2019 Project Abstract
For the Period Ending June 30, 2024

PROJECT TITLE: Farm-Ready Cover Crops for Protecting Water Quality
PROJECT MANAGER: Keith Olander
AFFILIATION: Central Lakes College – Ag & Energy Center
MAILING ADDRESS: 1830 Airport Road
CITY/STATE/ZIP: Staples, MN 56479
PHONE: 218-894-5163
E-MAIL: keith.olander@clcmn.edu
WEBSITE: clcmn.edu/ag-energy-center/
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2019, First Special Session, Chp.4, Art. 2, Sec. 2, Subd.04l

APPROPRIATION AMOUNT: $ 741,000
AMOUNT SPENT: $ 741,000
AMOUNT REMAINING: $ 0

Sound bite of Project Outcomes and Results (50 words or less)

By integrating Kura Clover and Camelina into row crop production we were able to supply producers with data about crop production and water quality impacts to influence adoption. Camelina demonstrates promise when double cropped with soybeans and Kura Clover can be an aggressive nitrogen scavenger and offer opportunities in forage production.

Overall Project Outcome and Results (300 words or less) Abstract

This multi-year project evaluated the effectiveness of incorporating Kura Clover (KC) and Winter Camelina (WC) into corn and soybean rotations to mitigate nitrate contamination in water supplies. Each species provides living cover of the soil during the fallow period of corn-soybean rotations when soils are most vulnerable to erosion and nutrient loss. WC is established in the fall following corn silage or other short season crop (wheat, dry bean). The following spring, regrowth occurs early and soybeans are no-till planted into the living stand of WC. In late June, WC is harvested from the field and the relay-cropped soybeans continue on to harvest maturity. In the KC system, a solid stand is established in spring and allowed to grow one season without competition. The following year, strips are tilled or sprayed when corn or soybeans are to be planted creating a continuous living cover that exists between the commodity crop rows. In 2019, the WC and KC rotations were initiated along with a best management practices (BMP) system at 4 different farm locations around Staples, MN. Yield data and other growth parameters were collected from each component of the described systems. Three lysimeters were installed in each system to collect soil water samples for nitrate analysis. Soil water nitrate was generally reduced in the KC system compared to WC and BMP, particularly in soybean cropping years. Several challenges were encountered including weather, irrigation, and inter-species competition between cover crops and main cash crops. While BMP yields of corn and soybean alone were greater than in the WC and KC system, oil yield, which includes soybean and WC, was greater in the WC system. These findings detail the potential for cover crops to be integrated into crop rotations and be profitable. The total-farm enterprise budget and crop hydrologic models illustrate the tradeoffs between yield, farm economics, and water protection.

Project Results Use and Dissemination (100 word or less)

The LCCMR project's dissemination efforts have evolved over time, adapting to challenges posed by the COVID-19 pandemic. Despite limitations on in-person events, the team has successfully utilized online platforms, articles, reports, and presentations to share valuable information with diverse audiences, contributing to the project's visibility and impact. This comprehensive and adaptable outreach strategy targeted a diverse audience, including farmers, community leaders, industry representatives, and federal/state agencies, with an estimated

reach of over 2,000 people through online engagement and in-person events. Here are two examples of products of our work:

1. *Winter Camelina Supply Chain Development in Minnesota - AURI*
2. *Impact of Cover Crops on Nutrient Mobility for Wellhead Protection Areas*

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

Today's Date: February 18, 2025

FINAL REPORT

Date of Work Plan Approval: June 5, 2019

Project Completion Date: December 31, 2023

PROJECT TITLE: Farm-Ready Cover Crops for Protecting Water Quality

Project Manager: Keith Olander

Organization: Central Lakes College

College/Department/Division: Ag and Energy Center

Mailing Address: 1830 Airport Road

City/State/Zip Code: Staples, MN 56479

Telephone Number: (218)894-5163

Email Address: keith.olander@clcmn.edu

Web Address: clcmn.edu/ag-energy-center/

Location: Central, Metro, Northwest, Southwest, Southeast

Total Project Budget: $741,000

Amount Spent: $ 741,000

Balance: $0

Legal Citation: M.L. 2019, First Special Session, Chp.4, Art. 2, Sec. 2, Subd.04l as extended by M.L. 2022, Chp. 94, Sec. 2, Subd. 19 (c.1) [to June 30, 2023]

Appropriation Language: $741,000 the first year is from the trust fund to the Minnesota State Colleges and Universities System for Central Lakes College to demonstrate conservation benefits of using camelina and Kura clover as continuous living cover with corn-soybean rotations and to develop secondary markets to increase farmer adoption of this practice for protecting water quality in vulnerable wellhead protection areas. This appropriation is subject to Minnesota Statutes, section 116P.10.

M.L. 2022 - Sec. 2. ENVIRONMENT AND NATURAL RESOURCES TRUST FUND; EXTENSIONS. [to June 30, 2023]

I. **PROJECT STATEMENT:**

Protecting water quality and supporting economically viable agriculture is fundamentally important to Minnesota. **We will lead a farm-based effort to adopt Kura clover and winter camelina cover crops into corn-soybean rotations to protect vulnerable wellhead areas from nitrate contamination.** These cover crops *fit within corn-soybean rotations*, distinguishing them from other LCCMR-recommended programs that rely on perennial crops such as Kernza® and alfalfa for wellhead protection. More importantly, our small-plot research shows these cover crops can reduce nitrate leaching by over 70%. Seven working farms across Todd, Otter Tail, Dakota, and Stearns Counties will support a farm-community demonstration and research effort aimed at increasing cover crop adoption statewide including the 100,000+ acres of row crops on highly vulnerable wellheads. Leveraging economic advantages of cover crops will incentivize and drive adoption by farmers. For example, Kura clover can supply a majority of the N demand for corn, reducing or eliminating external N application while building organic matter and protecting soil. Similarly, winter camelina oilseed crops are poised to provide a new annual revenue stream. Despite the benefits of these cover crops for water quality and agriculture, barriers must be overcome to realize economically-driven protection of wellhead areas. We address these barriers in this proposal:

1) Field-scale reduction in nitrate contamination: Determine whether cover crops provide the same or greater nitrate reductions as other currently recognized best management practices at the field scale.
2) Market development: Commercial markets are lacking for camelina but critical to farmer adoption.
3) Education: Outreach programs demonstrating the agronomics and economic/ environmental benefits of continuous living cover to farmers and other land managers need to be expanded for greater adoption across the state.

II. OVERALL PROJECT STATUS UPDATES:

First Update December 1, 2019

Farm-based activities have been initiated to examine the potential to adopt Kura clover and winter Camelina cover crops into corn and soybean rotations to protect at risk areas that provide surface and ground water to public water supplies from contaminants. Our field scale research will examine the effect that these cover crops have on reducing fertilizer runoff, building a better soil, and providing a new income for the agriculture industry. Three cropping systems were established at four locations throughout the growing season by preparing soils and planting crops. Water flow monitor sensors and lysimeters have been installed that provide sampling of nutrients in water and water movement in the soil.

Second Update June 1, 2020

Activities have begun in the second year of research to protect public water supply areas from nitrate contamination. Field scale cover crops were established the previous year in 1.5 A to 2 A “fields” to examine the potential leaching of nitrates in the soybean rotation for 2020. Installation of water flow monitor sensors and lysimeters have started to provide data to the researchers to chart information to examine the potential of cover crops in corn – soybean rotations. With weekly pictures being taken, the Kura and Camelina crops have shown tremendous health and growth in the early part of the season. With little to no snow, the weather has allowed the rotation of soybean planting to begin early.

Third Update December 1, 2020
Throughout the remainder of the year, work continued to be accomplished to evaluate the effectiveness of establishing camelina and Kura clover in corn-soybean cropping rotations. An issue we had overall was the lack of water early in the season. This affected the timing of the camelina harvest, making it later than originally hoped and intended. The camelina did not dry down as anticipated either leading to combining issues during harvest as the rains later in the season caused the camelina to recover and partially regrow. This caused plugging of the combine header and sieve shakers. Another challenge that we had was harvesting the soybeans in the Kura clover plots. The off-farm sites had a few issues with plugging up the cutter bars of the combine as the soybeans were run through the combine. The CLC research farm site had to take a different approach altogether as the soybeans were only three to four inches taller than the Kura clover. The Kura clover was very aggressive as we had tried to stunt its growth with a couple Roundup applications. The plots of soybeans and Kura clover at the farm ended up being cut for forage for a local dairy farmer. This was baled and hauled off the plots in early September. The lack of rain early in the season also affected soybean germination leading to more sparse stands in camelina and Kura plots.

Amendment Request as of December 1, 2020:
LCCMR noted that the appropriation end date and the timeline end date for this project are different. To bring the completion date in-line with other projects and to permit enough time to complete project outcomes, an appropriation extension is requested for a project end date of June 30, 2023. LCCMR staff have indicated this request will be submitted for consideration by the LCCMR and Legislature in 2022.

Amendment pending further LCCMR and legislative action as of 12/23/2020
Updated by LCCMR to indicate this project has been added to a list of projects needing COVID-related extensions awaiting legislative action in 2022 (12/17/2021)
COVID extension granted by the legislature through passage of M.L. 2022, Chp. 94, Sec. 2, Subd. 19

Fourth Update June 1, 2021

2021 brings the start of the third year of research on three different cropping systems, Best Management Practices (BMPs), Double Cropping (DC), and Perennial Cover (PC) and their relation to nitrates in water. Time domain reflectometers (TDRs) and lysimeters continue to provide data for the project's researchers. Data collected from the lysimeters last year has been put into a report, relaying the different trends of nitrate concentrations throughout the different plots and locations. Pictures are taken every ten days at the time of lysimeter sample collection. This year's cash crop is corn and has been planted throughout all of the plots.

Fifth Update December 1, 2021

December brings the closing of the third year of research on three different cropping systems and their relation to nitrates in water. Lysimeter and TDR data collection has been completed for the year, bringing field work to an end. Lysimeter samples were collected every ten days. Plot pictures were also taken at the time of lysimeter collection to track the progress of the plots as well as to give a visual to those associated with the project that were unable to make it to the plots in-person. The data collected will be reported on in the coming months. Despite the drought conditions this year, the corn grew successfully with the help of irrigation. The corn has all been harvested and yields calculated.

Sixth Update June 1, 2022

June 2022 marks the final growing season for the Farm-Ready Cover Crops for Protecting Water Quality project. Soybeans have been planted into Kura clover (PC), Camelina (DC), and conventional (BMP) treatments. Field

work continues to be replicated as in years previous. Lysimeter samples and photos will be collected every 10 days to determine the amounts of nitrogen concentrations in soil pore water throughout the treatments. This data will be used for reports and further dissemination. The plot located at the Ag and Energy Center in Staples is also outfitted with time domain reflectometers (TDRs) which track the movement of water in the soil as well as soil and water temperatures.

Seventh Update December 1, 2022

December 2022 completes the final cropping season for the Farm-Ready Cover Crops for Protecting Water Quality project. Data collection protocols were same as the years previous. The overall growing season was not as extreme as 2021, which experienced heavy drought conditions. During the 2022 growing season, spring started with average rainfall for this area. Late summer and early fall was drier than average, but the crops were not stressed due to water needs being met through adequate irrigation. Data from collaboriting researchers is being compiled and analyzed for the final report.

03/02/2023

Amendment # 1: We are requesting an administrative extension to extend this project from June 30, 2023 to December 31, 2023 to match the timeline of a related grant from the Agriculture Research Service to USDA for research that parallels our work in water quality as it relates to camelina and kura clover within row crop production. The 2023 cropping cycle allows us to bring corn back into the rotation and grow the dataset for the project as well as the ARS project focused on similar outcomes. Because the federal grant can augment our work and outcomes, the extension serves to grow the LCCMR project impact and adoption of practices demonstrated. The graphic under activitiy one demonstrates the rotation so we will replcate the 2021 crop plan as noted below. We expect final work on the plot will end on November 15, 2023. Outcome tables and reporting placeholders have been updated to reflect this extension.

Amendment approved by LCCMR 3/20/2023

Amendment #2: Central Lakes College is the operational partner for the 2023 crop rotation. CLC will not be adding additional staff but will be extending their labor force commitment through the 2023 growing season. To accommodate the payroll and because the USDA has access to additional funds, $56,000 will be moved from USDA to CLC. Additionally, COVID limited farmer participation so we are moving $4500 from “Participating Champion Farmers” to CLC for payroll offset. Finally, COVID also limited partner travel leaving a substantial balance for travel to $10,000 will be moved from travel to CLC staff budget. Finally, we were able to drive efficiency in equipment purchase so we will move $3,000 from equipment budget to CLC staffing for the final growing season of this project. In total we are requesting a re-allocation of $73,500 to CLC staff from above mentioned categories.

Amendment approved by LCCMR 3/20/2023

Amendent # 3: AURI is making a few minor changes within their budget as listed in attached , primarily from internal staffing & supplies to contracted services ($28,000). Aditionally, their scope of work will also include testing use of camelina oil for diesel and aditional feedstuff by-products available for animal palitability. See attached.

Amendment approved by LCCMR 3/20/2023

Final Report, submitted by December 31, 2023

This multi-year project focused on evaluating the effectiveness of incorporating Kura Clover and Winter Camelina into corn and soybean rotations to mitigate nitrate contamination in water supplies and provide additional income for growers. Winter camelina is established as winter cover crop following a soybean production year, as this allows time after harvest for planting and establishment. Winter camelina renews growth in the spring and the seeds can be harvested by mid to late June. Camelina seeds are rich in omega-3 fatty acids, and the oil can be used for numerous industrial and agricultural purposes. Kura clover is a persistent green cover, i.e., perennial, established between crop rows. The Kura clover can be harvested for forage and is set back with strip tillage or herbicide so as not to compete with the commodity crop.

Because these two covers grow outside the traditional grain crop growing season, they can use up excess nitrates in the soil. This use, we call "plant uptake," can prevent nitrate loss to ground water or runoff during times of the year when no other crops are growing. Key project activities include establishing three cropping systems—Best Management Practices (BMP), Relay Cropping (RC) (Camelina), and Perennial Cover (PC) (Kura Clover)—and evaluating harvest yields from each system. There were several challenges, including weather, irrigation, and inter-species competition between cover crops and main cash crops. While BMP yields tend to be greater than the RC and PC system in this project, the enterprise budget detailing the economic benefits of cover crops and crop-hydrologic models illustrates the tradeoffs between yield, farm economics, and water protection. Finally, analysis and application development of winter camelina seed meal and oil in the feed, food, biofuel, and bioproduct industries took place over the entire course of the project.

Amendment request submitted 2/14/25

- Add $2560 to personnel due to labor exceeding budget
- Add $8860 to contract with University of Minnesota (Act 1) due to labor exceeding budget
- Reduce by $10,419 contract with AURI due to contractor being under budget and funds being needed for personnel and contract to UMN
- Reduce by $1026 travel due to less travel than budgeted and funds being needed for personnel and contract to UMN

Amendment approved by LCCMR 2/18/25

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1 Title: Field-scale test of water quality protection from cover crops in corn-soybean rotations

Description: Over 70% of the nitrate contamination in Minnesota waters originates from farm runoff and leaching. On each of four sites on the Ag and Energy Center, a working farm in southern Wadena County, we will establish field-scale research plots (ca. 2 acres each) comparing nitrate reductions from: 1) perennial Kura clover groundcover in corn-soybean rotation, 2) fall-seeded, spring harvested winter camelina oilseed in corn-soybean rotation, and 3) conventional corn-soybean rotation with best N management (Figure 1). This design will result in a total of 24 experimental acres comparing cover crops to current best management practices for N management. Plots will be established along topographic gradients to test how effectively cover crops limit the surface and subsurface movement of nitrate. Agronomics (e.g. yields, N and fuel inputs) will be measured to compare economic costs and returns from conventional practices and cover crops. Using hydrologic field data, we will

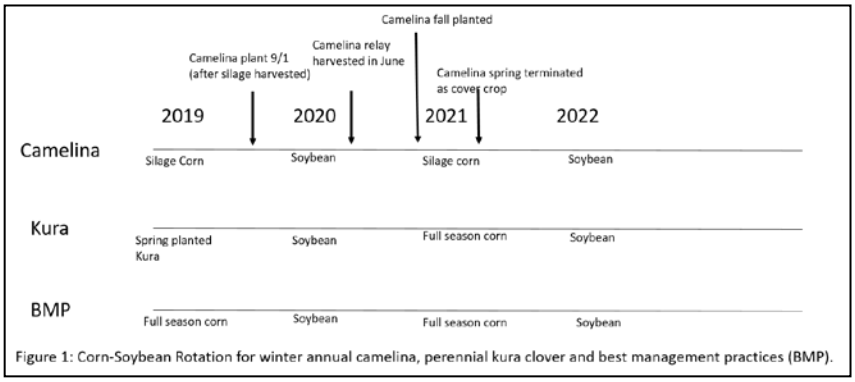


Figure 1: Corn-Soybean Rotation for winter annual camelina, perennial kura clover and best management practices (BMP).

build crop-hydrological models illustrating tradeoffs between yield, farm economics, and nitrate contamination to inform agricultural policy on water protection.

To monitor N subsurface movement, lysimeters will be established at a depth of 60 cm for 6 locations along a topographic gradient within each plot and sampled for water nitrate concentration every 1-3 weeks from April through October, sampling more frequently in the spring when most of the nitrogen escapes from farm fields. Nitrate moves with water, hence tracking water movement is critical to understanding nitrate subsurface losses. We will install time domain reflectometry (TDR) sensors at 4 soil depths for 2 locations within each plot to monitor daily changes in water flux. We will also track changes in soil carbon and nutrients by measuring total soil C and N as well as inorganic N and P at 2 depths twice each year. To monitor surface (overland) flow of N and P, we will install a weir near the bottom of the topographic gradient of each plot. Our experimental and sampling design will allow us to test how effectively cover crops prevent N losses across farm fields by integrating the complex interactions among surface and subsurface movement of N. For example, cover crops may limit surface movement of N (runoff) to depressional areas that would otherwise experience greater subsurface N movement (leaching) from upland runoff. A better understanding of how cover crops can mitigate N movement across such complex field scale dynamics is critical to determining the landscape level efficacy of cover crops in mitigating surface and ground water N contamination. To accomplish this, we will use our field data to build crop-hydrologic models that will predict the effectiveness of these conservation plantings for similar soils and landscapes in Minnesota.

To increase cover crop adoption by farmers in Minnesota, we will also demonstrate their implementation and agronomic benefits. Small-scale plot research is underway to refine best agronomic practices. We will scale-up these practices to test their implementation with farm scale equipment (e.g. 16 row planters) and quantify the agronomic inputs and outputs to build an enterprise budget detailing the economic components of each production system.

ACTIVITY 1 ENRTF BUDGET: $511,000

Outcome	Completion Date
1. Field-scale test efficacy of cover crops to mitigate nitrate, phosphorus and sediment contamination	*October 1, 2022*
2. Enterprise budget showing farmers how to maximize economic benefits of cover crops	*October 1, 2022*
3. Crop-hydrologic model illuminating guidance for mitigating nitrate pollution from corn-soybean rotation	*December 1, 2023*

First Update December 1, 2019

At the Ag and Energy center, a farm in southern Wadena County, we have installed TDRs (time domain reflectometry) to measure the movement of water though soils and soil moisture. We have also installed lysimeters. With these instruments in place we will be able to compare differences in nutrients found in water from the Kura Clover groundcover in corn-soybean rotation, fall seeded, spring harvested winter Camelina in corn-soybean rotation, and corn-soybean rotation in best management practices. We will begin sampling for water nitrates starting in April and continuing through October or as weather allows. We also hope to install soil run off collectors to monitor the movement of soil, nutrients, and water in horizontal overland flow and better understand how cover crops influence this movement.

Second Update June 1, 2020

The spring began by taking soil samples from all plots to have baseline samples for the growing season. In the fields we have installed an additional moisture sensor (TDRs) at a different depth to give a better picture of

water movement through the soil. These sensors are attached to a logger to provide ground water data in the surrounding soil. The information will be downloaded weekly to watch for moisture trends throughout the year. Approximately every 10 days, since the end of April, water samples have been taken from the lysimeters in all the plots. They are sent to the lab and processed for nitrates as spring is when most of the nitrogen escapes from farm fields.

Third Update December 1, 2020

Throughout the remainder of the 2020 growing season, data continued to be collected as well as harvest data from all plots both on the CLC research farm site and off-site plots in collaboration with local farmers. The following data collection was accomplished on all the plots. Lysimeter samples were taken every ten days and shipped to the USDA in Morris, MN. Bi-weekly pictures continued to be collected and posted to the team Google Drive. Water infiltration samples were conducted by the team from the USDA located in Morris, MN mid-growing season. The camelina plots were all harvested by the University of Minnesota at the end of June using an Almaco plot combine. The soybeans were harvested from all plots at the beginning of October using a field scale combine. The University of Minnesota also collected biomass samples of each of the plots throughout the season. Soil samples were taken from all of the plots in the spring and in the fall to be evaluated for N, P, K, and soil organic matter. At the CLC research farm site, there was additional data collected. Data logger information was downloaded and posted to the Google Team Drive every ten days. The data loggers are connected to the TDR moisture sensors measuring water flow through the soil. Another water infiltration test was conducted in October as well. Overland water flow collectors were not established as water infiltration tests took their place in collecting data for the modeling.

Fourth Update June 1, 2021

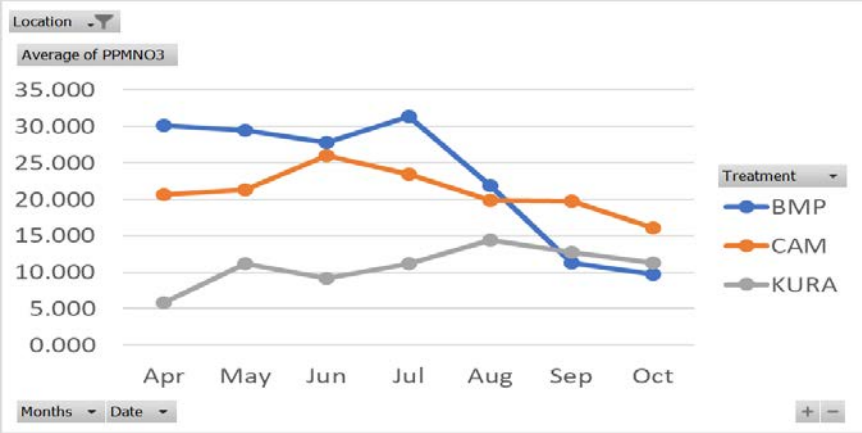
As with last spring, soil samples were taken on April 21st at the AG and Energy Center's plots to provide a baseline for the upcoming growing season. The USDA was tasked with taking samples on the off-site locations. These samples were unable to be taken until mid-May, which was after planting and fertilizing.

This spring lysimeter and TDR lines were buried before planting occurred for ease of planting. Last spring soybeans were not tilled into the ground, and when the planter came upon instrumentation, the planter was lifted up over the instrumentation as to not cause damage. CLC's team went in after the planter and manually planted soybeans in the areas the planter was lifted. This method proved to be not as concise when compared to what a farmer typically does in the field as germination was not as successful with this method. The new method of planting directly over the instrumentation as a result of burying the lysimeter and TDR lines results in corn growing directly around the instrumentation and being planted by field equipment versus hand planting. The TDR and lysimeter lines were then unburied and re-installed after planting this spring.

Before planting occurred, camelina and BMP plots were tilled following typical farmer practices in the area in preparation of planting, and the Kura clover plots were strip-tilled. Pictures and videos of this process were taken and uploaded to the google team drive. Lysimeter sample collection began in late April of 2021.

Before strip tilling occurred on the Kura clover plots, biomass samples were taken, per direction of the University of Minnesota. For sampling, a quarter of a square meter is randomly placed in the plot in three different locations, and the Kura is cut down to ground level and bagged. The samples are then put into a dryer to dry out the sample for further calculations of yield. This spring, Zastrow's plot yielded 748.5 lbs/acre, Katterhagen's yielded 392.3 lbs/acre, and The AG Center yielded 282.3 lbs/acre.
Tuinstra's Kura clover plot was not sampled, as it was accidentally chisel plowed this past fall, due to unforeseen circumstances. Despite being chisel plowed, the Kura clover is reestablishing. The team at CLC also went in this spring and hand broadcasted seed to help reestablish the clover, especially around instrumentation.

Data from last year's lysimeter samples have been compiled. Overall, nitrate concentrations varied throughout the growing season. Greater concentrations of nitrates occurred within the Camelina and BMP treatments early on in the season and then decreased as soybeans reached maturity. Nitrate concentrations under the Kura treatment remained at a low level throughout the growing season. Averaged over the entire assessment period, soil water nitrate content was 22mg/L in BMP, 21 mg/L in Camelina and 11mg/L in Kura. Trade-off for camelina and Kura plots was a loss in soybean yield.



Data collected from the Ag and Energy site was as follows. The BMP cropping system yielded 52 bu/A. The DC system yielded 33 bu/A plus the camelina yield ranging from 450-650 lbs./A. The camelina yields were lower than expected as compared to prior experience of the U of M growing the crop on heavier, finer soils. The goal was to harvest the soybeans as grain in the PC system, and after three applications of glyphosate applied at 1 qt/A, the decision was made to harvest the PC systems as forage. The PC system presented a challenge for harvest as the Kura clover was green and four inches shorter than the soybeans in overall height. Total yield was 14,000 lbs. at 67 percent moisture equivalent to 1.17 tons/A. Forage quality tests were completed, and relative feed value averaged 154 and crude protein averaged 20.1. Data collected from the off-site farms was as follows. Katterhagen's soybean yield was 65 bu/A across all three cropping systems. Zastrow's soybean yield was 35 bu/A in the PC system, 22 bu/A in the DC system, and 55 bu/A in the BMP system. Tuinstra's soybean yield was 16 bu/A in the PC system, 10 bu/A in the DC system, and 56 bu/A in the BMP system.

Fifth Update December 1, 2021

As the growing season of 2021 progressed, data continued to be collected on a regular basis. The following data collection was accomplished on all of the plots. Every ten days lysimeter samples and plot pictures were collected. The Lysimeter samples were sent to USDA in Morris, MN where they are analyzed for nitrate and phosphate concentrations. The plot pictures were all uploaded to the google team drive for analyzation. Water infiltration samples were conducted by the team from the USDA located in Morris, MN three times throughout the growing season- spring, summer, and fall. The corn in the DC cropping system was harvested late summer as silage in preparation of planting winter camelina. After chopping, Silage samples were collected and sent to DHIA laboratories in Sauk Centre, MN for forage quality reports. The plots were then assessed and sprayed with glyphosate to suppress weeds. The camelina was planted at a rate of seven pounds per acre. On the farms in Long Prairie and Staples the corn in the DC system was also taken as silage as there was insufficient grain.
The CLC research farm site collected the biomass samples of the Kura clover this year. The biomass samples were sent to the team at the University of Minnesota for analyzation. Soil samples were taken from all of the plots in the fall to be evaluated for N, P, K, and soil organic matter. The final piece of data collected was from the data loggers. The data loggers were un-installed in November, and the data collected was downloaded and posted to the google team drive.

Drought-like conditions proved to be a challenge this year, especially on the plot located in Long Prairie that is not irrigated. Through the supplementation of irrigation, the other plots were able to make it through relatively unscathed. As the season progressed, the PC system was the shortest corn observed in the treatments. The Kura clover proved to be a competitor throughout the season despite being sprayed three times with glyphosate and strip tilled early spring. An observation by one of the producers was that whenever you have two crops planted together, they are competing against each other for nutrients, water, and sunlight. This was reflected in the yield data that has been compiled for the treatments located at the Ag and Energy Center for the 2021 growing season. It is shown in the table below. The BMP system had an average grain yield of 211 bu/A under irrigation. The DC system had an average silage yield of 18 tons/A. The PC system was 168 bu/A. This is 20.3 percent less than the BMP system. We have one more growing season for data to be collected in 2022.

Treatment	Corn Yield
BMP	211 bu/A
Camelina	18 ton/A
Kura	168 bu/A

Sixth Update June 1, 2022

With a late winter and a wet spring, field work started slower than usual. The lysimeters were charged for sampling May 6, 2022 as opposed to April 21, 2021. Though we are not currently being affected by COVID restrictions, we have been affected by the disruption in the supply and workforce chain. Due to supply issues, we questioned whether or not we would receive the proper machinery in time for planting. Machinery was delivered on time and the Central Lakes College plots were planted on 5/23/2022. Some of the partners in the project have been affected by staffing shortages. Because of this, even though the data has been collected, there has been a delay in compiling reports for dissemination. Throughout the 2022 growing season data will continue to be collected.

Seventh Update December 1, 2022

Data collection happened consistently throughout the remainder of the 2022 growing season. Soil samples were collected in the spring and fall on all sites to analyze soil parameters between the different cropping systems, and Lysimeter samples were collected every ten days. The USDA in Morris retrieved the samples from the Ag and Energy Center in Staples on a consistent basis. After retrieval, the samples were analyzed for nitrate and phosphorus concentrations. Water Data collected in 2022 will be processed and included in the final report. Photos continued to be collected at the time of lysimeter sampling. Several drone flights also took place at the Ag Center plot throughout the year. The photos taken were organized and uploaded to the google team drive for collaborative viewing.

2022's cash crop was soybeans. A wet and cold spring resulted in a later than normal planting. However, the extra moisture was welcome after experiencing drought conditions the previous year. Soybeans were no-tilled into the camelina and Kura plots. Before the Kura plots were planted, they were suppressed with glyphosate in order to decrease competition from the Kura clover at the time of soybean germination. The BMP plot was tilled and planted conventionally according to standard practices in the Staples area. Throughout the year, the Kura plots were suppressed a total of three times with chemical controls. The first two applications that were applied to the Kura were glyphosate applications. The glyphosate applications were unable to suppress the Kura clover perennial cover crop sufficiently. There was still too much competition between the Kura clover and the

soybeans leading to poor soybean germination and growth compared to the other treatments. This led to a third application of Liberty. After the Liberty was applied, it looked like the Kura clover had been terminated. This was not the case as it slowly began to recover during the rest of the growing season and became a green carpet again before the time of harvest.

The Camelina was ready to be harvested early July. Due to poor stand and weed pressure, the camelina was not harvested. The camelina was terminated with an application of Liberty to open up the canopy above the soybeans and allow the soybeans to grow with less competition. This practice was replicated across all three farm locations.

July 12th brought a hailstorm that resulted in about fifty percent defoliation of the soybeans at the Ag Center location. The soybeans recovered, but the yield was affected. This is evident in comparing the yields across all three farm locations.

Late summer brought drought-like conditions. Through the supplementation of irrigation, the two farm sites in Staples were relatively unaffected. The Long Prairie farm location's crops were shorter than the other locations due to the lack of moisture, as this is a dryland site. Even though the Long Prairie site had shorter crops throughout the growing season, this site had the highest BMP yield of all the locations. This is due in part to the nature of the soil at this farm location. Harvest was a success as all treatments were harvested across all three locations. An average yield of all plots and location combined is shown below. BMP consistently outperformed the other treatments across the project. This is due to the Kura and Camelina competing for resources with the soybeans.

Treatment	**Average Bu/a**
BMP	39.2
KURA	23.3
CAM	27.4

Final Report Update Activity I

2021 Corn

The 2021 growing season was a drought year, so many fields were receiving irrigation treatments. At the Ag Center lysimeter samples were collected every 10 days. Average monthly concentrations of nitrates increased during the growing season as the corn crop matured and nitrogen requirements declined. Lower early season soil water N reflects the physiological aspect of early N uptake by corn. Lysimeter data indicates that available N was reduced in the treatments with growing Kura clover and prior year with winter camelina relayed with soybean. The late season peak in October could be due to corn residue and Kura die off. Nitrogen contents displayed in Figure 1 were largely influenced by the lysimeters placed at the edge of the field, where corn growth was reduced. Mid field lysimeter positions did not have significant treatment differences in soil water nitrate content, as shown in Figure 2, and concentrations were low compared to the whole field average, shown in Figure 1. Regardless of treatment, nitrate concentrations past June were all above the 10-ppm drinking water standard.

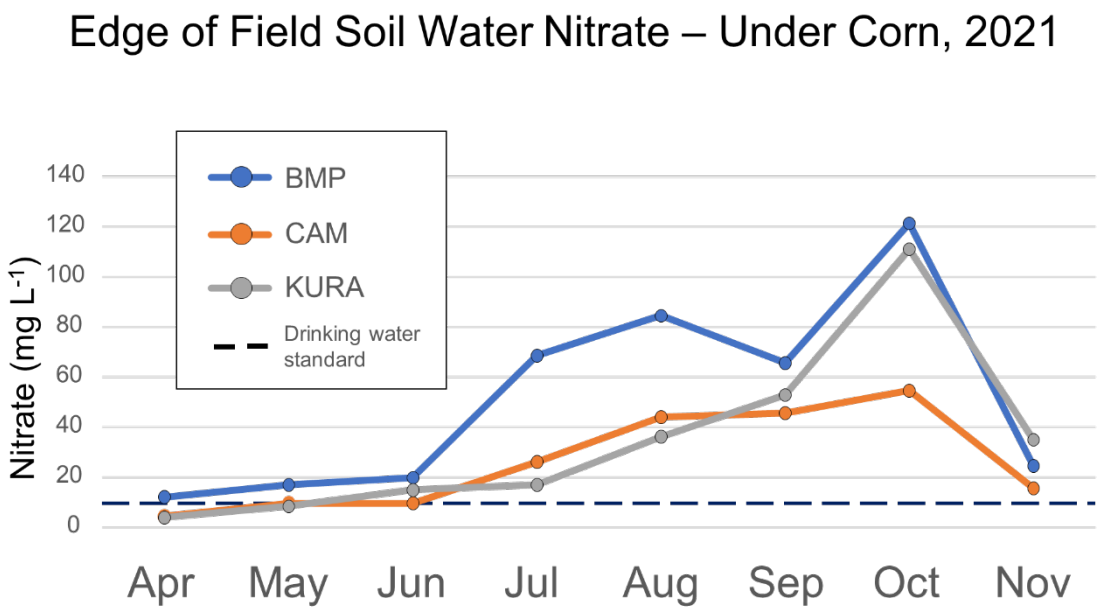


Figure 1. Edge of field soil water nitrate concentrations in mg/L (ppm) under corn for the 2021 growing season. BMP – best management practices, Cam- fall seeded winter camelina, Kura – Kura clover living mulch established in 2020. d.

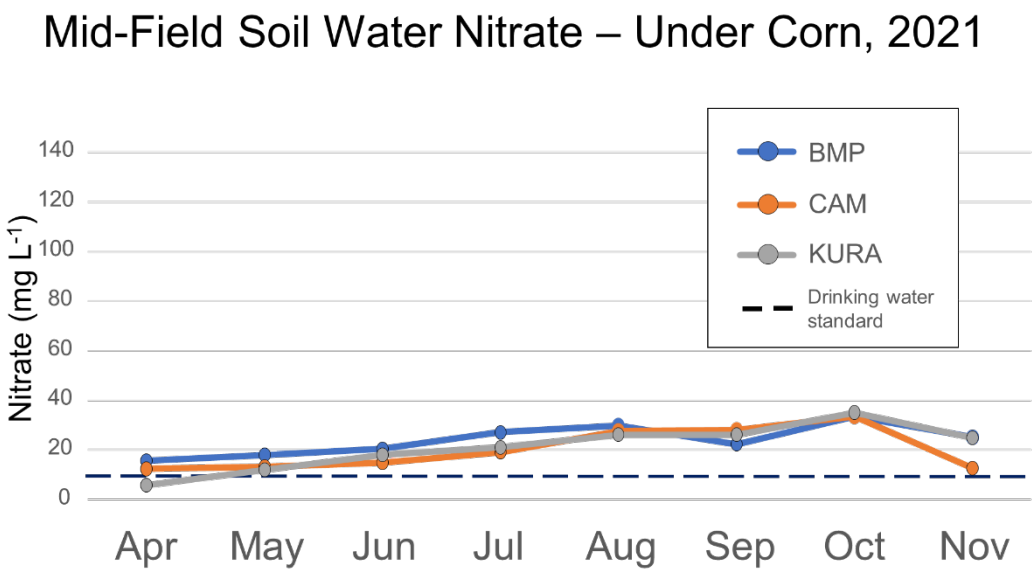


Figure 2. Soil water nitrate in mg/L (ppm) at midfield locations under corn for the 2021 growing season. BMP – best management practices, Cam- fall seeded winter camelina, Kura – Kura clover living mulch established in 2020.

2022 Soybean

The 2022 growing season marked the second rotation of soybean with three treatments of a winter camelina relay crop, a living Kura clover mulch and a best management strategy with soybean only. Unlike the 2021 growing season, 2022 nitrate concentrations did not seem to vary with respect to soybean growth stages. Periodic peaks in nitrate in the winter camelina treatments might be a result of compromised soybean growth. As in 2021, Kura treatments displayed lower nitrate concentrations in soil water than best management or winter camelina. However, concentrations regardless of treatment were still above the drinking water standard.

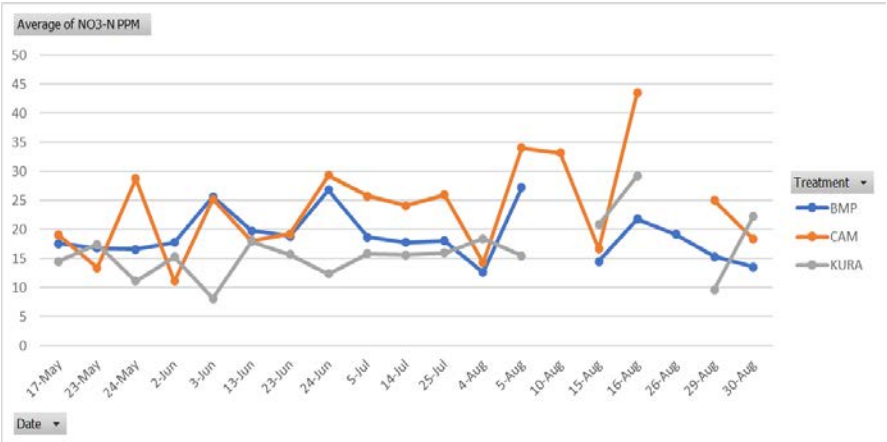


Figure 3. Average soil water nitrate for the 2022 soybean growing season. BMP – best management practices, Cam- fall seeded winter camelina, Kura – Kura clover living mulch established in 2020.

2023 Corn

Activities during the 2023 growing season included lysimeter water sample collections on a 10-day basis. The lysimeter samples are being processed and analyzed. Additionally, to improve interpretations of soil hydrology intact soil cores at three depths (0-2, 6-8 and 10-12 cm) were obtained and are being processed for laboratory analysis of saturated hydraulic conductivity.

Soil hydrologic dynamics 2020-2021

Moisture sensor data, measured as matric potential, have been obtained every growing season from May through October. The more negative the matric potential, the greater the effort crops need to obtain moisture. Data obtained was inconsistent due to issues with sensors, extremely dry conditions, or freezing temperatures. In the 2020 soybean year, early season (May-June) soil moisture content was reduced in Kura living mulch and winter camelina treatments (> -91 kPa). In comparison, soil moisture under BMP did not decline until mid-season (July-Aug), in line with soybean growth parameters. In part, some winter camelina plots continued with low soil moisture, which likely contributed to lower soybean yields. In the 2021 corn season, Kura living mulch treatments had substantially lower early season soil moisture, but due to implementation of irrigation, seemed to regain then maintain soil moisture status after June (Table 1). In comparison, mid field soil moisture was similar between winter camelina and BMP treatments, likely because of the absence of winter camelina, which was not planted the previous fall. However, hydraulic parameters seemed to be influenced more by landscape position, whereby edge of field areas displayed substantial midseason (Jun-Aug) reductions in soil moisture content, more so in BMP than winter camelina.

Table 1. Soil water matric potential (kPa) under corn in 2022 at mid field and edge of field locations. The more negative the number the less moisture is available.

	Kura	Kura	Cam	Cam	BMP	BPM
	Mid field	Edge of field	Mid field	Edge of field	Mid field	Edge of field
May	-197.4	-1044.2	-7.5	-10.4	-18.2	-10.9
Jun	-495.8	-855.0	-7.9	-9.8	-8.6	-12.7
Jul	-20.0	-13.2	-8.3	-19.0	-9.8	-91.5
Aug	-45.1	-34.0	-8.4	-152.5	-10.4	-440.4
Sep	-34.7	-44.9	-8.3	-16.3	-8.8	-16.2
Oct	-11.8	-10.5	-8.0	-8.4	-9.4	-10.0
Nov	-10.1	-10.4	-7.8	-8.4	-10.7	-10.9

Summary:

Activity 1. Field-scale reduction in nitrate contamination: Determine whether cover crops provide the same or greater nitrate reductions as other currently recognized best management practices at the field scale. Results obtained to date indicate early season soil nutrient status during the soybean growing season was reduced in the presence of cover crops and living mulches, which correlated with the reduction of soil water nitrate concentrations. During the corn season the application of fertilizers, which is necessary for sufficient grain yield, overwhelmed the influence of the living mulch (no winter camelina in these years) on soil nutrient status, and treatment differences were due to landscape position where edge of field areas had less crop coverage. Potential nitrate losses were more likely to occur early in the season or in the absence of cover crops or living mulches. The cover crop/living mulches evaluated in this project perform similarly to other winter covers in reducing the potential for nitrate losses.

Soil hydrologic dynamics were evaluated with the use of matric potential water sensors. Moisture sensors indicated that in the soybean year, Kura living mulch and winter camelina reduced early season soil moisture content, which might compromise crop yields, but late season moisture was greater than under BMP. In the corn year, moisture status was influenced more by landscape position than cropping practices, however, moisture conditions were better under Kura clover than either BMP or winter camelina. But even in a drought year with irrigation (2022), moisture content was maintained at a better metric potential in treatments that had or have had living or winter covers. This outcome indicates a continuing need for improved winter cover cropping practices prior to a corn year.

Weyers, S. L., Wells, S. S., Detloff, C., & Olander, K. (2021) Impact of Cover Crops on Nutrient Mobility for Wellhead Protection Areas in Minnesota [Abstract]. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. https://scisoc.confex.com/scisoc/2021am/meetingapp.cgi/Paper/133313

For production summary, Best Management Practices (BMP), Relay Cropping (RC), and Perennial Cover (PC), were evaluated from each system. There were several challenges, including weather (e.g., rainfall), irrigation, and inter-species competition between cover crops and main cash crops. While BMP yields tend to be greater than the RC and PC system in this project, the enterprise budget detailing the economic benefits of cover crops and crop-hydrologic models illustrates the tradeoffs between yield, farm economics, and water protection.

Table 1. Year--Summer Annual Crop Yield

Cropping System	2019 Corn	2020 Soybean	2021 Corn	2022 Soybean
BMP	169 bu ac^{-1}	52 bu ac^{-1}	211 bu ac^{-1}	39.2 bu ac^{-1}
RC	23 ton ac^{-1}	33 bu ac^{-1}	18 ton ac^{-1}	37.4 bu ac^{-1}
Camelina*	--*	533 lbs ac^{-1}*	--*	1002 lbs ac^{-1}*
PC	--	11.7 ton ac^{-1}	168 bu ac^{-1}	23.3 bu ac^{-1}

Enterprise Budget for Double Cropping Camelina and Soybean

- Cost of Camelina seed = ($2.5 per lb * 7.5 lbs/Ac) =
  - **$17.50 / Ac**
- Cost of Fertilizer for Camelina = (50 lbs N/Ac supplied as urea @ $400/ton ($.20/lb * 108 lbs urea to get 50 lbs N)=
  - **$21.60 / Ac**

- Expected Camelina Yields 1000 lbs/Ac @ $0.235 /lb =
    - **$235 / Ac**

I spoke with some folks who have contracts for camelina with farmers this winter to get the $0.235 value. Cargill is handling the shipping so that is the on-farm purchase price of their harvest.

Here is the table that we pulled from the report that shows our observed yields from the projects hosted at the CLC research farm.

In the RC line on soybean years, we have 2 values, top one = relay soybean yield, bottom = camelina yield. Adding the net profit from each could be compared to the BMP soybean in that year.

	Year--Summer Annual Crop			
Cropping System	**2019 Corn**	**2020 Soybean**	**2021 Corn**	**2022 Soybean**
BMP	169 bu/A	52 bu/A	211 bu/A	39.2 bu/A
RC (Camelina Yield)	23 ton/A	33 bu/A (533 lbs/A)	18 ton/A	37.4 bu/A (1002 lbs/A)
PC	--	11.7 ton/A**	168 bu/A	23.3 bu/A

** Soybeans and clover were cut and baled for forage due to growth factors.

Other budget factors: Land cost was $275/acre for this land, common direct costs need to be applied for planting, growing, and harvesting.

ACTIVITY 2 Title: Develop and bring to market new products from camelina to spur producer adoption of cover crops

Description: This activity will establish new and viable supply chains from farm to market for camelina-based food, biofuel, and bioproducts serving as an economic driver to promote farmer adoption of camelina. We will develop a detailed analysis of oil and seed meal composition for camelina to support usage in food, biofuel, bioproduct, and livestock feed industries. The analysis will illuminate which commercial applications are most suitable for camelina oil and seed meal. For example, oilseeds with high content of polyunsaturated fatty acids (e.g. omega-3 fatty acids) are healthy oils for human consumption while oils high in polysaturated fatty acids are high in energy content and better for supporting biodiesel production. Additional oil tests will evaluate stability over time (i.e. shelf life) and at high cooking temperatures to develop practical healthy cooking oils. Our work will also explore the feasibility of biodiesel from camelina oil. We will help facilitate camelina feeding trials on fish, poultry, swine and beef by making information and feed products developed during the project available for use by producers and industry partners.

We will support supply chain development by analyzing the transactions and pathways necessary to move camelina from the point of production to the point of consumption for industrial, feed or food uses. Supply chain analysis will include four parts: 1) determine costs of farm operations and camelina yield; 2) assess costs, rates and options for camelina seed processing (e.g. seed cleaning, pressing, packaging); and 3) evaluate market demand and opportunities as well as 4) identify equipment and infrastructure needs specific to process camelina seed. The analyses will highlight opportunities to strengthen the value chain by aligning required production acreage to support camelina production, market opportunities and gaps in the value chain.

Using the supply chain analysis, we will strategically support the expansion of camelina by engaging external partners and private businesses in developing pilot-scale projects demonstrating the pressing, refinement and marketing of oilseeds. We will engage and network with multiple stakeholders including producers (e.g. sugar beet, soybean, corn and other producers) and private businesses to facilitate relationship-building leading to strong community adoption and integration of production systems. Including processors with compatible extrusion or oil extraction capabilities in these discussions will provide necessary intermediary processing support. Building on the information and connections we develop, we will engage the broader farm and industry communities by presenting commercial application and supply-chain development information to farmers and businesses through events and outreach, including forums as part of the AURI Innovation Network program's new and emerging crops programming, renewable energy roundtables, as well as one-on-one networking and meetings.

Finally, we will present progress on supply chain development by tracking the development of camelina markets: production (e.g. number of farmers adopting camelina, production acres and/or yields), processing facilities established in Minnesota (including their outputs), number of retailers in Minnesota (determine total sales), clients incorporating camelina into product lines and/ or feeding operations. All information will be presented on a state or regional basis to protect proprietary information. We will track attendance at cover crop roundtables, and media (e.g. articles and press releases) as awareness of camelina grows in Minnesota. Satisfaction and qualitative surveys information will be collected routinely to adaptively improve our program.

ACTIVITY 2 ENRTF BUDGET: $121,000

Outcomes supporting farmer adoption of camelina	Completion Date
1. Commercial analysis and application development of camelina seed meal and oil	October 1, 2020
2. Supply chain analysis for farmers, commodity groups, and co-ops	October 1, 2020
3. Stimulate development of supply chains supporting establishment and linkages among producers, processors, distributors, and consumers of camelina	October 1, 2021

First Update December 1, 2019

We have begun evaluating the equipment options and requirements for camelina seed cleaning, pressing for meal, and oil filtration to improve quality and stability. Once pressed, analysis will be performed on both meal and oil to identify chemical characteristics. Initial market work will be focused towards oil in food products and viability in biofuels. Meal will be studied for protein isolation and animal feed qualities. Identification of protocols and equipment necessary for protein isolation from meal is underway. These assessments will support the supply chain and identify preliminary market opportunities for camelina.

Second Update June 1, 2020

AURI has contracted a private commercialization consultant to support our work in ecosystem development and supply chain analysis. This work includes a detailed review of the Minnesota camelina supply chain and meetings with key industry stakeholders. AURI's commercialization team has met with key stakeholders and leadership at the Forever Green Initiative to connect our work for CLC to wider networks supporting camelina commercialization. AURI's technical and commercialization teams have been working with the University of Minnesota to organize, promote, and host Virtual Oilseeds Field Days in May and June to highlight new oilseeds including camelina. AURI has also engaged in initial conversations with a company in the bio-based products sector about camelina's potential use for resins and bio composites. Work continues on identifying potential pilot projects. AURI's food science team, in partnership with the Forever Green Initiative, is developing plans to pursue FDA Generally Recognized as Safe (GRAS) status for camelina as a food ingredient. Lack of this status has been identified as a key obstacle to successful commercialization. AURI's events team, AURI Connects, has also been working on developing roundtable events highlighting new and emerging crops that will include camelina-focused content.

Third Update December 1, 2020

AURI's supply chain development work focused on winter camelina has made steady progress over the past several months. Unfortunately, COVID-related issues have created some challenges to accomplishing our outcomes as planned, as our ability to host in-person events and conduct outreach has been restricted. While we are pursuing options for online/virtual events and outreach to disseminate information and build our commercialization network, we have experienced delays as we identified new options to address the unique challenges presented by the pandemic. AURI's plans to work with stakeholders have also been impacted/delayed, as COVID limited the ability to conduct outreach and in-person work.

Despite these limitations, AURI's supply chain assessment and development work has continued to move forward. These efforts have supported a commercialization consultant engaged by AURI to assist in AURI's project activities. We continue to regularly coordinate with key project partners, including the Forever Green Initiative and University of Minnesota, to align efforts and identify areas of potential action. Our technical and business development team took part in virtual meetings with industrial representatives to determine ideal markets for camelina meal, seed, and oil as part of our supply chain development activities. These meetings identified the animal nutrition/feed market as a notable area of focus for future supply chain development efforts. Guided by this input, AURI's technical team began developing informational documents with technical data on winter camelina's nutritional profile and a feed value assessment to share with potential end users. AURI will continue its supply chain development efforts into 2021, engaging with potential end users to share information, assess demand, and identify potential pilot projects.

The AURI technical team has launched a twelve-month shelf-life study of seed, meal, and oil to test long-term stability and mold/yeast growth for long term storage. Work started in mid-2020 and is utilizing seed harvest at project plots. The zero and three-month analyses were completed with the data being compiled. AURI has also coordinated with the University of Minnesota's Forever Green Initiative to provide winter camelina oil samples to industry stakeholders for research and development purposes. This includes assessment for use in food and biobased products. Additionally, camelina oil was discussed at the Biodiesel Technical Workshop November 10-12 as an emerging feed stock for biodiesel adding use for camelina as a biofuel. AURI's Food Science team was working with partners at the Forever Green Initiative to examine how to create new markets for human consumption of camelina-based products. These efforts have identified winter camelina's lack of FDA "Generally Recognized as Safe" status as a food ingredient as a major barrier to commercialization in the food market. AURI's food science team began working with the team at Forever Green to identify options to address this challenge and will continue to offer technical support to these efforts in 2021.

While outreach and dissemination efforts have been hampered by COVID, AURI has been working to find alternative ways to share information about Winter Camelina and its potential uses with a wider audience. AURI experts took part in a virtual "Winter Oilseeds Field Day" in June, sharing information about camelina with potential growers and users. The AURI Connects team also launched a new "Fields of Innovation" webinar series focused on new and emerging crops. Camelina-focused content will be featured as part of this series during the first half of 2021.

Fourth Update June 1, 2021

AURI has continued to make progress on its supply chain activities, despite challenges and delays created by the ongoing COVID-19 pandemic. In February, AURI hosted a virtual event featuring winter camelina as part of its "AURI Connects: Fields of Innovation" webinar series. AURI is also coordinating with project partners to participate in and plan new winter camelina field days. The AURI business development team has also been working with an outside consultant to complete a winter camelina commercialization and supply chain study. The consultant completed a draft, and the findings are under review by AURI for use to guide continued

outreach to industry and development of new supply chain connections. The AURI technical team continued its work on a shelf-life study of seed, meal, and oil to test long-term stability and mold/yeast growth for long term storage. Data from the six and nine-month analyses was compiled. Small batch biodiesel synthesis work was initiated using winter camelina oil, is expected to be completed in the second half of 2021. The technical team has also been pressing winter camelina to provide meal and oil for testing and analysis by project partners and potential end users.

Fifth Update December 1, 2021

AURI continued to make progress on its supply chain activities over the past six months, despite challenges and delays created by the ongoing COVID-19 pandemic. AURI staff participated in a field day led by the University of Minnesota in June and a field day in August hosted by Central Lakes College to discuss winter camelina, share information, and connect with stakeholders. AURI staff also attended a Biodiesel Technical Workshop that included discussion of winter camelina as a future feedstock for biodiesel and renewable diesel. Progress was also made on the development of a draft supply chain report, which staff will continue to update based on information gathered over the remainder of the project. A final copy of this report will be included in the overall project report. AURI also worked with the University of Minnesota to coordinate a winter oilseed field day in September, which was postponed due to increasing COVID-19 infections. This event is now planned for spring, 2022. The AURI technical team concluded its 12-month shelf-life study of seed, meal and oil investigating long-term stability and mold/yeast growth. Small batch biodiesel synthesis work was also completed, and the results will be used to guide future research and product development activities. Also, AURI opened a new food grade processing lab in Waseca allowing for food grade winter camelina oil to be prepared for project partners and potential end users. Our technical team has also continued coordination with partners including the University of Minnesota's Forever Green initiative to connect potential end users with samples of winter camelina oil and meal for review.

Sixth Update June 1, 2022

AURI continued to make progress on its supply chain activities over the past six months, despite challenges and delays created by the ongoing COVID-19 pandemic. AURI staff helped organize and participated in a field day led by the University of Minnesota in May 2022 to discuss supply chain development for winter camelina, share information and connect with industry stakeholders. AURI's commercialization team was also able to meet with multiple industry stakeholders over the past six months, exploring opportunities to press and process winter camelina at scale in Minnesota. The team also made progress on the development of an updated supply chain report, planned for completion in summer 2022. Release of the report to key stakeholders will be coordinated with the Forever Green Initiative. A final copy will be included in the overall project report and will contain information gathered over the remainder of the project. The AURI technical team is working with the Central Lakes College and University of Minnesota to prepare to receive and process grain from the 2022 harvest for continued analysis and shelf-life testing. Utilizing the new food grade oil press, winter camelina oil and meal (ranging from 1-300 pounds), samples were provided to multiple project partners and potential end users to facilitate R&D on several food and feed applications. AURI's technical team continues to coordinate with partners including the University of Minnesota's Forever Green initiative to connect additional end users with samples of winter camelina oil and meal for review.

Seventh Update December 1, 2022

The Agricultural Utilization Research Institute (AURI)'s technical and commercialization teams continued to make progress on work plan activities over the past six months.

AURI's technical team developed new plans for a pilot research project focused on solvent extraction and processing of winter camelina oil. This project will develop data on processing methods and analyze the quality

of meal and oil produced using hexane-based extraction processes, with a focus on developing data to help guide commercialization activities by Minnesota-based processors. The technical team also met with external research partners to develop a new pilot research project focused on assessment of winter camelina oil for utilization in bioresins and bioplastics. Work on both projects will take place over the next six months, and findings will be included in the final project report.

AURI staff also continued efforts to engage with key stakeholders to identify and discuss commercialization opportunities. Contacts included seed cleaners and distributors, university research leaders and ecosystem policy advocates with an interest in winter camelina's potential use in continuous living cover cropping systems. Some industry partners indicated interest in exploring opportunities in winter camelina meal and coproducts, which may offer complementary market opportunities for winter camelina oil-based biofuels.

AURI outreach and networking activity over the past six months included participation in multiple events. In August, AURI staff participated in Central Lakes College's Field Day, sharing information with attendees on the project, winter camelina and commercialization opportunities for the crop. In November, AURI's Dr. Michael Stutelberg attended the Biodiesel Technical Workshop in St. Louis, Missouri, connecting with key stakeholders to discuss utilization opportunities for winter camelina in the renewable diesel and sustainable aviation fuel markets.

Final Update Activity 2

The Agricultural Utilization Research Institute (AURI) spent 2023 focused on finalizing work on the work plan for Activity 2, including additional outreach and dissemination initiatives to educate and raise awareness of emerging market opportunities for winter camelina. As part of wrapping up project activities, AURI completed an updated version of its Supply Chain Development report during 2023, which will be included as an additional document with this update. AURI's commercialization team continued to build connections to industry stakeholders over the past several months that will be used as a foundation for ongoing winter camelina market development in 2024 as part of another LCCMR-funded project- Scaling a Market-Driven Water-Quality Solution for Row-Crop Farming. (2022-046) Technical team activities since the last update included completing hexane extraction trials in partnership with the Northern Crops Institute in Fargo, North Dakota. AURI also completed research on the pelleting of winter camelina meal for use in animal nutrition products, and developed a meal feed value assessment. The results of these studies are included in the Supply Chain Report submitted to Central Lakes College (CLC) along with this final update.

Work Completed, Outcomes, and Related Findings

AURI completed significant work in all outcome areas for Activity 2. Analysis and application development of winter camelina seed meal and oil in the feed, food, biofuel, and bioproduct industries took place over the entire course of the project. This research and analysis was combined with guidance from key stakeholders to develop findings and recommendations included in AURI's final supply chain development report. While the development of markets for winter camelina remains nascent, with data on yields and costs of production still being developed by researchers, industry, and growers, interest in the crop has increased during this project. As of 2023, Minnesota industry stakeholders are moving beyond research and into initial field-scale production, which should open new possibilities for processors and end-users in the state over the coming years. Throughout the project, AURI coordinated with key partners, including the Forever Green Initiative, to share information on winter camelina, its analytical and utilization profile, and the handling and processing of the crop with industry stakeholders to simulate ongoing supply chain development. AURI also provided numerous winter camelina oil, meal, and seed samples to industry and research partners to enable pilot-level product and process research and development. While pandemic-related restrictions caused challenges in outreach and dissemination activities, AURI and its partners were able to host multiple online and in-person events featuring winter camelina programming over the course of the project, sharing information about the project, its

research, and ongoing market development activities with producers, industry, and interested members of the public**.**

CAMELINA MARKET DEVELOPMENT

One of the additional objectives of this project aimed to boost the availability of camelina seed for broader scaling and the development of supply chains. In June 2020, researchers from the University of Minnesota (UMN) and Central Lakes College (CLC) harvested, cleaned, and prepared around one ton of seed for future planting.

In September 2020, a 30-acre field was planted with seed sourced from the LCCMR project, not only to expand seed production but also to serve as a field-scale experiment assessing greenhouse gas fluxes and soil health parameters within a continuous living cover system.

In the ensuing spring of 2021, a harvest of 20,000 pounds of camelina took place, and the harvested produce was transported to Albert Lea Seed Company for cleaning and distribution. During the fall of 2021, MBOLD (a coalition comprising agri-businesses, nonprofits, and research institutions from Minnesota) launched a pilot program to cultivate camelina on 300 acres in Minnesota and Iowa. This initiative aimed at commercial development and the evaluation of market opportunities for camelina seed.

ACTIVITY 3 Title: Farm-based outreach program supporting adoption of water quality-protecting cover crops
Description: Cropping systems will be demonstrated on 90 acres across seven working farms in Todd, Otter Tail, Dakota, and Stearns counties including “high” or “very high risk” Minnesota wellhead protection acres. The 90 acres includes the approximately 24 experimental acres in Todd County and 2-20 acres of cover crops on each of the six other working farms. Our farmer-led outreach effort will cultivate “Champion Farmers” who will grow continuous living cover and co-present at field day events to provide first-hand demonstrations of oilseed production, in-field N management efficiency, cash crop production capacity, and market opportunities for camelina-based products. Working with SWCDs in each county, farmers in our program will leverage federal cost-share funds (e.g. Conservation Stewardship Program) to support cover crop adoption on wellhead protection areas.

Our outreach program will connect to farmers, farm community leaders (e.g. Minnesota Farm Bureau), industry, and federal and state agencies (e.g. MDA, DNR, NRCS) through field days, farm forums, local and national meetings, a series of web-based educational publications, blogs, and newsletters to reach an estimated 3000+ producers. Educational curriculum and field demonstrations will outline wellhead protection services and economic advantages of continuous living cover that protect water quality. We will organize 4 field days annually on farms demonstrating cover crop practices across Todd, Otter Tail, Dakota and Stearns Counties. Field days will be co-led by farmers demonstrating cover crop practices to other farmers in their region and advertised through local Soil and Water Conservation Districts. Our initiative will directly reach over 800 farmers annually at meetings for Central Lakes College Farm Forum, Central Minnesota Irrigators Corporation, Crow Wing Forage Council, Irrigators Association of Minnesota, Soil Health Summit- Sustainable Farming Association, Todd County Corn & Soybean Growers, Minnesota Farm Business Management, East Otter Tail and Wadena Soil and Water Conservation District. We will reach an even broader audience by posting extension publication(s) online to the U of Minnesota Extension Soil Management Health website (extension.umn.edu/soil-and-water/soil-management-and-health), developing blog postings on the Minnesota Crop News (blog-crop-news.extension.umn.edu/) with currently over 2200 subscribers, and developing a project webpage through the Ag and Energy Center homepage (clcmn.edu/ag-energy-center/).

ACTIVITY 3 ENRTF BUDGET: $109,000

Outcome	Completion Date
1. Implement outreach program with the aim of increasing cover crop adoption across 100,000+ acres of row crops on highly vulnerable wellhead protection areas	December 1, 2022
2. Develop publications supporting state-level guidance on implementation and impacts of continuous living cover farming to mitigate nitrate contamination of groundwater	December 31, 2023

First Update December 1, 2019

Farm -Ready Cover crops for protecting Water Quality Update
Land contracts have been signed with three working farms from Staples, Long Prairie and the Browerville area. The plot location at the Ag and Energy Research Farm was also determined. The cropping plan was finalized, leading to plot corners being flagged and tracked through GPS coordinates. All baseline soil samples were also taken at that time.
Corn was the first crop to be planted in establishing the three cropping systems. Kura clover treatments were established across all the locations. During the summer, the Kura clover was mowed 3 times with a brush hog for weed control. Across the winter Camelina cropping system treatments, corn was harvested for silage, and camelina was planted to establish before winter to allow spring harvesting and double cropping of soybeans. There was one plot that we were unable to harvest the corn for silage as the field conditions were extremely wet.
Lysimeters were installed in mid-June at three GPS locations per treatment. Lysimeters will be used to collect water samples at a depth of three and a half feet. The water samples are then examined for nitrates. There were also soil moisture sensors installed late October next to each lysimeter for monitoring water movement.

Second Update June 1, 2020

During the winter, the Ag and Energy Center scheduled meetings with the partnerships of the grant to discuss the upcoming growing season. The first meeting was with the researchers to establish the task list, roles and expectations for the year. The second scheduled meeting was with the farmers of the off-site fields. We were able to provide them with a report on the health and qualities of their soils. We also discussed the 2020 planting, processes and roles of all involved.
We were able to enter the field that was extremely wet last year, so the corn was harvested but as grain, and spring camelina was planted into the plot. It does set this field back but will soon produce the same cover crop as the winter camelina that was planted last fall in the other fields.
Working with the farms from Staples, Long Prairie and the Browerville area, the second-year crop, soybeans, have been no-tilled into all the fields to allow the existing Kura and Camelina crops to be disturbed as little as possible.

Third Update December 1, 2020

During the remainder of the growing season, regular meetings with farmers one-on-one were continued to keep farmers aware of the data being collected as well as the next steps. I met with one farmer located near Long Prairie, MN right when harvest was being completed and experienced first-hand the challenge of harvesting the soybeans out of the Kura clover. Overall, the farmer was pleased with how the experiment was progressing. The farmers were interested in the water infiltration and lysimeter data that we hope to report back to them this winter after it has all been analyzed by the USDA out of Morris, MN.

The plot that was wet the fall before and planted to spring camelina located near Browerville, MN ended up having a couple challenges thrown at it throughout the growing season as the farmer in collaboration with us missed the plot flags and ended up killing the back fourth of the plot as he was managing the best management plot. Then as the season progressed, the spring camelina was not able to be harvested except for biomass samples by hand. The reason for this was because the spring camelina and soybean growing seasons run parallel instead of at opposite times. The soybeans out-grew the spring camelina as it was beginning its dry down process.

The farm site plot near Staples, MN under irrigation in sandy soils also had a few challenges. The lack of moisture this spring was a major issue in this field for soybean crop establishment. The Kura clover that existed struggled throughout the growing season leading to a sparse stand, but the competition from the existing Kura clover stand for moisture did have an influence on the soybean establishment and caused soybean stands to be sparse. The camelina came back this spring, but the soybeans were not able to compete with the camelina in the spring for moisture leading to a sparse soybean stand later in the season. When a comparison was done with the best management soybeans to the other plot soybeans, the camelina and Kura cover crops were definitely an issue as the best management soybeans were tall, lush, and well-established. Competition for moisture at soybean emergence was one of the main factors that affected soybean establishment in this field.

Fourth Update June 1, 2021

During the late winter of 2020, The Ag and Energy Center scheduled a meeting, via zoom, with the partners of the grant to discuss 2021's growing season. This meeting with the researchers also established tasks, roles, and expectations for the year. We were able to meet with the off-site farmers in-person, to discuss planting, herbicide usage, and processes and roles of all involved. Their main question was, "What are we learning?" We were able to share with them soil and lysimeter sample data to help answer their questions.

Fifth Update December 1, 2021

Throughout the growing season of 2021 we were able to meet with the farmers one-on-one to keep them up to date on data collection and things we had learned so far. Cooperation with the farmers this year went very well. The farm site located in Long Prairie, MN is not irrigated. As a result, it lagged behind the other plots due to the drought. The Kura clover at this farm outcompeted the corn for water, leaving the corn stressed. The corn in this PC system was requested to be taken as silage instead of grain by the farmer.

The farm site plot near Staples, MN also experienced the same thing. This plot was irrigated, but with the sandy soil the irrigator was unable to keep up with the demand from the corn. Once again, the Kura outcompeted the corn for resources- Even with being hit with glyphosate three times to slow it down. The farmer associated with this plot also requested to take the corn in the PC system as silage instead of grain.

With the one-year extension of the project being approved, we met with the farmers associated with the project to make sure they were on board for continuing with the project for another year. The Browerville, MN farm location is the only plot that will not be continuing with the project.

Sixth Update June 1, 2022

The winter of 2021 granted us time to compile data and schedule meetings. Two meetings were scheduled for planning the growing season of 2022. The first meeting was scheduled for January 12th. The farmers and partners associated with this project were all in attendance in person and via zoom. This meeting covered 2021 plot observations, data, and addressed the farmers' questions. The farmers from Long Prairie requested weirs be installed into their field to analyze the runoff in hopes of learning the potential of how much applied fertilized and sediment moves horizontally across the ground in large rain fall events and lost to runoff. We also

established tasks, roles, and expectations for the 2022 growing year. The second meeting occurred on April 6th. Once again, most of the farmers and partners were in attendance in person or via zoom. At this meeting we finalized tasks, roles, and expectations for 2022.

Seventh Update December 1, 2022

With the closing of the final 2022 growing season, cooperation with off-site farmers continued to be a positive experience. If questions arose, on both ends, phone calls were made, and clarification was given. A final meeting will be scheduled in 2023 to meet with the farmers to share data and what has been learned by both researchers and farmers.

The farm located in Long Prairie requested weirs to be installed on their land for the 2022 growing season. The team from USDA, Morris met their request and installed the instrumentation. Although we did not experience the same drought conditions as last year, rain showers, on average, did not produce enough precipitation to result in any runoff at the plot. This plot also does not have any type of irrigation. Even still, some samples were collected and will be analyzed by USDA, Morris.

Final Update Activity 3

Despite limitations on in-person events, the team has successfully utilized online platforms, articles, reports, and presentations to share valuable information with diverse audiences, contributing to the project's visibility and impact. This comprehensive and adaptable outreach strategy targets a diverse audience, including farmers, community leaders, industry representatives, and federal/state agencies, with an estimated reach of over 2000 people through online engagement and in-person events. Here are two examples of products of our work:

1. *Winter Camelina Supply Chain Development in Minnesota - AURI*
2. *Impact of Cover Crops on Nutrient Mobility for Wellhead Protection Areas*

The Central Lakes College Ag and Energy Center holds a large field day, attracting a gathering of 200+ individuals. Spanning the years 2019 to 2023, the event has consistently placed the spotlight on the LCCMR Cover crop project, integrating cover crop content into both the lunch program and the dynamic field presentations. The Ag Center's annual report showcases the LCCMR cover crop project, becoming a staple distributed to an audience exceeding 200 people each year.

Noteworthy is the active engagement of three local farmers who participated in this initiative and served as ambassadors for the practice adoptions. Their dedication transcended mere involvement as they offered their land for on-site research, elevating the project's scope and impact.

Finally, Central Lakes College has hosted multiple technical trainings for Natural Resource Conservation professionals that have included cover crop operations, adoption, and agronomic impacts. These individuals work with hundreds of producers statewide on soil health and conservation efforts.

IV. DISSEMINATION:

Description: We will disseminate information to farmers, farm community leaders (e.g. Minnesota Farm Bureau), industry, and federal and state agencies (e.g. MDA, DNR, NRCS) through field days, local and national meetings, blogs, and newsletters to reach an estimated 3000+ producers. We will organize 4 field days annually on farms demonstrating cover crop practices across Todd, Otter Tail, Dakota and Stearns Counties. Field days will be co-led by farmers demonstrating cover crop practices to other farmers in their region and advertised through local Soil and Water Conservation Districts. Our initiative will directly reach over 800 farmers annually at meetings for Central Lakes College Farm Forum, Central Minnesota Irrigators Corporation, Crow Wing Forage

Council, Irrigators Association of Minnesota, Soil Health Summit- Sustainable Farming Association, Todd County Corn & Soybean Growers, Minnesota Farm Business Management, East Otter Tail and Wadena Soil and Water Conservation District. We will reach an even broader audience by posting extension publication(s) online to the U of Minnesota Extension Soil Management Health website (extension.umn.edu/soil-and-water/soil-management-and-health), developing blog postings on the Minnesota Crop News (blog-crop-news.extension.umn.edu/) with currently over 2200 subscribers, and developing a project webpage through the Ag and Energy Center homepage (clcmn.edu/ag-energy-center/). The ENRTF will be acknowledged for support in all information disseminated through this project.

First Update December 1, 2019

We have begun the process of disseminating information to producers, farm community leaders, industry, and federal and state agencies. One event that we will give out information about the three different cropping practices is the 32nd Farm Forum, Perspectives in Agriculture for 2020, on Tuesday, December 3 at Central Lakes College in Staples, Minnesota. This forum will cover the current issues in agriculture. We also hosted an event and shared information at the Ag and Energy Research Center Field Day on August 23, 2019 at the college. There were approximately 200 people that participated in various demonstrations, tours and agricultural updates.

Second Update June 1, 2020

The current COVID-19 situation has stopped all in person interaction with the public and farmers. We have filmed no till planting of the soybeans into our cover crops. These videos have been used by our researchers for instructional purposes. They have also been shared on Ag Centric YouTube website (https://www.youtube.com/watch?v=aTAk3t3y8oE&feature=youtu.be), for the public to watch.
There has also been information shared in team meetings and the annual Ag and Energy Report that was published February 1, 2020. We have modified operations to accommodate directions and oversight from research partners virtually. Agronomic operations are fairly normal for the project, crops are planted for the season and datalogger information is being collected. We are experiencing disruption in overland flow collection due to limited research operations (USDA, U of M).

Third Update December 1, 2020

Dissemination of research findings continued to be a challenge with the current covid-19 environment we are living in. Even with these current challenges, we were still able to hold our annual field day on August 21, 2020. Attendance was lower than a typical year, but we were still able to report out findings to 100 people that attended our field day. Scott Wells with the University of MN as well as Sharon Weyer from the USDA in Morris, MN came to the field day and presented to two different groups of the specifics related to this project. Videos and photos continued to be shared as well online. Another presentation with BWSR was completed this October to technicians involved with NRCS and SWCD.

Fourth Update June 1, 2021

COVID-19 has continued to put a stop to in person interactions with the public and farmers. Despite this setback it has not stopped us from sharing data and information. Research manager, Hannah Barrett wrote an article for the irrigators association of MN (IAM) titled, **LCCMR Cropping System Comparison Study**, and Sharon Weyers, Research Soil Scientist, USDA ARS Morris, and M. Scott Wells, Associate Professor, Cropping Systems, University of Minnesota, St. Paul wrote an article for the local newspaper/ regional farm Ag edition titled, **Water Quality Benefits of Cover Crops.** Data and information about the LCCMR project in general was also shared through our 2020 annual report that was mailed to over 100 recipients. With Covid-19 restrictions lessening, we are looking forward to hosting more events this summer. Our annual field day will take place on August 27th. We will also host several organizations over the summer for tours and plot demonstrations.

Fifth Update December 1, 2021

With COVID 19 restrictions lessening, dissemination has become more feasible. On July 20th Hannah Barrett and Noah Boelter presented the LCCMR project to a group of twenty-five for the CLC research farm's NRCS field day. A follow up presentation was given on November 3rd to the same group with data from the growing season. We discussed the project with approximately 200 farmers, legislators, and community members at our annual field day on August 27th, and the project was also highlighted to the AFREC group that came for a tour. Sharon Weyers from the USDA in Morris, MN has written a presentation regarding water quality data from the past years on the project that can be shared with future groups. Videos and photos continue to be shared online via the google team drive.

Sixth Update June 1, 2022

This spring, we had several opportunities for dissemination. Central Lakes College Ag and Energy Center's research manager, Hannah Swartzentruber, assembled an annual report for the center, which included information on the LCCMR project. The annual report was shared at our advisory meeting, and two NRCS training events which took place on May 3rd and 5th at the Ag and Energy Center. Farm director Cory Detloff also had the opportunity to present the LCCMR project at AURI's field day in Waseca.

Seventh Update December 1, 2022

Dissemination throughout the growing season had far reaching results. On August 27th the Ag and Energy Center hosted their annual field day where 200+ persons were in attendance. Research analyst Noah Boelter presented the LCCMR project to a group of 20 people at the plot farm location in Staples. Over the course of the year the 2021 Ag and Energy Center annual report, written by Hannah Swartzentruber, was handed out to more than 500 individuals. The annual report contains research projects that occur at the farm, one of which is the LCCMR project.

Final Dissemination Update

Despite being impacted by the COVID-19 pandemic during part of the project period, commercialization and technical team members from the Agricultural Utilization Research Institute (AURI) were able to host and take part in multiple in-person and virtual outreach events over the full course of the project. During these events, AURI team members were able to build connections with supply chain stakeholders, coordinate with project partners, share information about the project, and highlight winter camelina market and product development opportunities in Minnesota.

AURI outreach efforts in support of winter camelina market development during the project included the following events and activities:

Winter Annual Oilseeds: Virtual Field Days May 26, June 2, and June 9, 2020

- AURI partnered with the University of Minnesota's Forever Green Initiative to host a series of three interactive webinars highlighting winter camelina and pennycress research and development.
- The events featured presentations from university researchers, AURI staff, and industry stakeholders, panel discussions, and interactive question-and-answer sessions.

  Session 1: Environmental Benefits, Breeding, and Agronomics
  Session 2: Food Science and End-Use Applications
  Session 3: Supply Chain and Market Development; Industry Interest

- AURI presentations included a step-by-step walkthrough of the oil pressing and filtration process for winter camelina.

AURI Connects: Fields of Innovation Webinar- "Growing Markets for Winter Oilseeds: Camelina and Pennycress" February 26, 2021

- Featured presentations from university and industry experts working to develop and commercialize winter camelina.
- Recording available online at https://www.youtube.com/@AURIMN

Winter Oilseeds Supply Chain Field Day May 18, 2022

- Hosted by AURI and the University of Minnesota's Forever Green Initiative at the AURI facility in Waseca, Minnesota
- The event included presentations on the environmental benefits of winter oilseeds, postharvest handling and cleaning, and oil extraction. The event also shared information about market opportunities for winter camelina and examined current and future uses for the crop.

AURI Connects: Fields of Innovation Event- "Growing and Developing Markets for Minnesota Oilseeds" June 9, 2023

- Hosted at the Northwest Research and Outreach Center on the University of Minnesota-Crookston Campus
- Over 50 attendees joined in person and virtually to learn more about winter camelina and other new and specialty oilseed crops. In addition to presentations on winter camelina and other oilseed crops, the event included a tour of the new Ag Innovation Campus in Crookston. Recording available online at https://www.youtube.com/@AURIMN

Information Sharing and Promotion

In addition to organizing events, AURI pursued several other activities to share information about the project and winter camelina market opportunities.

Information Sheet: Winter Camelina Cleaning and Dehulling

- AURI technical experts developed an information sheet on cleaning and dehulling winter camelina. This short guide was developed to provide potential growers and end-users with key technical information on post-harvest handling of winter camelina. The guide was made available online and at events and shared with project partners for further dissemination.

Biodiesel Technical Workshops

- AURI technical staff attended the Clean Fuels Alliance America's Biodiesel Technical Workshop conferences in 2020, 2021, 2022, and 2023.
- o During these events, AURI staff made connections with biodiesel industry stakeholders and shared information about winter camelina research and market development activities in Minnesota.

Winter Annual Oilseed Field Day June 11, 2021

- Rosemount, Minnesota

- o AURI participated at the University of Minnesota's winter oilseed field day at the Rosemount Research and Outreach Center to connect with industry stakeholders and share information about ongoing winter camelina research and market development efforts.

Central Lakes College Ag and Energy Research Center Field Days August 2021, August 2022, and August 2023
Staples, Minnesota

- o AURI team members took part in multiple Central Lakes College Field Days over the course of the project, hosting exhibits, taking part in tours and presentations, and sharing information about winter camelina and its market potential with attendees.

Ag Innovation Campus Grand Opening September 14, 2023

- o AURI team members hosted an exhibit at the grand opening of the new Ag Innovation Campus in Crookston, Minnesota, sharing information about winter camelina, its uses, and the potential role the center may play in supply chain development for the crop by offering crushing and processing for specialty oilseeds.

Media
In addition to participation in events, AURI also featured project activities in support of winter camelina market development in its quarterly newspaper, Ag Innovation News.

AURI Ag Innovation News, "2022 Winter Oilseeds Supply Chain Field Day" Vol. 32, No. 3 (Jul – Sep 2022)

- o Provided a short overview of the program that occurred at the Winter Oilseeds Field Day hosted by AURI and the University of Minnesota in May 2022.

AURI Ag Innovation News: "AURI Explores Market Opportunities for Winter Annual Oilseeds," Vol. 33, No. 2 (May – Jul 2023)

- o The article shared information about winter camelina and its uses, including a focus on its potential as a feedstock for renewable diesel production.

V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures

N/A

Explanation of Capital Expenditures Greater Than $5,000:
N/A

Explanation of Use of Classified Staff:
N/A

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

Enter Total Estimated Personnel Hours for entire duration of project: 6,365	Divide total personnel hours by 2,080 hours in 1 yr. = TOTAL FTE: 3.06

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

Enter Total Estimated Contract Personnel Hours for entire duration of project: 6,406	Divide total contract hours by 2,080 hours in 1 yr. = TOTAL FTE: 3.08

VI. PROJECT PARTNERS:

A. Partners outside of project manager's organization receiving ENRTF funding
University of Minnesota: Dr. Scott Wells will lead research of cover crops (Act. 1).
Agricultural Utilization Research Institute: Dr. Michael W. Stutelberg will lead commercialization of camelina (Act. 2).
USDA-Agricultural Research Service: Dr. Sharon Weyers will provide sample processing only, no salary (Act. 1).

B. Partners outside of project manager's organization NOT receiving ENRTF funding
Minnesota Department of Agiculture: Mr. Ryan Perish will provide guidance on hydrological monitoring (Act. 1).
Todd, East Otter Tail, Dakota and Stearns Counties Soil & Water Conservation Districts: Support farmer recruitment and identification of vulnernable wellhead protection areas.

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

This project is designed to test and demonstrate economically driven conservation farming practices for reducing nitrate contamination supporting future expansion of continuous living cover beyond the four-county area targeted in this proposal. We will seek future funding from grants and organizations such as the USDA Conservation Innovation Grant and Corn Growers Association to test nitrate reduction, agronomic productivity, and soil health dynamics from long-term (3+ years) implementation of continuous living cover systems.

VIII. REPORTING REQUIREMENTS:

Project status update reports will be submitted June 1 and December 1 each year of the project. A final report and associated products will be submitted by December 31, 2023

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2019 Budget Spreadsheet
Legal Citation: M.L. 2019, First Special Session, Chp 4, Art 2, Subd 04I
Project Manager: Keith Olander
Project Title: Farm-Ready Cover Crops for Protecting Water Quality
Organization: Central Lakes College
Project Budget: $741,000
Project Length and Completion Date: 4 Years, June 30, 2023 Extended to 12/31/23
2/14/2025

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 411,571	$ 411,571	$ 0
Farm Manager, **$43,837** (77% salary, 23% benefits) 17% FTE/ yr for 3 years		**$ 73,299**	
Research Coordinator, **$76,620** (77% salary, 23% benefits) 41% FTE/ yr for 3 years		**$ 105,201**	
Undergraduate Research Assistant, **$18,720** (100% salary, 0% benefits) 25% FTE/ yr for 3 years		**$ 15,157**	
Outreach Coordinator, **$44,396** (70% salary, 30% benefits) 11% FTE/ yr for 3 years		**$ 91,053**	
Event and Publications Coordinator, **$17,478** (77% salary, 23% benefits) 8% FTE/ yr for 3 years		**$ 20,936**	
Grant project manager **$134,460** (70% salary, 30% fringe 83% FTE for 3 Years)		**$ 105,925**	
Professional/Technical/Service Contracts			
University of Minnesota **Activity 1**: Team will develop enterprise budget of agronomic inputs/returns, build crop-hyrdological model and develop peer-reviewed publication. Agronomy Research Scientist - Data analysis, enterprise budgets, and synthesis of peer-reviewed publication - **$27,429** (75% salary, 25% benefits) 9% FTE/ yr x 3 yrs; Agronomy faculty; Undergraduate Research Assistant - field and laborartory data collection - **$18,720** (100% salary) 25% FTE / yr x 3 yrs. Travel for establishment of experimental plots and instrumentation 2 trips per year @ $250/ trip including mileage and per diem x 3 years (**$1,500**) **Activity 3**: Event and Publications Coordinator- Responsible for development of educational curriculum, extension material and publications - **$24,034** (75% benefits + 25% benefits) 8% FTE/ yr x 3 yr. Travel to grower meetings, field days- 2 trips/ yr @ $250/ trip including mileage and per diem x 3 years (**$1500**)	$ 82,069	**$ 82,069**	$ (0)
Agricultural Research Service - USDA **Activity 1**: Water & soil sampling occurs in years 2020, 2021 and 2022 Water and soil sample processing and instrumentation. 6 lysimeter sampling locations / farm-field plot x 12 farm-field plots; Sample water in each lysimeter every 1-3 wks = 14 samples per lysimeter per year x 72 lysimeters x 3 yrs for yr 1 = 3,024 total samples @ $10/ sample for solution filtration and nitrogen analysis supplies (**$26,460**). Sample soil at 2 depths x 72 lysimeter sampling locations x 2 sampling periods x 3 yrs = 594 samples for total Carbon, Nitrogen $10/sample (**$5,940**), Inorganic Nitrogen $5/ sample (**$2.970**), Phosphorus $5/ sample (**$2,970**). Time domain reflectometry (TDR) measurements of water movement carrying nitrogen: 2 sampling locations/ farm-field plot x 6 farm-field plots = 12 TDRs; Each TDR includes 1 data logger @ $500 each + 4 waveguide soil probes for 4 soil depths @ $175 each = $1,200 per TDR sampling location x 24 sampling locations (**$28,800**). 1 weir for estimating overland nitrogen and sediment loss / farm-field plot x 12 farm-field plots = 12 weirs @ $5,000, each for construction and installation (**$54,840**); 42 sampling events / 12 weirs/ yr x 3 yrs = 1,512 total water samples of water Nitrogen $10/ sample (**$15,120**) and water/sediment Phosphorus $10/ sample (**$15,120**). 3 water infiltrometers @$1700 ea (**$5100**) Research Student **$15,000** (75% Salary + 25% Fringe) 46% x 2 yrs.	$ 116,320	**$ 116,320**	$ -
Agricultural Utilization Research Institute **Activity 2**: The project commercialization (supply chain and value-add) team will map, develop and report on Camelina seed processing and application in food and bioproducts developmement. Project Manager - **$99,000** (78% salary, 22% benefits) 43% FTE/yr x 2 yrs. Camelina market research and technical services for seed cleaning and food-grade oil extraction (**$6,000**). Supplies for chemical analyses and media (**$8,000**). Organizing targeted forums, dissemination and outreach activities (**$3,000**). Travel to participating in business, grower meetings, and end-users- 5 trips / yr @ $500/ trip including mileage & per diem x 2 years (**$5,000**).	$ 110,581	**$ 110,581**	$ 0
Participating "Champion" Farmers: **Activities 1 & 3**: Participating farmers will be compensated for use of farmland at market rates. Land rent for 45 total acres @ $100/acre/year x 3 yrs (**$27,000**)	$ 9,000	**$ 9,000**	$ -
Equipment/Tools/Supplies			
Baker Tillage System equipment use $2000/ yr x 2 yrs (**$4,000**); Interseeding, spraying and harvesting equipment $1000/ yr x 3 yrs (**$3,000**); Herbicides $5/ acre/ yr x 3 yrs x 90 acres (**$1,350**); 10 lbs Kura clover/ acre x 35 acres x $8/lb (**$2,800**) and 8 lbs camelina/ acre x 35 acres x $2.78/ lb x 3 years (**$2,336**)	$ 10,486	**$ 10,486**	$ -
Travel expenses in Minnesota			
Activity 1 travel for establishment of experimental plots, instrumentation, sample collection by Central Lakes College Ag Center - 12 trips to research plots per year @ $250/ trip including mileage & per diem x 3 yrs (**$9,000**). **Activity 3** Outreach team will travel to grower meetings, field days- 4 trips / yr @ $250/ trip including mileage and per diem x 3 years (**$3,000**)	$ 974	**$ 974**	$ 0
Other			
	$ -	$ -	$ -
COLUMN TOTAL	$ 741,001	$ 741,000	$ 1

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State: USDA-ARS Dr. Sharon Weyers $12,853 (77% salary, 23% benefits) 5% FTE / yr x 2 years	Secured	$ 25,608	$ 25,608	$ -
State:		$ -	$ -	$ -
In kind:		$ -	$ -	$ -

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
Current appropriation:	$ 21	$ 741,000	$ 741,000	$ (0)
Past appropriations:		$ -	$ -	$ -