farm operations manager		Manages technical operations of the CLC research facility.			29.6%	45		\$27,994
CLC research coordinator		Coordinates administrative tasks of the CLC research facility.			29.6%	75		\$44,712
CLC ag technician		Conducts technical tasks of the CLC research facility.			29.6%	45		\$20,995
CLC Ag & Energy center director		Supervises and provides overall management of project.			29.6%	83.01		\$109,973
UMN project manager		Provides coordination and logistical management across project activities.			36.5%	126		\$93,836
UMN nitrate experiment technical manager		Oversees, conducts, collects and analyzes data of the Activity 1 nitrate scavenging experiment.			31.8%	249.99		\$143,638
UMN undergraduate student		Provides technical assistance conducting and collecting data from the Activity 1 nitrogen scavenging experiment.			0%	75		\$22,848
UMN graduate student		Assists conducting, collecting and analyzing data of Activity 1 nitrogen scavenging experiment.			19.9%	40		\$15,124
CLC student intern		Provides technical assistance to Activity 1 experiment block and rotation demonstration at CLC Ag & Energy Center			0%	300		\$23,040
							<b>Sub Total</b>	<b>\$502,160</b>
<b>Contracts and Services</b>								
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.				45		\$51,480
Agricultural Utilization	Sub award	AURI Technical team (comprising of Process Engineer, food scientist, and analytical scientist)will work on assessing grains for				56.4		\$64,522

Research Institute		proximate analysis, nitrogen, and provide economic impact of hemp compared to other grains.						
Agricultural Utilization Research Institute	Sub award	AURI Outreach and Innovation Network will organize 2 hemp field days over the grant period to assist in education and awareness of growing industrial hemp in a crop rotation.				22.5		\$21,107
Agricultural Utilization Research Institute	Sub award	AURI: Travel by the technical team, business development team, and outreach team.				-		\$7,300
Agricultural Utilization Research Institute	Sub award	AURI reagents and lab consumable supplies/chemicals.				0		\$551
UMN	Professional or Technical Service Contract	Water sample collection service at UMN-ROCs for the nitrate scavenging experiment; \$500 x 4 experimental blocks x 3 years.				0		\$6,000
							<b>Sub Total</b>	<b>\$150,960</b>
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Land costs: six acres/yr + four acres/yr = 10 acres/yr x 3yrs x \$275/acre	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
	Tools and Supplies	UMN experiment and sample analysis material costs	\$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 = \$811 yr 1 + \$811 yr 2 + \$810 yr 3					\$23,732



							<b>Sub Total</b>	<b>\$37,952</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	UMN Plot management	St. Paul to Waconia, Lambertson, 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) Year 2 – 6 trips = \$2,112 (minivan rental + hotel) year 3 - 6 trips = \$2,112 (minivan rental + hotel)					\$4,928
							<b>Sub Total</b>	<b>\$4,928</b>
<b>Travel Outside Minnesota</b>								
	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
							<b>Sub Total</b>	<b>\$4,000</b>
<b>Printing and Publication</b>								
							<b>Sub Total</b>	-
<b>Other Expenses</b>								
							<b>Sub Total</b>	-

							<b>Grand Total</b>	<b>\$700,000</b>
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## Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
<b>Travel Outside Minnesota</b>	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
<b>State</b>				
In-Kind	Minnesota State Colleges and Universities: Central Lakes College	Unrecovered ICR (29.4% of salary+fringe)	Pending	\$65,000
In-Kind	University of Minnesota	Unrecovered ICR (55% of UMN costs)	Pending	\$170,000
			<b>State Sub Total</b>	<b>\$235,000</b>
<b>Non-State</b>				
			<b>Non State Sub Total</b>	-
			<b>Funds Total</b>	<b>\$235,000</b>

## 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	<a href="#">b9706182-d82.docx</a>

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

**Does your project have patent, royalties, or revenue potential?**

No

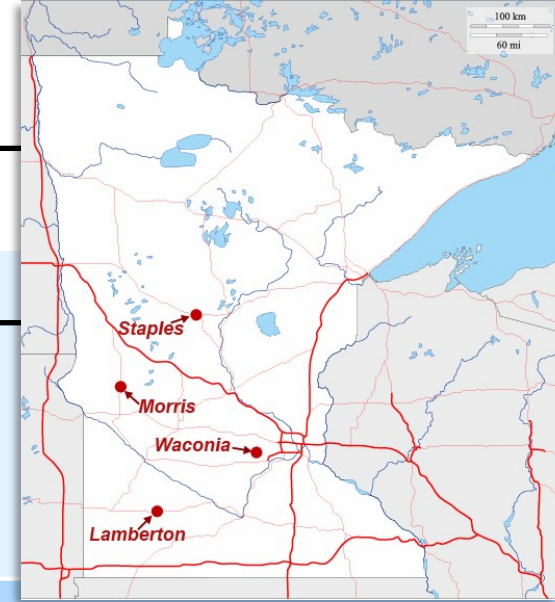
**Does your project include research?**

Yes

**Does the organization have a fiscal agent for this project?**

No

# Implementing Hemp Crop Rotation to Improve Water Quality

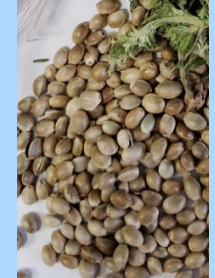
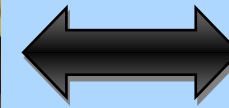
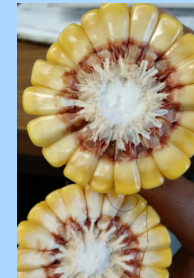


## Question: Does hemp affect water quality?

- 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

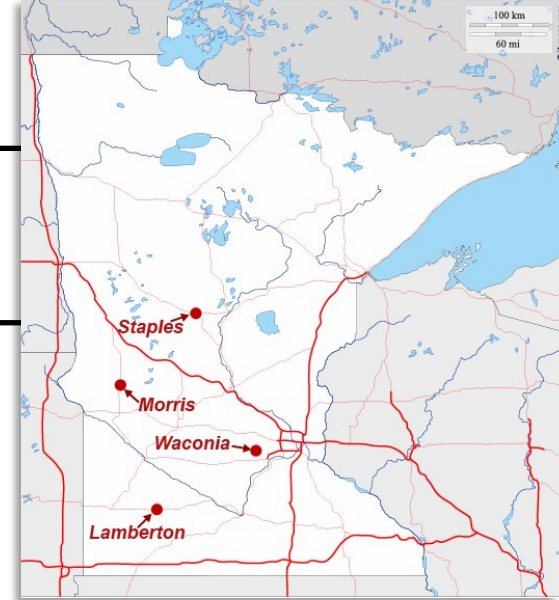
Year	2022	2023	2024
Crop Comparisons	Corn	Hemp	Corn
	Hemp	Corn	Hemp

## 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

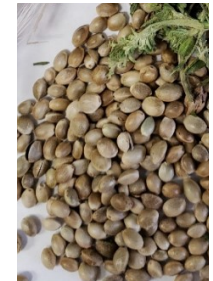


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	Hemp	Corn	Soybeans
	Small Grain	Hemp	Corn
	Soybeans	Small Grain	Hemp

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

## Outcomes

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