

2019 Project Abstract

For the Period Ending June 30, 2022

PROJECT TITLE: Accelerating perennial crop production to prevent nitrate leaching

PROJECT MANAGER: Dennis Fuchs

AFFILIATION: Stearns County Soil and Water Conservation District (SWCD)

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04k

APPROPRIATION AMOUNT: \$440,000

AMOUNT SPENT: \$345,225

AMOUNT REMAINING: \$94,775

Sound bite of Project Outcomes and Results

Perennial cropping systems that include Kernza and alfalfa are effective in reducing nitrate leaching in sandy soils of Central Minnesota. Improved Kernza value chains for food, beverage and non-food have increased interest from farmers, food processors and consumers. The potential for Kernza production to provide future ecosystems services is great.

Overall Project Outcome and Results

The City of Cold Spring in Central Minnesota has long struggled with increasing nitrate concentrations in its public water supply. Perennial cropping systems may reduce the amount of nitrate leached into groundwater. In partnership with the University of Minnesota Forever Green the project measured nitrate leaching under three perennial plant systems: 1) native prairie, 2) intermediate wheatgrass (Kernza), and alfalfa under irrigation and dryland plots. This research was conducted at the Rosholt Research Farm in Pope County (managed by the Pope Soil and Water Conservation District). The site has similar sandy soils as in the Cold Spring area. The native prairie planting had limited growth during study because of its slow growth and weed pressure. The perennial cropping systems that included Kernza and alfalfa were effective in reducing the nitrate concentrations in groundwater. Kernza was slightly more effective than alfalfa. Averaged across the growing season, the concentration of nitrate in the soil water measured by lysimeters was 0.64 mg/L, which is consider very low and like other reports below Kernza. It was also discovered that Kernza grain yields were highly affected by drought conditions in 2021, even under irrigation, significantly reducing yields. In partnership with the Agricultural Utilization Research Institute (AURI) value chains for Kernza were explored which will ultimately increase demand for production by farmers. Local breweries and bakeries developed products that provided valuable feedback for new product development. Field day attendance indicated that farmers were interested in growing more Kernza if a market exists. Also, consumers in attendance were interested in Kernza food and beverage products. In addition, both food and non-food value chains will need additional investment to fully develop the market. Kernza production in drinking water supply management areas could reduce nitrate leaching. This could save cities millions of dollars in water treatment costs.

Project Results Use and Dissemination

The SWCD's [final grant report](#) is posted online. The [full AURI report](#) is also available online. University of Minnesota will be preparing a peer-reviewed report to be submitted as a future addendum to this report. Several field days and outreach events were completed during the project period, information about which are included in the SWCD final report.



Environment and Natural Resources Trust Fund (ENRTF)

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

Today's Date: 8/15/2022

Final Report

Date of Work Plan Approval: 06/05/2019

Project Completion Date: 06/30/2022

PROJECT TITLE: Accelerating perennial crop production to prevent nitrate leaching

Project Manager: Dennis Fuchs

Organization: Stearns County Soil and Water Conservation District

College/Department/Division:

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Location: Pope County, Stearns County

Total Project Budget: \$440,000

Amount Spent: \$345,225

Balance: \$94,775

Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04k

Appropriation Language: \$440,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Stearns County Soil and Water Conservation District to reduce nitrate leaching on sandy soils of central Minnesota by developing water-efficient production methods, supply chains, and end-use markets for three perennial crops: Kernza, prairie species, and alfalfa. Net income from the sale of products or assets developed or acquired through this project may be reinvested as described in the work plan approved by the Legislative-Citizen Commission on Minnesota Resources according to Minnesota Statutes, section 116P.10.

I. PROJECT STATEMENT:

The sandy soil cropland in Central Minnesota is prone to nitrate leaching; an environmental concern that degrades groundwater and poses human health risks for communities relying on groundwater for drinking water. Nutrient laded water flows quickly through these sandy soils. As a result, farmers need to irrigate crops, which further exacerbates nitrate leaching. Perennial plants are more effective at accessing nitrogen and water deep in the soil where annuals cannot, which means that perennial crops can be particularly effective at reducing nitrate leaching in sandy soils.

Our objective is to 1) measure nitrate leaching and 2) identify and develop commercialization opportunities for seed, forage, and grain from three perennial crops grown on sandy soil:

- **Native prairie** because it's known to provide ecosystem services and retain nitrogen on sandy soil but requires value chain research to improve the economics of seed production (for prairie restorations).
- **Intermediate wheatgrass (Kernza)** because it's a deep-rooted perennial grain that has potential to be profitable if supply chain work is conducted to align growers and end-users.
- **Alfalfa** because it's Minnesota's most common perennial crop but has limited nitrate retention benefits because it fixes nitrogen.

Native prairie and Kernza provide valuable seed, and all three perennials also provide biomass as a non-food co-product that can enhance profitability from sales as forage, straw, or biofuel. **This project will compare total net revenues from seed and biomass within each perennial cropping system with and without irrigation to determine economic viability on sandy soil while reducing nitrate leaching.**

The expansion of perennial crops in Central Minnesota is possible only if a market for their seed and biomass exists. Furthermore, identifying markets for their co-products will accelerate the adoption of these nitrogen-conserving crops. Currently, demand for Kernza exceeds supply because of supply chain challenges related to grain cleaning, processing, storage, and transportation. Minnesota's agricultural communities likely possess the technology and innovation to overcome the Kernza supply chain challenges, and this project will identify those assets and facilitate the supply chain resources necessary for rural Minnesota to capitalize on this unique economic opportunity. **This project will also conduct supply-chain research to identify markets for Kernza grain, native prairie seed, and perennial crop biomass.** This project will empower a unique team to study and implement Kernza so that it can reduce groundwater nitrate pollution and stimulate rural economies.

II. OVERALL PROJECT STATUS UPDATES:

AMENDMENT REQUEST November 25, 2019

Stearns County SWCD has developed subcontracts for each of the named partners (University of Minnesota, Agricultural Utilization Research Institute [AURI], and Pope SWCD/Rosholt Research Farm). In that process, AURI requested additional clarity to the scope of their work. Those adjustments are included in Activity 3. Therefore, Stearns County SWCD requests that the workplan be amended accordingly. In addition, descriptions of specific Professional/Technical/Service contract items are modified, though the total budget for each subcontract is unchanged.

Stearns SWCD has identified and contracted with two producers within the Cold Spring Drinking Water Supply Management Area to plant Kernza on 36 acres. Those crops were seeded in September 2019. Pope SWCD completed initial field work to prepare and plant the first Kernza planting at Rosholt Research Farm.

Amendment approved by LCCMR 1/13/20.

AMENDMENT REQUEST November 25, 2019

The activities identified above will be completed by the Agricultural Utilization Research Institute (AURI). Since the grant was awarded, AURI has brought on new staff who have evaluated the project and suggested adjustments to the scope of work as indicated. The overall activity budget remains unchanged. The activities will be completed in close cooperation with various food entrepreneurs, Minnesota food companies, U of MN food science faculty, identified growers, and seed and grain handlers in the state. Value chain development is important to ensure an economic and sustainable system for the landowners (farmers) as well as the community's environmental goals within the wellhead protection area. **Amendment approved by LCCMR 1/13/20.**

First Update March 1, 2020

Research plots to test soil nitrate levels under Kernza, native prairie, and alfalfa under both irrigated and non-irrigated conditions have been established at the Rosholt Research Farm. Thirty-seven acres of Kernza were planted in fall 2019 within the Cold Spring Drinking Water Supply Management Area. Although not funded by this grant, an additional ten acres of Kernza was planted adjacent to the City of St. Cloud's wastewater treatment plant to provide additional research opportunities on the ability of Kernza to uptake nitrate. Utilization and market research has begun but no results are yet apparent.

Second Update September 1, 2020

Lysimeters were installed to monitor water quality at the Rosholt Research Farm and Cold Spring. Water samples are being collected and water quality information will be presented in a future update. All the sites had the Kernza grain harvested in August. The Kernza grain and straw will be evaluated by AURI for seed cleaning, processing, and end-uses. Now with Kernza seed and straw available, AURI will be working with food and beverage companies to explore using Kernza in their products. A virtual field day was held on August 20, 2020 with over 150 registrations.

Third Update March 1, 2021

Few lysimeter samples were recovered from established Kernza fields during the 2020 growing season because of dry conditions. Stearns SWCD certified production and issued payment for the second (and final) payment at \$321 per acre for Kernza production to the two landowners in the Cold Spring DWSMA. AURI has continued research into the properties of Kernza grain and byproducts working with the Northern Crops Institute (milling) and C2Renew (straw). In addition, AURI has developed relationships with a variety of potential supply chain partners, including mills, bakeries, and breweries/maltsters. In October 2020, AURI hosted a Kernza webinar as part of its AURI Connects: Fields of Innovation initiative. The event featured presentations from Kernza experts at the University of Minnesota and Land Institute.

AMENDMENT REQUESTS June 29, 2021

Amendment Number One:

This amendment requests to extend the project by 1 year, to June 30, 2022 through the current expiration of the Legislative appropriation. This extension is needed due to delays caused by COVID-19 and a longer timeline to achieve the goals of the project.

Amendment Number Two:

This amendment requests the following changes to the “Professional/Technical/Service Contracts: Agricultural Utilization Research Institute” section of the budget for project Activity 3:

- Personal: Process Development would be reduced by \$4,400 to a revised budget of \$13,750
- Subcontract budget would increase by \$5,000 to a revised total of \$25,000
- Travel expenses in Minnesota budget would be reduced by \$1,250 to a revised total of \$2,750
- Equipment budget would increase by \$4,000 to a revised total of \$24,000
- Supplies budget would be reduced by \$3,350 to a revised total of \$2,650

Grain cleaning trials/contracted services with outside partners have reduced AURI’s workload in the Personal: Process Development area, allowing resources to be redirected to other budget lines. Additional contracted services funds will be used to cover expanded activities and testing with outside partners on product and process development, allowing AURI to pursue additional testing and provide more depth and breadth of information in the final report. AURI travel was lower than initially anticipated due to the pandemic, allowing funds to be reduced in this line item. Costs to obtain and ship the indent separator and impact dehuller were slightly higher than expected, leaving limited flexibility to address other emergent project needs. The proposed increase to the equipment line will provide additional funds for small equipment and associated supplies needed to support project activities, including grain storage bags and boxes for Kernza harvested from project plots and sieves for use on the impact dehuller. Due to the good yields and quality of Kernza harvested at the project test plots during 2020, the need to purchase additional grain for project activities has been quite limited. As a result, the supplies line is proposed for reduction. Expenses for supplies will also include costs to ship samples of Kernza grain and ingredients to labs and pilot partners for testing and product development activities. The budget line for “other”, which includes event expenses, remains unchanged, but now proposes to use some of these funds to cover costs to produce and distribute food samples that include Kernza-based ingredients to attendees at project field days/events to demonstrate the crop and its potential commercial uses. Feedback from event participants who try these samples will be gathered and used to inform ongoing Kernza ingredient and product development activities.

Amendment Approved by LCCMR 7/28/2021.

Fourth Update September 1, 2021

Field work and sampling continued throughout the 2021 growing season both at Rosholt Research Farm and the demonstration plots within the Cold Spring drinking water supply management area. Fertilizer (N) was applied to fields and plots and irrigation was frequently used at Rosholt due to the dry conditions. Technical evaluation of Kernza’s properties and processing for use in a variety of foods as well as coproducts has significantly advanced. Private sector vendors, including malters, brewers, millers, and bakers have been working with project partners to test new markets for processed grain. Several educational events were completed during the reporting period, including a field day at Rosholt Research Farm and a demonstration in conjunction with ROCORI FFA.

Fifth Update March 1, 2022

University of Minnesota continues analysis results to demonstrate nitrate leaching on Kernza fields and the Rosholt Research Farm has been maintained for ongoing research purposes. Agricultural Utilization Research Institute (AURI) has continued to research improvements in grain processing and handling and coordinate with industry to develop supply chain and marketing opportunities for processed grain. Dissemination activities have included a presentation at the Minnesota Water Resources Conference and several publications from AURI and Stearns SWCD. A final report with full analysis will be completed by June 30, 2022.

Final Report between project end (June 30) and August 15, 2022

The results of the studies funded through this project were compiled into a [final project report](#). The findings indicate that both Kernza and alfalfa should be considered suitable perennial crops for production on sandy soils in Minnesota, though nitrate levels in Kernza were found to be lower than alfalfa. The University of Minnesota will continue to compile the results into a peer reviewed paper as this project moves into phase 2. A [value chain and technical use report](#) was also developed, demonstrating market opportunities for Kernza use, both grain and byproducts, in the food and agriculture industry.

Overall Project Outcomes and Results

The City of Cold Spring in Central Minnesota has long struggled with increasing nitrate concentrations in its public water supply. Perennial cropping systems may reduce the amount of nitrate leached into groundwater. In partnership with the University of Minnesota Forever Green the project measured nitrate leaching under three perennial plant systems: 1) native prairie, 2) intermediate wheatgrass (Kernza), and alfalfa under irrigation and dryland plots. This research was conducted at the Rosholt Research Farm in Pope County (managed by the Pope Soil and Water Conservation District). The site has similar sandy soils as in the Cold Spring area. The native prairie planting had limited growth during study because of its slow growth and weed pressure. The perennial cropping systems that included Kernza and alfalfa were effective in reducing the nitrate concentrations in groundwater. Kernza was slightly more effective than alfalfa. Averaged across the growing season, the concentration of nitrate in the soil water measured by lysimeters was 0.64 mg/L, which is consider very low and like other reports below Kernza. It was also discovered that Kernza grain yields were highly affected by drought conditions in 2021, even under irrigation, significantly reducing yields. In partnership with the Agricultural Utilization Research Institute (AURI) value chains for Kernza were explored which will ultimately increase demand for production by farmers. Local breweries and bakeries developed products that provided valuable feedback for new product development. Field day attendance indicated that farmers were interested in growing more Kernza if a market exists. Also, consumers in attendance were interested in Kernza food and beverage products. In addition, both food and non-food value chains will need additional investment to fully develop the market. Kernza production in drinking water supply management areas could reduce nitrate leaching. This could save cities millions of dollars in water treatment costs.

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1 Title: *Quantify and compare nitrate leaching and yields of prairie, alfalfa, and Kernza grown with and without irrigation on sandy soils of Central Minnesota.*

Description: We will test the hypothesis that Kernza and native prairie seed production are more effective at reducing nitrate leaching than alfalfa on sandy soils of Central Minnesota under irrigated and rain-fed conditions by measuring soil water nitrate content using lysimeters. We will test the hypothesis that Kernza and native prairie seed and biomass yields will result in equal profitability with and without irrigation by measuring seed/grain and biomass yield annually. Economic assessments will be conducted using results from value chain research in Activity 3. This research will be conducted at the Rosholt Research Farm, a public research facility owned and operated by the Pope Soil Water Conservation District and within the Bonanza Valley Groundwater Management Area.

ACTIVITY 1 ENRTF BUDGET: \$251,608

Outcome	Completion Date
1. A report comparing soil water nitrate beneath Kernza, native prairie, and alfalfa managed with and without irrigation	June 30, 2022
2. A report comparing grain, seed, and biomass yield from Kernza, prairie, and alfalfa growth with and without irrigation	June 30, 2022

First Update March 1, 2020

Pope Soil and Water Conservation District completed site preparation and Kernza, native prairie, and alfalfa planting at Rosholt Research Farm between September 4 and September 6, 2019. The seed was planted using a Truax Drill rented from Swift SWCD. The test plots are both irrigated and non-irrigated. Lysimeters for measuring nitrate were installed under each of the plots.

In addition, the City of St. Cloud agreed to plant Kernza on 10 acres adjacent to the wastewater treatment plant. Although no payment was made for the acres, data will be collected there to supplement other information. Lysimeters will be installed in Spring 2020.

Second Update September 1, 2020

The first round of lysimeters installation occurred on May 14. The 24" lysimeters were successfully installed in all plots. Soil coring for the 48" deep lysimeters was unsuccessful. The hydraulic probe consistently encountered large rocks and coarse gravel at about 30" below the soil surface, which prevented the corer from being able to bore the hole deep enough for the lysimeters. The team used two different soil probe trucks with different auguring mechanisms, but neither were effective at boring through the rocks. Deep lysimeters were installed in 4 of the 12 plots. Soil moisture probe access tubes were installed. Urea was applied to the Kernza plots. Soil cores were collected on May 15 to quantify baseline soil conditions for comparing effects of perennial crops on soil nitrogen. The first alfalfa cutting occurred on June 17. Prairie plots were planted on June 23. Irrigation was applied on July 10 and July 13. The second and third alfalfa cut occurred on July 17 and August 19, respectively. Kernza grain was harvested on August 5. Lysimeters are being sampled at least every two weeks based on soil moisture conditions.

Third Update March 1, 2021

Lysimeter sampling continued until October 20, 2020. Lysimeter samples were collected from 17 dates during the growing season. Samples were analyzed by the UMN Research Analytical Lab for nitrate concentration. Soil moisture data were collected from 5 dates during the 2020 growing season. IWG grain samples were threshed in the lab, alfalfa biomass was ground and is being prepared for NIR scanning to determine forage quality. Plans are underway for spring fieldwork in 2021. Pope SWCD has provided ongoing field work assistance to maintain the plots, pulling of water quality samples, and irrigation of the plots.

Fourth Update September 1, 2021

University of Minnesota completed lab analyses of 2020 water and biomass samples in early spring 2021. Pope SWCD has completed ongoing field work to maintain plots, pull samples, and other needs as directed by University of Minnesota researchers. Lysimeters were primed on April 30 and samples were collected throughout the growing season. Fertilizer (100 kg N per ha) was applied to the IWG on May 7. Alfalfa harvest occurred on June 5 and August 3. IWG grain and biomass was harvested on August 3. Irrigation was applied on 6/8, 6/10, 6/14, 6/21, 6/24, 6/30, 7/2, 7/9, 7/12, 7/16, and 7/19

Fifth Update March 1, 2022

Grain and biomass yields have been determined after post-harvest processing. Yields were reported during a presentation at the Minnesota Water Resources conference by Dr. Jacob Jungers on October 19, 2021. Nitrate analyses on over 220 lysimeter samples were conducted to estimate nitrate leaching. These data were also reported during the conference presentation. Data analysis is underway for the final report in 2022.

Final Report between project end (June 30) and August 15, 2022

University of Minnesota researchers compiled and analyzed the data gathered during the two growing years of this study (2020 and 2021). The data and findings are [included in the full report](#). In summary, the research results indicate that Kernza grain yields were highly affected by drought conditions in 2021, even in the irrigated treatment, with less of an effect on straw and biomass. Alfalfa experienced much smaller reduction in yield between 2020 and 2021. Soil water nitrate, an indication of nitrate leaching potential, was substantially lower beneath Kernza compared to alfalfa and the in-process prairie restoration in both years of the study. This study

supports previous findings that Kernza’s deep and expansive root system is effective at capturing and utilizing nitrogen in the soil and soil water, thus reducing risks of nitrate leaching to groundwater.

Pope SWCD staff and newly hired interns assisted UM researchers in implementing agronomic and research activities during the 2022 growing season. This work will continue into Phase 2 of this project (M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 04i).

ACTIVITY 2 Title: *Kernza demonstration field in a Drinking Water Source Management Area*

Description: Establish two Kernza demonstration fields totaling 36 acres on privately owned, row-crop agricultural fields within the City of Cold Spring Drinking Water Source Management Area in Stearns County. These fields will be monitored for nitrate leaching and demonstrate field scale production. They will be the sites of two field days and outreach events. Grain from these fields will be used for supply chain research described in Activity 3.

ACTIVITY 2 ENRTF BUDGET: \$23,112

Outcome	Completion Date
1. Establish 36 acres of Kernza on two farms in Drinking Water Source Management Areas	June 30, 2021
2. Produce 12,000 pounds of Kernza grain for testing processing techniques and research	June 30, 2021
3. Demonstrate nitrate leaching reductions beneath Kernza fields	June 30, 2022
4. Host two field days and education events at the Kernza demonstration fields	June 30, 2022

First Update March 1, 2020

Stearns SWCD identified and contracted with two farmers within the Cold Spring Drinking Water Supply Management Area. The fields total 37 acres; 1 acre is being paid by the SWCD rather than charged to the grant. Stearns SWCD made payments for the first year for the field rent and custom services.

A tour on August 2, 2019 for the Minnesota Association of Professional Soil Scientists include an extensive stop at one of the Kernza fields. Participants learned about the project and the research being conducted. A full field day is planned for July 2020.

Second Update September 1, 2020

Lysimeters were installed in the 1st year Kernza field immediately north of Cold Spring on June 8. Similar to the Rosholt site, soil probes were unable to bore holes for lysimeters deeper than 30” as a result of large rocks and coarse gravel. Four lysimeters were installed 24” beneath the soil surface at this site, and the second-year Kernza field owned and operated by Brandon Dingmann in partnership with Stearns SWCD. Few lysimeter samples were collected at these sites as a result of relatively dry soil conditions and infrequent precipitation. Soil samples were collected for baseline analysis on June 23 and grain yield samples were collected on July 31.

All Kernza fields had varying degrees of weed pressure. To facilitate harvest all fields were windowed allowing the Kernza to dry a few days before combining. Kernza yields averaged approximately 400 lbs/ac across all fields.

A virtual field day (due to COVID-19 restrictions) was held on August 20 by the Pope and Stearns SWCD with 156 registered participants. The field day was done via ZOOM platform with 10-minute pre-recorded videos shared in advance to registrants. Presentations during the virtual field day included: Jake Jungers, Ph. D. Assistant Professor at the University of Minnesota titled “*Kernza and Water Quality*”, Constance Carlson, Co-Director Statewide Sustainable Ag and Food Systems with Forever Green Initiative titled “*Developing Supply Chains and Markets for Kernza*”, and Matthew Leiphon, Project Manager with Agricultural Utilization Research institute titled “*Kernza Perennial Grain*”. The virtual field day included 5-minute presentations from each presenter with a question-and-answer section of the panel of speakers. The event also included Clean Water Funded research trials including irrigation, living mulches and covers, and nitrogen. The virtual event was an hour and fifteen

minutes long. Opening and concluding remarks were shared from Pope and Stearns SWCDs and the Minnesota Department of Agriculture Commissioner Thom Peterson gave a few opening remarks. It was a successful partnered educational event and was widely publicized and advertised by various partners.

Third Update March 1, 2021

Few lysimeter samples were recovered from these fields during the 2020 growing season because of dry conditions. IWG grain yields were estimated by threshing seeds from harvested seedheads in the lab. In addition to grain yield estimates at the lysimeter points, additional samples were collected from the field site nearest the city of Cold Spring for high spatial resolution estimates of grain yields across the entire field.

Stearns SWCD certified production and issued payment for the second (and final) payment at \$321 per acre for Kernza production to the two landowners in the Cold Spring DWSMA. There are 36 acres of Kernza covered by these agreements and the crop is in good condition. Grain was harvested on August 5, 2020 with an average yield of 500 pounds per acre.

Fourth Update September 1, 2021

One of the demonstration fields (Dingman) was terminated in early May in accordance with the original farmer agreement and grant end date of June 30, 2021. Lysimeters in the other demonstration field (Thielen), nearer to the City of Cold Spring, were checked throughout the growing season; due to the drought, no samples were collected this year. Grain and biomass were harvested from that site on 7/27. Additional samples were collected throughout the field in conjunction with a UAV flight to determine if grain moisture and yield can be predicted using remote sensing. A self-guided tour of the demonstration sites was arranged in conjunction with the ROCORI FFA event (see IV. Dissemination).

Fifth Update March 1, 2022

UM has continued analysis of research results to demonstrate nitrate leaching beneath Kernza fields at the Rosholt Research Farm. Pope SWCD provided field services and treatment to the fields as requested by UM. Grain and biomass yields have been determined after post-harvest processing. Yields were reported during a presentation at the Minnesota Water Resources conference by Dr. Jacob Jungers on October 19, 2021. Nitrate analyses on over 220 lysimeter samples were conducted to estimate nitrate leaching. These data were also reported during the conference presentation. Data analysis is underway for the final report in 2022.

Final Report between project end (June 30) and August 15, 2022

University of Minnesota researchers compiled and analyzed the data gathered during the two growing years of this study (2020 and 2021) at the two dryland demonstration plots located near Cold Spring. The data and findings are [included in the full report](#). In summary, grain yield declined in year 2 (because of the drought) but was higher than dryland values observed at the Rosholt Research Farm that same year. Kernza straw yield was lower than yield at the Rosholt Research Farm. Averaged across the growing season, the concentration of nitrate in the soil water measured by lysimeters was 0.64 mg/L, which is consider very low and similar to other reports below Kernza.

ACTIVITY 3 Title: *Develop value chains for food and non-food applications of Kernza and native prairie seed and biomass*

Description: For food applications, examine Kernza as a food ingredient (bread, cereal, pasta, beer, etc.) with MN companies and map local processor capabilities, opportunities and barriers. Provide a preliminary assessment of supply chain costs, including buyer and seller price points; assess potential post-harvest aggregation points, processing, storage, and end-uses for organic and non-organic Kernza. Characterize and provide technical information on handling (clean and de-hull), storage, formulation and shelf life of selected Kernza product development concepts. Supply nutritional profiles for food/beverage containing Kernza and conduct sensory analysis (taste, texture, aroma, color) of general and selected Kernza-based food and beverage

applications. Develop a list of additional food and beverage applications utilizing Kernza as an ingredient for future development. Share this information at educational events.

For non-food applications, characterize Kernza and native prairie straw for feed value and identify potential markets; evaluate straw as pelleted fuel or biomass blend for heating and as composite for plastic/fiberglass/pressed wood applications and identify the companies that process the fiber. Examine the use of straw for poultry litter or bedding material. Report on the market size and options within Minnesota. Identify limitations and propose solutions.

ACTIVITY 3 ENRTF BUDGET: \$165,280

Outcome	Completion Date
1. Map, develop and report on Central Minnesota value chains utilizing Kernza in food and beverage production, including technical information on handling, storage, use, and formulation of Kernza food application concepts. Coordinate with project partners to provide information at educational events.	June 30, 2022
2. Investigate potential uses of Kernza and native prairie coproducts (straw and chaff) for utilization as feed, fiber, and fuel. Identify limitations of these coproducts and possible solutions	June 30, 2022

First Update March 1, 2020

A final contract was negotiated and approved by Stearns SWCD and AURI. AURI has identified the equipment that will be purchased for the project. Research has begun but no results are yet apparent. No funds have been spent to date.

Second Update September 1, 2020

Since project initiation, AURI process development staff have consulted with private and public sector experts to identify and refine cleaning and dehulling processes for Kernza. This work has included a focus on developing and sharing knowledge regarding food grade processing standards and processes. AURI is currently working with two private sector businesses interested in developing Kernza processing capacity and assisting them with equipment selection and food grade processing considerations. As part of this work, AURI will be arranging cleaning and dehulling of a portion of the remaining grain at Sprowt Labs in Savage in order to test their newly commissioned process and to produce grain for use in pilot projects. AURI is in the process of setting up the Forsberg Dehuller and is currently waiting for the completion of an indent separator which will be housed at AURI’s Waseca location to showcase small scale cleaning and dehulling of Kernza and to provide small amounts of cleaned, dehulled grain for research and product development among any potential pilot project partners who would like to experiment with the grain.

Over the past two months, AURI coordinated with project partners to facilitate the safe harvest and storage of the project’s Kernza plots. 18,000lb of Kernza grain which was harvested this year and vomitoxin and aflatoxin testing results indicate it will all meet standards needed for food grade pilot projects.

A portion of the Kernza harvested this year is being transported to HFI in Valley City to be cleaned and dehulled. This 6,000lb is expected to yield between 1,500-2,000lb of clean grain which will then be transported to the Northern Crops Institute in Fargo for milling and food product development work. AURI Food Science staff has been preparing plans over the past several months and will be working with NCI to facilitate these tests. The plan is to run trials for whole grain pasta, crackers, tortillas and donuts and to also get an updated milling report and yield for refined flour from Kernza.

In addition to work on food uses, 200lb of Kernza straw from this year’s harvest will be transported to C2Renew in Fargo for compounding into a biocomposite material to evaluate and showcase a potential market

opportunity. AURI's Coproducts team has been analyzing the opportunity to use Kernza straw and hulls as a feed, animal bedding, and bio-fuel pellets over the past several months and will include data and guidance on these uses in the final report.

AURI's supply chain and business development team has begun networking with various businesses who are interested in testing the use of Kernza in food and beverage products. Interested industries include bakeries, restaurants and breweries. Progress is being made on a supply chain map for cleaning, processing, and end-users which will provide an overview of the players in the industry and potential interest and new developments in the state of Minnesota surrounding Kernza.

While COVID issues have restricted our ability to stage in-person events to promote Kernza and its uses, AURI staff have participated in multiple virtual and in-person events of the past year to share information developed as part of our work on this project and our prior LCCMR-funded Kernza work. The AURI Connects team is continuing to identify alternative options for outreach and dissemination as part of the AURI Connects: Fields of Innovation program, and is planning to make use of webinars/online presentations to continue sharing information about Kernza with potential growers and end users over the next 9 months.

Third Update March 1, 2021

Despite challenges and delays caused by the COVID pandemic, AURI continues to make progress on multiple areas in our scope of work supporting this activity over the past several months.

AURI contracted with the Northern Crops Institute (NCI) in Fargo, ND to conduct milling assessments and food product development with Kernza® Perennial Grain. The work is now complete, and NCI is preparing a final report on their findings. Milling tests were conducted for both whole grain and refined flour. As part of this work, additional refined flour trials were performed at the Wheat Marketing Center (WMC) in Portland, Oregon. Flour from these trials was used in product development testing conducted at NCI under guidance from the AURI food science team. These trials tested Kernza® at various inclusion rates in applications including pasta, crackers, donuts, sourdough bread and tortillas. The AURI team is in the process of conducting a virtual internal sensory analysis of the NCI finished food products with results shared in the final project report.

As part of its work on developing pilot projects, AURI engaged with multiple central Minnesota businesses to try Kernza® products and processing applications. One key project has been launched with Swany White Milling in Freeport, which has been engaged as a toll milling partner. AURI visited the mill multiple times and run product through both a hammer mill and stone mill to produce ground whole grain flour. This flour will be used in other pilots and to provide samples as part of AURI's commercialization work.

Other notable pilot partners include a regional grocer in central Minnesota, which is exploring using Kernza® in its baked goods, and a local baker which is interested in using Kernza® in naan and flatbread products. Other businesses working with AURI's commercialization and technical team are exploring plans to pilot Kernza® in cereal and soups. AURI is also working with project partners to engage with restaurants and chefs to pilot the use of Kernza® pasta.

Breweries and maltsters have shown great interest in Kernza®, and several pilot projects are currently under development. Brewing projects are planned for both malted and unmalted grain. Early results from University of Minnesota testing showed in-hull grain is desirable for malting, while dehulled is useful for brewing successfully without malting. AURI separated in-hull grain from free threshed grain in Waseca using the indent separator to supply grain samples to Minnesota maltsters for initial testing. AURI is also working with Vertical Malting in Crookston, MN, to malt a pilot batch of Kernza® for use in brewing pilots over the next three months. AURI will collect feedback from all brewers on their experiences using Kernza® under the project and compile it in the final report.

In addition to its pilots exploring food uses, AURI has been working with C2Renew in Fargo, ND, to test the use of Kernza® straw in developing biocomposite materials. A successful compound was made with Kernza® straw sourced and ground at the AURI Waseca lab. C2Renew are currently working on a potential commercial use for the product in cups, plates and bowls.

To further this project's work, AURI purchased and commissioned an impact dehuller and indent separator, which along with an existing on-site aspirator, allows AURI the ability to clean and dehull Kernza® grain in Waseca at a scale of about 50-100lb/hr. AURI is in the process of installing a new food grade lab space as part of its which has space available to accommodate the Kernza® cleaning and dehulling activities. The food grade space should begin operation in March 2021, opening new opportunities for AURI to provide Kernza® for product testing and develop improved cleaning and processing procedures.

Work continues on development of a report on the current state and future outlook of the Kernza® supply chain in central Minnesota. A graduate intern from the Carlson School of Business at the University of Minnesota has been involved in developing this report, which will be included in the final project report. AURI has also engaged with regional producers who are working to develop a Kernza® growers cooperative, and efforts to support supply chain development activities in central Minnesota are ongoing.

Fourth Update September 1, 2021

AURI's value chain development efforts made significant progress over the past six months on multiple areas of its plan of work.

Collaboration continued with multiple project partners to build awareness of Kernza with potential end users. The AURI project team has coordinated with the University of Minnesota's Forever Green Initiative and the new Perennial Promise Growers Cooperative to share information and connect Minnesota businesses with samples of Kernza-based ingredients for initial product development testing. Potential end-users received samples of flour, Kernza pasta, cleaned grain, and malted Kernza to help build awareness, guide product development, and gather feedback from key stakeholders. AURI also initiated multiple pilot projects with multiple Minnesota businesses over the past several months to test products for market and has several potential projects, currently delayed due to pandemic-related challenges, in development. Active or pending pilot partners include restaurants, chefs, millers, grain cleaners, brewers, maltsters, and bakers.

AURI's pilot milling relationship with Swany White Milling in Freeport, MN has also continued. They continue to be a toll milling partner to provide Kernza flour to interested pilot project partners and new end users. Swany White is exploring the possibility of becoming a regional Kernza miller, which could play a key role in continued development of Kernza supply chain in central Minnesota.

Brewing and malting projects continue to show great potential. Rahr Malting malted several hundred pounds of cleaned, dehulled Kernza provided by AURI at their pilot scale malting facility, housed at the Rahr technical development center in Shakopee, MN. Rahr is in the process of writing a detailed report about their experience malting the grain which will be a deliverable of the project. Several Minnesota breweries have received samples of the Rahr malted Kernza to produce test batches of beer and provide feedback on its brewing characteristics. Minnewaska House Brewing, in Glenwood, MN, has also worked with AURI to develop two Kernza-based beers over the past six months. Baking uses are also an area of strong potential, with flatbreads showing particular promise. St. Cloud-based Artisan Naan Bakery has worked with AURI to develop new products and is currently working with AURI and other partners to develop supply chain connections that will allow them to produce more Kernza-based products in the future.

Analytical and process development work on Kernza product formulation has also made great progress. The Northern Crops institute has completed and submitted a detailed final report to AURI outlining the milling and food product development work conducted as part of the project. The report contains recommendations of

Kernza inclusion levels for the various tested products including crackers, tortillas, sourdough bread, pasta and donuts. The report is under review by AURI's food science team and will help guide recommendations to potential end users looking to use Kernza in their products.

Analysis of Kernza-based coproducts has continued to make progress. A contracted service provider, C2Renew, was able to successfully produce 500lb of Kernza/PLA bio composite pellets. They are currently working on a report and identifying a molding partner to produce prototype commercial items from the pellets.

Efforts to build regional Kernza cleaning capacity in support of growers in Minnesota have also continued. AURI's food grade room is now in service and houses the lab scale Kernza cleaning and dehulling equipment. AURI is also working with regional grain cleaners to help them develop cleaning capacity. A regional organic grain cleaning and processing company that works with Minnesota growers, received four large totes of dirty grain from the project to dial in their cleaning and dehulling equipment to work with Kernza. As a mid-scale grain cleaner just over the MN/SD border, they are interested in working with Minnesota Kernza growers and filling the cleaning/dehulling piece of the supply chain in the state. Working in coordination with a Minnesota-based growers cooperative, AURI provided information regarding cleaning and dehulling and this company was able to utilize their existing equipment to bring the Kernza to 99.7% clean of impurities. AURI's process development activities and final report will be informed by information from this pilot project.

Fifth Update March 1, 2022

AURI's supply chain activities continue to make progress towards development of sustainable supply chains for Kernza® in central Minnesota. The Northern Crops Institute completed a final report containing information on the food product development and milling research they conducted in coordination with AURI during 2021. This work supplements earlier research on refined Kernza® flour milling conducted for AURI by the Wheat Marketing Center. The Rahr Malting technical development center in Shakopee, MN also completed research focused on Kernza® malt development as part of AURI's work to identify market opportunities in the brewing industry. A pilot project at Beaver Island Brewery in St. Cloud used several hundred pounds of the malted grain. As part of this project, AURI researchers worked with Beaver Island to conduct a consumer survey to gather feedback on the beer and provide guidance for future market development efforts.

Despite this progress, COVID-related delays continued to create some challenges. AURI's work with an outside contractor to research development of Kernza® straw biocomposite materials faced negative impacts as outside processors dealt with lab shutdowns and processing capacity issues. While there was progress made on development of Kernza®-PLA biocomposite pellets, planned molding work will likely see delays until after the end date of this LCCMR project. The final report will include the information developed and will also be used to pursue additional product development as part of continued pursuance of the LCCMR-funded Kernza® research by AURI on behalf of Stearns County Soil and Water Conservation District following the end of this project.

AURI also continued to expand its activities to share information developed during this project and coordinate efforts to build a sustainable supply chain for Kernza® in Central Minnesota. AURI's supply chain team has taken part in multiple meetings with key stakeholders, including the Minnesota-based Perennial Promise Growers Cooperative, the Forever Green Initiative and regional supply chain members including millers, grain processors, and bakers, to coordinate efforts for establishing supply chain logistics for Kernza® in the region. Over the past six months AURI also added a new Business Development Director of Novel Supply Chains, who will help lead AURI's efforts to use the knowledge and connections developed during this project to support continued development of supply chains for Kernza® throughout Minnesota.

Final Report between project end (June 30) and August 15, 2022

AURI's supply chain development, technical, and outreach teams have focused their efforts over the past several months on completing project activities and deliverables. In addition to this work, the AURI project team has been working with project partners to transition into the next phase of value chain development as part of the

LCCMR-funded Long-Term Nitrate Mitigation by Maintaining Profitable Kernza Production (ID: 2021-384) project led by SCSWCD through June 2024.

Outreach and networking efforts continued over the past four months, as AURI staff attended and presented at Kernza-focused events. In April, AURI's Director of Novel Supply Chain Development attended the Land Institute's Kernza Con22, to connect with stakeholders and share information about the project and ongoing efforts to develop sustainable supply chains for Kernza in Minnesota. In June, AURI staff attended Kernza Fest in Lake City, Minn, and made a presentation about the market development activities that have been supported by this project. In addition to attending events, in March AURI released a new "Innovator Profile" featuring St. Cloud's Beaver Island Brewing. This article, shared on AURI's website and social media channels, highlighted Beaver Island's pilot project creating a new Kernza-based beer.

As a final part of completing its project's activities, AURI developed a [value chain report](#) and will release a final version to raise awareness of the results of this project and promote ongoing value chain development efforts. Copies of this final report will be available online at auri.org.

IV. DISSEMINATION:

Description: Research results will be summarized and presented in the LCCMR final report document. In additions, research results from the Activity 1 will be published in a peer-reviewed manuscript, presented at the Minnesota Water Resources Conference, and summarized in a two-page handout designed for a broad range of audiences including farmers, policy-makers, business leaders, and others. This handout will be made available to attendees of a Kernza water quality field day that will be held in 2020 and 2021. Information from activity 3 will be disseminated at the field days, as well as in a value-chain summary report. This report will be made available online on multiple high-visitation websites.

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 March 1, 2020

No progress.

Second Update September 1, 2020

A virtual field day was held in August 2020. Project partners University of Minnesota and AURI presented information on their research projects and progress to date. Presentations may be viewed online: <https://drive.google.com/drive/folders/1WBj94RIA0seB0Dq1ZnsPitzevfl84PeB> (items 1 and 3)

Third Update March 1, 2021

Outreach and education efforts have also been ongoing, despite the challenges presented by the COVID pandemic. In October 2020, AURI hosted a Kernza® webinar as part of its AURI Connects: Fields of Innovation initiative. The event featured presentations from Kernza® experts at the University of Minnesota and Land Institute. Recordings of this event have been shared through AURI's online platforms. AURI also made a presentation about our Kernza® commercialization activities at events hosted by the University of Minnesota in February 2021 and continues to make plans for future events and outreach to share results of the pilot projects and build public awareness of Kernza®.

Fourth Update September 1, 2021

As part of its outreach and dissemination activities, AURI's commercialization and technical teams took part in supporting and staging multiple events over the past several months, sharing information about Kernza with a

wide variety of stakeholders. In July, AURI participated in a University of Minnesota Kernza Field Day at A-Frame Farm in Madison, MN. In August, AURI presented about Kernza and our commercialization efforts at the Pope SWCD Rosholt Field Day. AURI also partnered with the ROCORI High School FFA and other project partners to plan and host a Kernza Field Day in Cold Spring, MN on July 17. The event featured multiple presenters and exhibitors, sharing information about Kernza, its uses, and its environmental benefits and received coverage in multiple local media outlets, including a front-page article in the St. Cloud Times. AURI provided samples of Kernza-based products produced by AURI's pilot partners, including local bakeries, mills and chefs to the approximately 150 attendees, and feedback was collected from participants to guide future commercialization efforts and inclusion in the final value chain report. In addition, Stearns County SWCD created a self-guided tour option of the demonstration fields for interested attendees. AURI staff have continued working with ROCORI FFA to educate students and the community in Stearns County about Kernza and its potential uses, markets, and ecological benefits.

Fifth Update March 1, 2022

Jacob Jungers delivered a presentation on results from this study at the Minnesota Water Resources Conference. That presentation can be viewed here: https://mediaspace.umn.edu/media/t/1_wwfomlg8. PI and Co-PIs on this project were listed as collaborators and co-authors of the presentation.

AURI's dissemination activities have continued, with a focus on sharing information about Kernza® and its uses and environmental benefits with a wider audience. In February, AURI featured one of the project's pilot partners, Artisan Naan Bakery, and highlighted the work they are doing to develop and market new Kernza®-based products in an "innovator profile" shared through AURI's social media and online channels. AURI's outreach team also plans to take part in future field days and outreach events during the summer of 2022, to share more information about Kernza®, its uses, and disseminate information developed during this project.

Stearns SWCD included two pages about the ongoing Kernza project, including preliminary research results, in the 2021 Annual Report, released in late February 2022 (available online: <https://drive.google.com/file/d/1g6uyz8CO8fCsi497GjjhhY6PSL86zgOy/view?usp=sharing>).

Final Report between project end (June 30) and August 15, 2022

A final report compiling each of the pieces included in this project, as well as a full listing of dissemination events and publications, is [posted online](#) and will be hosted at www.StearnsCountySWCD.net/kernza.

A field day has been scheduled and is being advertised for August 18, 2022. "Kernza-A Perennial Grain Crop for Cleaner Water and Improved Soil Health" is one of the topics that will be presented at the field day.

V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures

Explanation of Capital Expenditures Greater Than \$5,000: For Activity 3, subcontractor Agricultural Utilization Research Institute (AURI) will purchase equipment valued at \$20,000 specific to the project:

- Forsberg Model 7-F Impact Huller SS
 - Estimated cost with shipping and taxes: \$11,000
- Lab-scale Indent Separate Machine and Screens for Hull Separation
 - Indent separator to be used for grain cleaning and dehulling process development
 - Screens for dehulling will be purchased base don need as process tests are conducted and technical standards are developed
 - Estimated cost with shipping and handling: \$9,000

Use of Equipment

This equipment will be used by AURI technical staff to characterize, test, and develop improved processes for handling, cleaning, dehulling, and processing Kernza grain and non-grain biomass for use by end users. The equipment will also be used to dehull Kernza grain harvested by project partners for use in the project’s product development activities and to examine opportunities and barriers in the development of Minnesota-based Kernza processing facilities.

Disposition of Equipment at End of LCCMR Project Period

Minnesota currently has no firms that offer specialized, small-scale Kernza dehulling services. AURI plans to use the equipment, and the technical data and processes developed using it, to provide a Kernza “dehulling test center” following the end of the LCCMR grant period. The equipment will be used to provide small scale users the ability to dehull Kernza for use in R&D and product development activities aligned with the goals of the initial LCCMR project. AURI will also use the equipment to provide training, data, and process development support to businesses interested in developing their own Kernza processing capacity. These efforts will be ongoing as Kernza production within the state grows. If this post-LCCMR use plan is not pursued or does not meet LCCMR standards for continued use of equipment after the end of grant period, AURI will follow the LCCMR guidance on “pay back” to the Environment and Natural Resources Trust Fund, and provide the ENTRF “an amount equal to either the cash value received or a residual value approved by the director of the LCCMR if it is not sold.”

Explanation of Use of Classified Staff: NA

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

Enter Total Estimated Personnel Hours for entire duration of project: NA, all in-kind	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE: None
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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: 5824	Divide total contract hours by 2,080 hours in 1 yr = TOTAL FTE: 2.8
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VI. PROJECT PARTNERS:

A. Partners outside of project manager’s organization receiving ENRTF funding

Name	Title	Affiliation	Role
Dr. Jacob Jungers	Research Assistant Professor	University of Minnesota	Oversee the experiments including crop agronomics, plant and soil sampling, and data analysis
Matthew Leiphon	Project Manager	Agricultural Utilization Research Initiative (AURI)	Manage team to conduct supply chain development activities and outreach events
Ms. Holly Kovarik	District Manager	Pope County Soil and Water Conservation District	Manages the Rosholt Research Farm

B. Partners outside of project manager’s organization NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Margaret Wagner	Supervisor, Clean Water Technical Assistance Unit	Minnesota Department of Agriculture (MDA)	Advise on project outcomes and deliverables
Mark Wettlaufer	Planning Supervisor	Minnesota Department of Health (MDH)	Advise on project objectives and deliverables, review reports
Aaron Meyer	Source Water Specialists	Minnesota Rural Water Association (MRWA)	Advise on project objectives and deliverables, review reports and outreach materials

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

The long-term strategy is to develop perennial crops with high economic value and environmental benefits including improved groundwater quality. This project complements the 2018 LCCMR project 057-B related to Kernza production in wellhead protection areas, which has been recommended for funding at 33% of the original project budget. This proposed project is unique in that it compares water quality benefits among other perennial crops, and that the research tests the effects of irrigation. Another differentiating feature that this project includes the supply chain aspects of marketing perennial crop seed, grain and biomass. This project will further expand the application portfolio for Kernza and perennial crops.

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted March 1 and September 1 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2022

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

- A. Budget Spreadsheet**
- B. Visual Component or Map**
- C. Parcel List Spreadsheet - NA**
- D. Acquisition, Easements, and Restoration Requirements - NA**

E. Research Addendum - NA

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, Sec. 2, Subd. 04k

Project Manager: Dennis Fuchs

Project Title: Accelerating perennial crop production to prevent nitrate leaching

Organization: Stearns County Soil and Water Conservation District

Project Budget: \$440,000

Project Length and Completion Date: Three years, 6/30/2022

Today's Date: 8/15/2022



ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Revised Budget 12/18/2019	Amount Spent	Balance
BUDGET ITEM			
Professional/Technical/Service Contracts: University of Minnesota	\$ 193,044	\$ 117,414.16	\$ 75,630
Personnel: Postdoctoral Researcher - 50% FTE per year for 2 years, 78.6% salary and 21.4% fringe to oversee field and lab research and produce deliverables. (Total = \$61,307)		\$ 55,669	
Personnel: Technician - 20% FTE per year for 2 years, 73.8% salary and 27.2% fringe conduct field research tasks such as planting, weeding, and harvesting research plots. Oversee processing of research samples. (Total = \$24,666)		\$ 31,608	
Equipment/Tools/Supplies - 64 lysimeters @ \$80 per lysimeter and 120 soil moisture sensors @ \$150 per sensor. (Total = \$38,055)		\$ 18,436	
Analysis - Plant C/N, soil C/N, soil nitrate, soil physical characteristics, lysimeter soil water nitrate. (Total = \$54,016)		\$ 3,173	
Travel expenses in Minnesota: Funds for 2 UMN personnel to make 12 trips per year from St. Paul to Rosholt Research Farm (245 miles round trip) to collect soil water samples. Expenses include M&IE each day and lodging for 10 nights. Travel expenses for 2 UMN personnel to make 12 trips per year from St. Paul to Cold Spring (160 miles roundtrip) to collect soil water samples. Expenses include M&IE each day and no lodging. Funds can also be used for travel in Minnesota to disseminate research findings as professional conferences, symposia, field days, or other appropriate meetings (Total = \$14,000)		\$ 8,077	
Research Plot Fees: 2 acres per year @ \$225 per acre for Rosholt Farm Research plot fee. (Total = \$1,000)		\$ 450	
Professional/Technical/Service Contracts: Pope County Soil Water Conservation District	\$ 58,564	\$ 50,194.64	\$ 8,369
Personnel: Rosholt Farm Administrator - 10% FTE per year for 2 years, \$64.67 per hour (including fringe and travel) to oversee and implement Rosholt Research Farm tasks specific to this project. (Total = \$26,903)			
Personnel: Undergraduate Intern - 50% FTE per year for 2 years plus 7.65% fringe to collect and process lysimeter samples. (Total = \$31,661)			
Professional/Technical/Service Contracts:Kernza production fee for services - Fee for services to operators to prepare fields, plant seed, apply fertilizer, harvest grain, and harvest biomass residue for Kernza production fields. Estimates of inputs and labor costs come from farm economic spreadsheet models developed by Bill Lazarus (http://wlarzus.cfans.umn.edu/william-f-lazarus-farm-machinery-management) = 36 acres @ \$321 per acre per year for two years. Total = \$23,112	\$ 23,112	\$ 23,112.00	\$ -
Professional/Technical/Service Contracts:Agricultural Utilization Research Institute	\$ 165,280	\$ 154,504.11	\$ 10,776
Personnel: Supply Chain - 13.9% FTE per year for 2 years at \$55 per hour (including fringe) to map, develop, and report perennial grain utilization in various applications. Total = \$31,900		\$ 31,892	
Personnel: Process Development - 6.0% FTE per year for 2 years at \$55 per hour (including fringe) to work on grain processing and food application development. Total = \$13,750		\$ 12,444	
Personnel: Analytical - 5.8% FTE per year for 2 years at \$55 per hour (including fringe) to evaluate and characterize Kernza byproducts and biomass. Total = \$13,200		\$ 8,924	
Personnel: Food Science - 8.2% of FTE per year for 2 years at \$55 per hour (including fringe) to characterize and examine Kernza for use in food applications. Total = \$18,700		\$ 17,518	
Personnel: Outreach, Events, and Dissemination - 7.0% of FTE for 2 years at \$55 per hour (including fringe) to organize and stage field days and educational programs to build awareness of Kernza and its uses. Total = \$15,950		\$ 15,950	
Personnel: Project Management - 5.9% of FTE per year for 2 years at \$55 per hour (including fringe) to manage the budget, scheduling, coordination of reports, and general oversight. Total = \$13,365		\$ 13,365	
Subcontract - Expenses for sub-contracting analytical services-. Total = \$25,000		\$ 23,265	
Travel expenses in Minnesota: Travel to collaborator sites, meetings with growers, end-users. Total = \$2,750		\$ 2,746	
Equipment - Purchase grain dehulling equipment as needed to test and develop Kernza processing technical information. Total = \$24,000.		\$ 23,994	
Supplies - Purchase additional Kernza and ship samples of Kernza grain and ingredients to research facilities and pilot partners as needed to meet testing and product development needs. Total = \$2,650		\$ 2,045	
Other: Expenses related to targeted forums, research dissemination and outreach activities. Expenses will include costs to produce and distribute samples of Kernza-based foods at field days to demonstrate the crop and its uses and gather consumer input on product development. Total = \$4,015		\$ 2,363	
COLUMN TOTAL	\$ 440,000	\$ 345,225	\$ 94,775

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Spent	Balance
Non-State:		\$ -	\$ -
State:		\$ -	\$ -
In kind: Stearns County SWCD time. 100 hour per year at \$65 per hour (salary + fringe) for two years (\$13,000). Kernza seed for Activity 2 - 36 acre demonstration field (\$2.00 per pound, 15 pounds per acre at 36 acres = \$1080)	secured	\$ 13,000	\$ (13,000)

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

