



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2019 ENRTF Work Plan (Main Document)

Today's Date: August 1, 2018

Date of Next Status Update Report: March 1, 2020

Date of Work Plan Approval:

Project Completion Date: December 1, 2022

Does this submission include an amendment request? No

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: (763) 257-2881

Email Address: kolander@clcmn.edu

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

Location: Central, Metro, Northwest, Southwest, Southeast

Total Project Budget: \$741,000

Amount Spent: \$0

Balance: \$741,000

Legal Citation: M.L. 2019, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

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 show 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 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

Second Update June 1, 2020

Third Update December 1, 2020

Fourth Update June 1, 2021

Fifth Update December 1, 2021

Sixth Update June 1, 2022

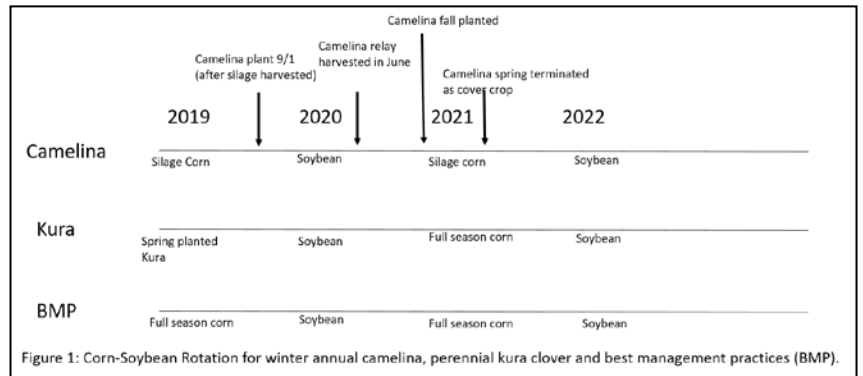
Final Report January 2, 2023

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 Todd 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 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, 2022

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, cosmetic,

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. We will determine gel point to ensure proper flow of biodiesel through engines at low temperatures. We will facilitate camelina feeding trials on fish, poultry, swine and beef meat quality and production among producers and industry partners.

We will support supply chain development by analyzing the transactions and pathways necessary to move camelina from point of production to the point of consumption for industrial, feed or food uses. Supply chain analysis will include three 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 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. sugarbeet, 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 (e.g. Union Creek Cooperative, Clearbrook Elevator) 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 3 to 6 targeted AURI Innovation Network program forums, 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

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 1, 2022

First Update December 1, 2019

Second Update June 1, 2020

Third Update December 1, 2020

Fourth Update June 1, 2021

Fifth Update December 1, 2021

Sixth Update June 1, 2022

Final Report January 2, 2023

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.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the [ENRTF Acknowledgement Guidelines](#).

First Update December 1, 2019

Second Update June 1, 2020

Third Update December 1, 2020

Fourth Update June 1, 2021

Fifth Update December 1, 2021

Sixth Update June 1, 2022

Final Report January 2, 2023

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 Equivalent (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 Equivalent (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: Drs. Jim Eckberg and Scott Wells will lead research of cover crops (Act. 1).
Agricultural Utilization Research Institute: Dr. Goutham Vemuri 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 Agriculture: 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 vulnerable 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 between December 1, 2022 and January 2, 2023

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

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



Legal Citation:
 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
 Today's Date: August 27, 2018

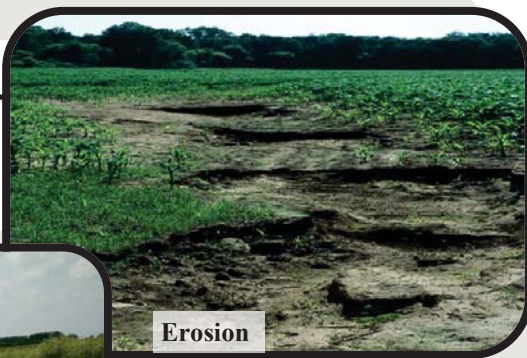
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	\$ 217,876	\$ -	\$ 217,876
Farm Manager, \$43,837 (77% salary, 23% benefits) 17% FTE/ yr for 3 years			
Research Coordinator, \$76,620 (77% salary, 23% benefits) 41% FTE/ yr for 3 years			
Undergraduate Research Assistant, \$18,720 (100% salary, 0% benefits) 25% FTE/ yr for 3 years			
Outreach Coordinator, \$61,221 (77% salary, 23% benefits) 11% FTE/ yr for 3 years			
Event and Publications Coordinator, \$17,478 (77% salary, 23% benefits) 8% FTE/ yr for 3 years			
Professional/Technical/Service Contracts			
University of Minnesota	\$ 177,318	\$ -	\$ 177,318
Activity 1: Team will develop enterprise budget of agronomic inputs/returns, build crop-hydrological model and develop peer-reviewed publication. Agronomy Research Scientist - Data analysis, enterprise budgets, and synthesis of peer-reviewed publication - \$81,101 (75% salary, 25% benefits) 27% FTE/ yr x 3 yrs; Agronomy faculty- Data analysis, enterprise budgets, and synthesis of peer-reviewed publication - \$50,463 (75% salary, 25% benefits) 14% FTE/ yr x 3 yrs; Undergraduate Research Assistant - field and laboratory 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 yrs. Travel to grower meetings, field days- 2 trips/ yr @ \$250/ trip including mileage and per diem x 3 years (\$1500)			
Agricultural Research Service - USDA	\$ 172,320		\$ 172,320
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 = 72 lysimeters @ \$80 each (\$5,760); 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 (\$30,240). Sample soil at 2 depths x 72 lysimeter sampling locations x 2 sampling periods x 3 yrs = 864 samples for total Carbon, Nitrogen \$10/sample (\$8,640), Inorganic Nitrogen \$5/ sample (\$4,320), Phosphorus \$5/ sample (\$4,320). Time domain reflectometry (TDR) measurements of water movement carrying nitrogen: 2 sampling locations/ farm-field plot x 12 farm-field plots = 24 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 (\$60,000); 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).			
Agricultural Utilization Research Institute	\$ 121,000		\$ 121,000
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 development. 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).			
Participating "Champion" Farmers:	\$ 27,000		\$ 27,000
Activities 1 & 3: Participating farmers will be compensated for use of farmland at market rates. Land rent for 90 total acres @ \$100/acre/year x 3 yrs (\$27,000)			
Equipment/Tools/Supplies	\$ 13,486	\$ -	\$ 13,486
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)			
Travel expenses in Minnesota	\$ 12,000	\$ -	\$ 12,000
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)			
Other	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ 741,000	\$ -	\$ 741,000

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	\$ 12,853	\$ -	\$ 12,853
State:		\$ -	\$ -	\$ -
In kind:		\$ -	\$ -	\$ -

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
Current appropriation:		\$ -	\$ -	\$ -
Past appropriations:		\$ -	\$ -	\$ -

Corn-Soybean Rotations

- Lack cover late fall to spring
- Risk of erosion



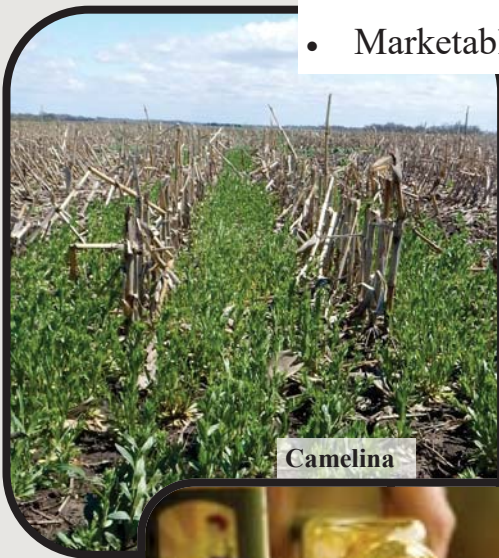
Erosion



Waterways

Cover Crops in Corn-Soybean Rotations

- Protect and build soil
- Mitigate nitrate leaching
- Marketable camelina oil production



Camelina

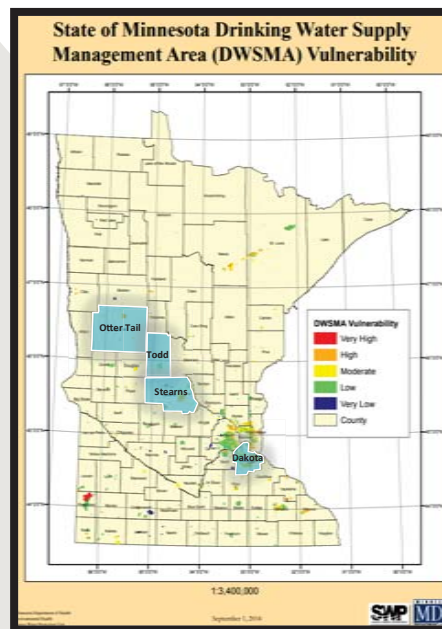


Kura Clover



Oilseed Production

Farm-Ready Cover Crops for Protecting Water Quality



Monitor Cover Crops and Water Quality

- Field-scale monitoring
- Target counties with vulnerable wellhead protection regions and erodible soils



Lysimeters



Soil Erosion Monitoring



