

Final Abstract

Final Report Approved on July 7, 2026

M.L. 2020 Project Abstract

For the Period Ending June 30, 2025

Project Title: Implementing Hemp Crop Rotation To Improve Water Quality

Project Manager: Keith Olander

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Website: <https://www.clcmn.edu/>

Funding Source:

Fiscal Year:

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

Appropriation Amount: \$700,000

Amount Spent: \$700,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

This project evaluated industrial hemp in Minnesota crop rotations as a potential tool to reduce nitrate loss, protect water quality, diversify cropping systems, and support new markets for sustainable grain, fiber, feed, erosion control, and building material products. Results provide early guidance for future research, growers, and resource managers.

Summary of Project and Outcomes

Industrial hemp is an emerging crop that may help Minnesota farmers diversify crop rotations while supporting water quality and new sustainable markets. This project studied whether adding hemp to corn and soybean rotations could reduce nitrate movement through soil and create new economic opportunities for grain and fiber production.

Research plots were established in 2022 at Central Lakes College in Staples, the University of Minnesota Southwest Research and Outreach Center in Lamberton, and the University of Minnesota West Central Research and Outreach Center in Morris. The study compared corn and hemp using replicated plots, soil water sampling, and yield measurements. Suction lysimeters were installed to track nitrate movement below the crop root zone.

Results varied by location. At Morris, no nitrate differences were found between corn and hemp on any sampling date. At Lamberton, average nitrate levels were higher under corn than hemp, and continuous corn had the highest nitrate

levels. At Staples, nitrate levels were higher under hemp on two sampling dates, but crops did not differ on other dates. These mixed results suggest hemp may have potential in some rotations and soil types, but additional years and locations are needed before firm recommendations can be made.

The project also advanced hemp market development. AURI completed a hemp commercialization report outlining opportunities in grain, fiber, animal feed, biobased construction materials, erosion control products, and other uses. Under 2025 market conditions, hemp grain grown under contract showed potential to compete economically with corn and soybeans, with possible additional income from fiber where processing contracts are available.

Overall, this project created important baseline data, expanded public and industry understanding of hemp's role in Minnesota agriculture, and identified next steps for using hemp to support water quality, soil health, crop diversity, and rural economic development.

Project Results Use and Dissemination

Project results were shared through field days, farm demonstrations, student tours, stakeholder meetings, reports, a national Tri-Societies poster presentation, and public media. Outreach included CLC Ag & Energy Center field days, University of Minnesota tours, and six hemp-focused events across Minnesota. AURI also hosted a "Building a Hemp Industry in Minnesota" event in Kimball with more than 60 participants and supported a Prairie Sportsman "Highway to Hemp" segment. Attachments include the AURI Hemp Commercialization report, University of Minnesota hemp rotation report, Tri-Societies poster, project summaries, and relevant photos or public-facing materials.



Environment and Natural Resources Trust Fund

M.L. 2020 Approved Final Report

General Information

Date: August 18, 2026

ID Number: 2020-031

Staff Lead: Mike Campana

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

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Project Reporting

Final Report Approved: July 7, 2026

Reporting Status: Project Completed & Additional Update Approved

Date of Last Action: July 7, 2026

Project Completion: June 30, 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? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & 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	Approximate 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	Approximate Completion Date
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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	Approximate 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 work 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	\$ Amount Spent	\$ Amount Remaining
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%	0.6		\$35,211	-	-
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		\$131,005	-	-
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	\$480,026	\$480,026	-
Contracts and Services										
Agricultural Utilization Research Institute	Subaward	AURI Business Development team will establish supply chain opportunities and investigate new markets with private businesses with industrial				1.02		\$147,893	\$147,893	-

		hemp products. AURI Technical team (comprising of Process Engineer, food scientist, and analytical scientist) will work on assessing grains for proximate 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		\$10,591	\$10,591	-
							Sub Total	\$158,484	\$158,484	-
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)					\$16,500	\$16,500	-
	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.					\$5,940	\$5,940	-
	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.					\$26,548	\$26,548	-
							Sub Total	\$48,988	\$48,988	-
Capital Equipment										
							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) Year 2 – 6 trips = \$2,112 (minivan rental + hotel) year 3 - 6 trips = \$2,112 (minivan rental + hotel)					\$8,502	\$8,502	-
							Sub Total	\$8,502	\$8,502	-
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	\$4,000	-
							Sub Total	\$4,000	\$4,000	-
Printing and Publication										
							Sub Total	-	-	-
Other Expenses										
							Sub Total	-	-	-
							Grand Total	\$700,000	\$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	\$ Amount Spent	\$ Amount Remaining
State						
In-Kind	University of Minnesota	Unrecovered ICR (55% of UMN costs)	Pending	\$170,000	\$170,000	-
In-Kind	Minnesota State Colleges and Universities: Central Lakes College	Unrecovered ICR (29.4% of salary+fringe)	Pending	\$65,000	\$65,000	-
			State Sub Total	\$235,000	\$235,000	-
Non- State						
			Non State Sub Total	-	-	-
			Funds Total	\$235,000	\$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....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Peer-reviewed Research Addendum	b9706182-d82.docx
Background Check confirmation	d6d1e64f-130.pdf
CLC Field Promotional Flyer	4f4ae33c-636.pdf
AURI - Hemp Commercialization in Minnesota	11b76c47-4da.pdf
Tri-Societies Hemp Poster	2d550ed9-5ef.pdf
U of M Hemp Project Overview on Crop Rotation	50a5316e-da8.pdf

Media Links

Title	Link
Prairie Sportsman on PBS:	https://video.pioneer.org/video/highway-to-hemp-dwitis/

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 understand that travel expenses are only approved if they 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 understand the Commissioner's Plan applies.

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

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

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Justification For Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	• Budget • Other • Dissemination • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Attachments	The U of M and AURI were under budget and CLC was over budget. Adjustments to the budget categories were made showing the final financial outcomes. The overall project budget did not change. The land and machinery costs for project were higher than anticipated as we experienced greater inflationary costs during this time frame compared to the estimates when the proposal was submitted. Our field day attendance was strong but brought additional costs.	May 12, 2026	Yes	May 15, 2026

Additional Status Update Reporting

Additional Status Update February 12, 2026

Date Submitted: May 12, 2026

Date Approved: May 15, 2026

Overall Update

Initiated in early 2022, the project established plots at CLC-Staples, Lamberton, and Morris. Corn-soy-hemp rotation trials were launched at CLC and Lamberton, with Morris dedicated to nitrogen and water quality monitoring. Suction lysimeters were installed in 2023 to track nitrate movement. The Anka hemp variety was planted each year. Favorable weather and lysimeter reinstallation at Staples in 2024 supported successful data collection, advancing research on hemp integration into crop rotations.

This project has brought together three entities in the quest to determine two fundamental impacts of hemp in a corn/soy rotation. The first determinant was focused around nitrate sequestration of nitrates in various soils in a comparison of corn and hemp with each requiring similar rates of nitrogen. Second, augmentation of the market potential through product development and demonstration. The overall conclusion from the team is that the three-year study did provide a start to answering these questions but should be carried forward for another set of years to verify results and bring about conclusions and recommendations. This continued research will provide critical information for growers adopting hemp into rotations and defining a market pathway that has resiliency driving future demand.

Activity 1

This activity was previously marked complete.

(This activity marked as complete as of this status update)

Activity 2

This activity was previously marked complete.

(This activity marked as complete as of this status update)

Activity 3

This activity was previously marked complete.

(This activity marked as complete as of this status update)

Dissemination

Dissemination efforts include multiple field days, farmer program presentations in the off-season, and fellow academic audiences to inform them of research progress and outcomes. We did 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. Specific study outcomes of hemp market augmentation should be reviewed in the attached AURI Hemp Commercialization report. Additionally, on a national scale, the TriSocieties presentation brought the project further outreach and that effort is captured in the attached poster used in that presentation. The U of M summary report is published through the U of M scope of work on hemp and the network engaged in moving the industry forward. Finally, Prairie Sportsman - "Highway to Hemp" - Program segment features AURI's hemp LCCMR-supported hemp commercialization work, including research on erosion control products and market development for hemp-based building materials.

Link to video: [Prairie Sportsman | Highway to Hemp | Season 16 | Episode 5 | Pioneer PBS](#)

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: May 12, 2026

Date Approved: May 15, 2026

Overall Update

Initiated in early 2022, the project established plots at CLC-Staples, Lamberton, and Morris. Corn-soy-hemp rotation trials were launched at CLC and Lamberton, with Morris dedicated to nitrogen and water quality monitoring. Suction lysimeters were installed in 2023 to track nitrate movement. The Anka hemp variety was planted each year. Favorable weather and lysimeter reinstallation at Staples in 2024 supported successful data collection, advancing research on hemp integration into crop rotations.

This project has brought together three entities in the quest to determine impacts of hemp in a corn/soy rotation. We focused on nitrate sequestration of nitrates in various soils in a comparison of corn and hemp with each requiring similar rates of nitrogen. The overall conclusion from the team is that the three-year study did provide a start to answering these questions but should be carried forward for another set of years to verify results and bring about conclusions and recommendations.

Activity 1

At the CLC Ag & Energy Center (Staples) the nitrate concentration reached 75 mg/L (ppm) on 6/25/2024. Nitrate level under the hemp crop was higher than under corn on 6/16 and 6/25, but on other sampling dates the crops did not differ. At UMN-WCROC (Morris) the highest water nitrate level (39 mg/L) was sampled on 4/29/2024. No water nitrate differences under corn vs hemp were found at any sampling date. At UMN-SWROC (Lamberton), nitrate levels averaged across all sampling dates were higher under corn compared to hemp. Nitrate in water collected following two years of continuous corn yielded the highest nitrate levels (53 mg/L). Continuous hemp and rotations including hemp resulted in lower nitrate levels. Variation among locations suggests that additional years and locations of study are needed before drawing firm conclusions. Under recent market conditions (June 2025), hemp has the potential to exceed the returns of corn, soybeans, and wheat. Current expected yields of hemp grain at 1250-1500lb/acre at a price of \$0.65 to \$0.70/lb (based on recent contract prices from regional buyers) will outperform average corn and soybean yields at June 2025 market.

(This activity marked as complete as of this status update)

Activity 2

Project milestones have been completed. AURI activities since the last update have been focused on finalizing a report compiling supply chain findings for submission to CLC, reviewing and sharing final analytical and economic data with project partners and industry stakeholders, and working with industry and research partners to plan and stage a "Building a Hemp Industry in Minnesota" event on July 17th in Kimball, Minnesota. This event, hosted at the Green Fox hemp processing plant, brought together over 60 key stakeholders to share information about the commercialization and market development opportunities that have been identified and supported during this project. Hemp's grain revenue potential can be complimented with the fiber component. Hemp returns in this assessment are based on grain sales only. Fiber sales in today's market can yield an additional \$300/acre at a price of \$200/ton and a yield of 1.5 ton/acre, provided processor contracts are available. The fiber market is still in its infancy and is not well established in Minnesota. AURI's commercialization team also continued its ongoing outreach and engagement efforts, connecting with key stakeholders to share information and build new connections to support ongoing market development and build on the progress made.

(This activity marked as complete as of this status update)

Activity 3

Outreach and education efforts began with field days at CLC (Aug. 2022) and SWROC (Sept. 2022), highlighting the corn-soy-hemp rotation study. Planning meetings with UMN clarified 2023 protocols, including lysimeter installation. Lysimeter data showed no significant nitrogen differences between corn and hemp. Project updates were shared through reports, farm events, and a November 2024 team meeting.

UMN researchers conducted a field tour of the corn/soybean/hemp rotation study for two wagon loads of participants at the 2023 CLC Ag & Energy Research Center field day. Participants were particularly interested in hemp biology and hemp's potential inclusion in regional crop rotations. In Fall 2023 and Fall 2024, UMN faculty highlighted outcomes of the corn/soybean/hemp rotation and nitrate loss studies during St. Paul field tours for three student groups each year. *(This activity marked as complete as of this status update)*

Dissemination

In July, AURI hosted a “Building a Hemp Industry in Minnesota” event in Kimball, Minnesota. Over 60 participants attended to learn more about hemp commercialization opportunities pursued during this project and tour the Green Fox production facility. AURI’s August podcast also covered hemp building materials, an area of focus during this project.

Outreach Link for Attachments Tab:

Pioneer PBS

Prairie Sportsman - "Highway to Hemp" - Program segment features AURI’s hemp LCCMR-supported hemp commercialization work, including research on erosion control products and market development for hemp-based building materials.

Link to video: [Prairie Sportsman | Highway to Hemp | Season 16 | Episode 5 | Pioneer PBS](#)

09/2022 Sisseton Wahpeton Dakota Sioux Executive Council Retreat,
Jackpot Junction Casino, Morton, Minnesota, “Hemp Economic Feasibility Study”

01/2024 University of Wisconsin-Madison, Department of Horticulture,
Madison, Wisconsin, “Cannabis conundrum: science & politics of America’s most controversial plant”

03/2024 Great Lakes Indigenous Farming Conference, Cohasset, Minnesota,
“Cultivating academic hemp research with indigenous collaborators: reflections on the past seven years”

U of M researchers were able to share data nationally through the American Society of Horticultural Science Annual Conference. The information presented is in attachments.

Status Update Reporting

Status Update April 1, 2025

Date Submitted: May 12, 2026

Date Approved: May 15, 2026

Overall Update

Since the last update in October, field operations have concluded. The last lysimeter samples were collected and sent to the UMN for analysis. The lysimeters will be removed when the ground has thawed sufficiently. The team convened via zoom in November to discuss the data that has been analyzed thus far. Preliminary data suggests that there is not a significant difference between the scavenging abilities between corn and hemp. The hemp that was remaining at the Central Lakes College Ag and Energy Center will be destroyed.

Activity 1

The newly installed lysimeters at the Ag and Energy Center operated effectively over the course of the 2024 growing season. The samples collected were sent to the UMN for analysis in January. Even though only of year of samples were successfully collected at the Ag Center, the samples will still be used to compare against the samples at the other farm locations plots. The hemp plot at the Ag Center was not harvested. Instead, it will be destroyed in the spring as there was no use for it, other than that of data collection.

Activity 2

AURI's technical, commercialization, and outreach efforts began to move toward completion over the past six months. Final reports outlining technical findings and supply chain developments are being prepared for delivery at the end of the project. AURI technical staff completed lab testing of hemp and corn biomass samples from project test plots, and results were shared with project partners. In January, AURI worked with partners from Minnesota and North Dakota to host the Northland Industrial Hemp Summit. The event featured industry experts and researchers from the U.S., Canada, and Europe, and shared information about market opportunities and innovation in the industrial hemp industry. In March, Pioneer Public Television's "Prairie Sportsman" program included a segment on AURI's LCCMR-supported efforts to develop new uses and markets for industrial hemp in Minnesota. In addition to this outreach, AURI commercialization staff continued to meet with industrial hemp stakeholders in Minnesota and beyond to offer support and explore opportunities for expansion of the industry in the state.

Activity 3

In November of 2024, the team gathered via zoom to share individual project updates and to discuss the project as a whole. At that time, we covered the lysimeter sample results from 2023. The data indicated that there was not a significant difference between the nitrogen scavenging abilities between corn and hemp. 2024 Lysimeter samples are in the process of being analyzed. Once analyzed, we will know whether or not the trend continues.

Dissemination

Operations have been relatively quiet over the winter season. CLC hosted an Ag advisory meeting in March with local farmers, industry leaders, and staff members. The Hemp LCCMR project was discussed when we covered the research component of the agenda. A complete report will go into the Ag and Energy Centers 2025 Annual Report when the project is finalized. This report is handed out to 200+ people over the course of the year.

Status Update Reporting

Status Update October 1, 2024

Date Submitted: October 21, 2024

Date Approved: November 26, 2024

Overall Update

Since the last update, we haven't held any Zoom or in-person meetings. However, project collaboration has continued to be successful, with team members effectively communicating via email whenever questions arise. The growing season has been successful and is now coming to a close. The corn and soybeans have been harvested from the plots, with only the hemp remaining. The hemp has passed testing and is fit for commerce. We are still in the process of deciding where it will go once harvested.

Activity 1

As mentioned in our previous update, the growing season began on May 14th with the planting of corn, followed by hemp a few weeks later on June 17th. This season has been notably different from last year, as we did not face drought conditions until September. Although our plots are located on an irrigated field at the Ag and Energy Center, we benefited from ample rainfall, reducing the need for additional watering. This spring, we also installed eight new lysimeters—four in the hemp and four in the corn plots. We're pleased to report that these new lysimeters effectively collected samples, enhancing our research efforts.

Activity 2

Over the past several months, AURI's commercialization and technical teams actively supported various private sector companies looking to establish or expand hemp fiber processing facilities and develop products from Minnesota-grown hemp. AURI collaborated closely with the MDA, DEED, utilities, equipment vendors, and regional economic developers to aid in regulatory efforts and business planning for these companies. Each company is exploring diverse opportunities to create value-added products from hemp, including construction materials, insulation, animal bedding, renewable fuels, and food-grade oils and proteins. While some projects are still in early development stages, others have advanced to financial due diligence, product development and testing, and the grand opening of fiber facilities. AURI team members also engaged with stakeholders at various events, hosting a field day with industry partners in September, and participating in events including a plant protein short course, a sustainable aviation fuel conference, and meetings with regional hemp associations and the USDA to share information, discuss market opportunities, and explore potential collaborations for research and market development. AURI is also gathering and organizing data about the economics of on-farm hemp production, to be included in the final project report.

Activity 3

We're in the process of planning a team meeting for mid-November. During this meeting, we'll share individual project updates for reporting purposes and discuss the project as a whole to reflect on what we've learned so far.

Dissemination

Central Lakes College Ag and Energy Center proudly hosted its annual Field Day on August 30th, attracting over 250 attendees. During the lunch program, highlights of the LCCMR hemp project were shared. Additionally, this project has been featured in several farm tours conducted at the Ag Center, showcasing its significance within the agricultural community.

Status Update Reporting

Status Update April 1, 2024

Date Submitted: July 29, 2024

Date Approved: August 6, 2024

Overall Update

The commencement of the 2024 growing season marks the initiation of project collaboration efforts. Originally slated for a planning meeting in March, inclement weather forced its cancellation. Despite subsequent attempts, a rescheduled meeting involving all relevant parties has yet to occur. However, Central Lakes College (CLC) managed to convene with the University of Minnesota (UMN) in May to delineate respective roles and responsibilities.

In this regard, UMN has relinquished its weed suppression duties, necessitating CLC to assume this task. Furthermore, operational issues with the lysimeters at the CLC site during the 2023 growing season remain unresolved, attributed either to installation errors or to the drought like conditions in 2023. To mitigate this setback, Ryan Perish from the Minnesota Department of Agriculture (MDA) has graciously offered to provide the project with eight new lysimeters. Despite these challenges, the collaborative endeavor has thus far yielded positive outcomes.

With the addition of these new lysimeters and concentrated weed suppression, we are confident we can bring additional value to the project, related outcomes, and crop management recommendations. The lysimeters are working for sampling and moisture availability is greatly increase this growing season to enhance project success.

Activity 1

The 2024 growing season for CLC kicked off on May 14th with the planting of corn in our designated plots, marking the start of agricultural activities. Hemp seeds have been received and are set for planting in the next few weeks.

In line with our commitment to thorough data collection, we're planning to install eight new lysimeters at the CLC site. This move aims to ensure comprehensive data capture during the final phase of the project's growing season.

Activity 2

Over the past several months, AURI's commercialization and technical teams have continued to provide information and assistance to several private sector companies exploring establishing or expanding hemp processing facilities and developing products from Minnesota-grown hemp. These companies, which include firms from Europe, Minnesota, and surrounding states, are examining and pursuing a variety of opportunities to produce value-added products from hemp, including construction materials, insulation, animal bedding, and food-grade oils and proteins. While some of their projects are still in the early in the development process, others have proceeded to later stages, including financial due diligence, product development and testing, and fiber facility construction. AURI team members have also met with stakeholders from regional hemp associations and the USDA to share information, discuss market opportunities, and identify potential opportunities for collaboration, research, and market development.

To date, for economics portion of the project, we have collected but have not collated any data around on-farm viability of this rotation. We will compile data to demonstrated economic viability as we complete year 3 of project.

Activity 3

A planning meeting originally set for March 26th had to be postponed due to unfavorable weather conditions. Despite efforts, the meeting remains unscheduled due to the busy schedules typical of the spring season. However, we are optimistic about rescheduling it by the end of June.

The purpose of the meeting was to review progress and share initial outcomes of our collaborative efforts in hemp cultivation. Despite the setback, Central Lakes College (CLC) and the University of Minnesota (UMN) managed to convene via Zoom to discuss responsibilities before the commencement of planting of corn on May 14th.

Dissemination:

Annually, the Central Lakes College Ag and Energy Center assembles a comprehensive report including farm activities and ongoing research endeavors. The 2023 edition features a section highlighting the progress of the project. This report is disseminated to an audience of over 200 individuals, ensuring widespread dissemination of our agricultural initiatives and findings.

Moreover, the project will garner further exposure at upcoming farm events, where it will be covered.

Dissemination

The largest outreach event during this quarter was the publishing of the Annual Ag & Energy report. We highlighted our work around fiber hemp related to this project. Additionally, we print 200 copies of this report and distribute to our industry and legislative partners. The report can be found here: <https://clcagandenergy.org/wp-content/uploads/2024/04/Annual-report-2023-agcenter-2.pdf>

We were forced to cancel our advisory meeting for the research center in March due to a snow event and that was not rescheduled.

Status Update Reporting

Status Update October 1, 2023

Date Submitted: October 9, 2023

Date Approved: January 3, 2024

Overall Update

Overall project collaboration for the 2023 growing season was a success. With the roles and responsibilities laid out in a previous meeting in the spring, teams were able to hit the ground running. Plots were planted, lysimeters were installed, and samples were collected in a satisfactory manner. Some troubleshooting was required periodically, but thanks to good collaboration, the troubleshooting was accomplished successfully. A meeting will take place later in the fall to discuss outcomes and results from the 2023 growing season.

Activity 1

Suction lysimeters were installed with the porous cup at a soil depth of 4' in nitrate study field plots at Central Lakes College (CLC), West Central Research and Outreach Center in Morris (WCROC) and Southwest Research and Outreach Center in Lamberton (SWROC). Multiple soil samples were drawn from each of the 16 plots at each location. Corn and industrial hemp were planted in these plots and the resulting stands were satisfactory. Weed pressure was low at WCROC and SWROC, higher at CLC. Water collected by the suction lysimeters was sampled several times during the growing season. Approximately half of the lysimeters in the fields yielded samples while others remained dry. Efforts are ongoing to determine whether the lysimeters require repair or whether the spring and early summer drought and resulting dry soils were the reason for absence of samples. Samples will be assessed for nitrate concentration following the end of the growing season.

Activity 2

The Agricultural Utilization Research Institute's (AURI) technical team pursued several areas of research and analysis over the past six months. Work included assessment of hemp fiber for use in erosion control and textile applications. AURI's business development team is working with economic development commission leaders in the Willmar region to potentially site a new hemp fiber plant. The effort resulted in a company (DunAgro) from the Netherlands initiating a hemp field trial for hemp fiber yields and harvest demonstrations. AURI is identifying markets and working with local farmers for acres, harvest equipment and infrastructure. The Minnesota Department of Agriculture met with DunAgro officials and regional collaborators several times in support of the project. The potential investment in this project could exceed 30 million USD. Additionally, AURI is working with Prairie PROducers in Renville County on its hemp fiber processing center, capable of producing high grade hemp hurd and specific fibers for proprietary markets. AURI is also working with the company on specific technical and business-related activities that may expand hemp production in the region and develop products for the construction trade

Activity 3

The growing season at the Central Lake College Ag and Energy Center began on June 7th, when the hemp was planted. Lack of rainfall and irrigation started the season off very slowly, however, Once the new irrigation system was in place the corn and hemp greatly improved. The lysimeter samples at the Ag center did not collect any samples this season. The reason for this is not yet known. The weed pressure in the corn plots proved to be quite strong. The competition for water and nutrients will more than likely affect the corn yield, which will be determined in October during harvest. The hemp has undergone sampling to determine if it is safe to harvest. Once determined, the hemp will be mowed and baled, provided it passes testing.

Dissemination

The Michaels lab participated in a Sustainability Opportunities for Agricultural Research (SOAR) summer undergraduate

intern program and mentored one of the approximately 10 undergraduate students from across the country who participated in the program. The student assigned to the Michaels lab was mentored by Cassie Kaplan, a MS candidate whose thesis research focuses on the LCCMR nitrate study. All of the students in the program attended a field day at the St. Paul industrial hemp breeding nursery where Colin Jones, a researcher and plant breeder working in the Michaels lab, described the LCCMR project in general terms and the nitrate study, lysimeter construction and operation in specific terms.

Tom Michaels and Cassie Kaplan participated in the Central Lakes College field day on August 25 and took a wagon load of attendees to the field where the LCCMR study was described, hemp morphology, physiology and agronomy were explained, issues associated with nitrate in groundwater and surface water were presented and lysimeters were demonstrated. Attendees joined Tom and Cassie in a hemp field so that they could see, feel and smell the characteristics of industrial hemp plants that Tom and Cassie had described.

Status Update Reporting

Status Update April 1, 2023

Date Submitted: April 12, 2023

Date Approved: May 3, 2023

Overall Update

Overall project collaboration continues to be a success. Over the past six months, several meetings took place to prepare for the 2023 growing season. Each collaborating entity has a clear understanding of their roles and responsibilities within the project for the 2023 growing season.

Activity 1

Because corn only was planted in the 2022 nitrogen use experimental plots per the year 1 objective of standardizing field conditions, we did not collect nitrogen nor crop yield data. Assembled lysimeters are ready for installation at all sites prior to 2023 planting. With staff at CLC-Staples, UMN coordinated project-wide lysimeter installation and sampling plans. Hemp planting seed for use in 2023 is secured for pick up in mid-April from Breckenridge, MN for distribution to the project field sites.

The 1-acre planting of hemp at CLC-Staples exhibited poor germination, low establishment, and heavy weed pressure from foxtail grass and lamb's quarters. A hail event in July 2022 damaged and bent the tender hemp stems, further hindering the capacity of the crop to form a closed canopy. Subsequently, the crop did not attain the expected height but remained more or less at the height of the surrounding weeds. Harvest samples collected in September 2022 will be used to estimate stand density and yield as a baseline of crop failure for comparison with the relative success of the hemp plot at SWROC Lamberton. Hemp-soybean-corn rotation harvest data from 2022 (year 1) at CLC-Staples and SWROC-Lamberton have yet to be analyzed.

Activity 2

The Agricultural Utilization Research Institute's (AURI) technical team pursued several areas of research and analysis over the past six months. Work included assessment of hemp fiber for use in textile applications and analysis of corn and soy samples grown as part of the project's hemp rotation trials to assess nutritional quality. AURI technical staff also collaborated with University of Minnesota researchers to support research examining hemp protein concentrates for use in food and feed products.

The AURI business development team met with multiple private sector companies and other key stakeholders over the past six months to identify and support new opportunities for hemp processing and product development in Minnesota. Several potential opportunities for expansion and development of the hemp supply chain in Minnesota are currently under assessment by AURI staff in collaboration with industry stakeholders. AURI researchers were also able to connect with senior technical staff at a major apparel manufacturer to discuss potential use of hemp fiber in their products.

Activity 3

On February 17th, Hannah Swartzentruber and Noah Boelter from Central Lakes College, traveled to the University of Minnesota to meet with Thomas Michaels and grad student Cassandra Kaplan. At this meeting the plan for the 2023 growing season was discussed. The primary point of conversation was on establishing a protocol for building, installing, and collecting samples from lysimeters.

The Central Lakes College team has prepared a protocol for the 2023 growing season. This protocol includes project tasks for which Central Lakes College is responsible in carrying out. The team has a clear understanding of the responsibilities included in the protocol and is ready for the 2023 growing season to begin.

Dissemination

Professor Michaels informed students in four of his classes (in Fall 2022: HORT 6101 Introduction to the Masters of

Professional Studies, HORT 5114 Knowing and Naming the Plants we Eat; Spring 2023: HORT 5114 again and FDSY 2101 Plant Production Systems) about the purpose and design of the nitrate leaching experiment. Michaels also gave a greenhouse tour to about 40 MN Department of Agriculture staff on Feb 1, 2023 where he spoke about the purpose and design of the project.

Status Update Reporting

Status Update October 1, 2022

Date Submitted: October 17, 2022

Date Approved: October 19, 2022

Overall Update

Overall progress continues to be on track for 2022. Meetings in the spring gave direction to field planning and preparation. During the growing season, if questions arose, collaborators responded in a timely manner with clear directions. Team cohesiveness continues to strengthen as time progresses.

The Waconia site is not a part of the project for 2022. The site had originally committed to the project and involved a private land site but had a change of operations for 2022. We are reviewing the possibilities for 2023. The scope and outcomes of the project is not affected due to the loss of this site. Please reach out if I should file an amendment for review by LCCMR.

Activity 1

Nitrogen movement study: Permanent (throughout the duration of the study) plot locations were identified at Central Lakes College (Staples), WCROC (Morris) and SWROC (Lamberton) in Spring 2022. Corn was grown on all plots during the 2022 growing season. Delays in reaching a subaward agreement between the UMN Sponsored Project office and CLC prevented purchase of supplies & materials until after July 5th. Parts for suction lysimeters, used to collect soil water, have been ordered and the lysimeters are under construction with installation under the plots planned for fall 2022 or spring 2023.

Corn - soy - hemp rotation study: Permanent (throughout the duration of the study) plot locations were identified at CLC and SWROC in Spring 2022. Adjacent plots of corn, soybean and hemp were grown during the 2022 growing season. Performance data will be collected in fall 2022. Hemp plots grown at SWROC and CLC were sample harvested during September 2022 and material was transported to University of Minnesota estimation of yield (fiber & grain), genetic testing, and biochemical analysis during late Fall 2022 and Winter 2023. Corn and soybean crops will be harvested by respective field station staff for yield estimates and grain samples retained for biochemical analysis.

Activity 2

AURI has begun to ramp up its business development and outreach efforts focused on industrial hemp in Minnesota over the last six months. The AURI technical team is coordinating with project partners to provide hemp fiber to AURI's Waseca laboratory for decortication tests. AURI scientists will perform compositional analysis on the decorticated fiber to determine technical properties and guide future product and process development activities. Our technical and business development teams have also been meeting with businesses and key stakeholders to discuss value-added applications for Minnesota-grown industrial hemp and explore potential market development opportunities. On July 26, AURI hosted a "Fields of Innovation" field day in Olivia, MN with stakeholders from across the hemp supply chain to discuss current and future applications and opportunities for Minnesota's hemp industry. AURI staff also participated in the Central Lakes College Field Day in Staples, MN on August 26th, 2022 where they discussed the project and value-added uses for industrial hemp with stakeholders and partners.

Activity 3

CLC (Staples): The corn-soy-hemp rotation study was highlighted during the Central Lakes College Ag and Energy Research Center annual Field Day event on August 26, 2022. Wenger and Weiblen spoke to attendees about the rotation study objectives and timeline, and showed the audience key botanical and agronomic characteristics of industrial hemp.
SWROC (Lamberton): The corn-soy-hemp rotation study was highlighted during a field tour hosted by SWROC on

September 14, 2022. Wenger and Michaels spoke to attendees about the rotation study objectives and timeline, and showed the audience key botanical and agronomic characteristics of industrial hemp.

Dissemination

On July 26, The Agricultural Utilization Research Institute (AURI) hosted, Exploring Food and fiber market opportunities for Minnesota's hemp supply chain, In Olivia MN. Participants were able to see how industrial hemp fiber is produced.

On August 26th Central Lakes College hosted an annual field day. One of the main rotations for the day focused on the LCCMR hemp plot. Jp Wenger from the University of Minnesota presented on hemp and the project.

Status Update Reporting

Status Update April 1, 2022

Date Submitted: May 31, 2022

Date Approved: June 10, 2022

Overall Update

Overall project progress is going well. We have had several planning meetings and the team is building cohesiveness. We have had some delays in contract approval simply due to the need for thorough review with each entity involved. We are set to operate for the crop season in 2022 with expectations that sub-contracts will finish in the coming days.

Activity 1

We have developed plot designs to function at three sites – CLC-Staples, ROCs at Morris and Lamberton. Planting design and nutrient plans are agreed to by all location managers and U of M researchers. Planning meetings have been held to finalize details for above details and to deploy the instruments for water quality monitoring.

For corn-soybean-hemp rotation, plot design and rotation plan has been finalized with teams with plots being deployed at CLC-Staples and Lamberton ROC. The Morris location will be only a water quality and nitrogen use study, not a crop rotation plot site. The yield measurements will serve as white mold indicator, aside from observed white mold infestation. This will provide outcomes of the crop rotation portion of the project of incorporating hemp into corn and soybean rotations. “Normal” nutrient plans for region will be followed.

Seed source has been identified and will arrive prior to June 1 planting. We have agreed to use the variety Anka in all plots.

Contracts for U of M are in review phase with U of M staff. Researchers have agreed to language within the contract, waiting on fiscal approval from U of M to finalize. No expenditures incurred.

Activity 2

We have met to get initial plans in place and contract. Currently, AURI is reviewing contract draft with senior staff. We have made plans for fall harvest of large rounds/squares of hemp and discussed retting preferences. Baled hemp will come from CLC-Staples, Lamberton and Morris ROCs. Additionally, we will be working to streamline our Anka variety hemp with other AURI projects to allow them research on fiber integrity.

Due to the nature of our work thus far is in the planning stages only, we have no expenditures to report this portion of the project.

Activity 3

To date, no activity has been completed in this area except to start setting dates for outreach events. Central Lakes College Ag & Energy Center will host their annual field day on Friday, August 26th. Our partners are working to get their events set on the calendar to coordinate messaging and education objectives around fiber hemp.

Dissemination

To date we have had nothing to disseminate. We do have plans for this and they are in the works to happen as the years unfold.