

Final Abstract

Final Report Approved on October 23, 2024

M.L. 2021 Project Abstract

For the Period Ending June 30, 2024

Project Title: Long-Term Nitrate Mitigation by Maintaining Profitable Kernza Production

Project Manager: Dennis Fuchs

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Funding Source:

Fiscal Year:

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 04i

Appropriation Amount: \$485,000

Amount Spent: \$435,763

Amount Remaining: \$49,237

Sound bite of Project Outcomes and Results

Kernza can improve agricultural sustainability by reducing nitrate leaching into groundwater - similar to levels achieved by a native prairie - while generating nutritious grain. Monitoring Kernza fields over multiple years, provided valuable insights into the crop's long-term impact on water quality and its potential to contribute to sustainable agriculture.

Overall Project Outcome and Results

Nitrate pollution from agriculture is a significant environmental and human health concern in Minnesota. This project aimed to evaluate the effectiveness of Kernza, a perennial grain crop, in mitigating nitrate leaching and providing other ecosystem benefits. By monitoring Kernza fields over multiple years, we assessed the crop's long-term impact on water quality, soil health, and agricultural profitability. Our findings indicate that Kernza can significantly reduce nitrate leaching compared to traditional annual crops. Additionally, Kernza has shown promise in improving soil health, promoting biodiversity, and sequestering carbon. These results highlight the potential of Kernza to play a crucial role in sustainable agriculture and environmental protection in Minnesota. One of the key challenges in promoting the adoption of Kernza is the development of profitable markets for the grain. This project has focused on developing sustainable supply chains and identifying potential markets for Kernza-based products. By working with farmers,

processors, and retailers, we have made progress in creating a viable market for Kernza, which can incentivize its adoption and contribute to the long-term sustainability of agriculture in Minnesota.

Project Results Use and Dissemination

The results of this project have been disseminated through a variety of channels, including peer-reviewed publications, conference presentations, and in-person outreach events. We have also collaborated with local and state agencies to inform policy decisions and promote the adoption of Kernza. By sharing our findings with a broad audience, we hope to raise awareness of the potential benefits of Kernza and encourage its adoption as a sustainable agricultural practice.



Environment and Natural Resources Trust Fund

M.L. 2021 Approved Final Report

General Information

Date: November 18, 2024

ID Number: 2021-384

Staff Lead: Michael Varien

Project Title: Long-Term Nitrate Mitigation by Maintaining Profitable Kernza Production

Project Budget: \$485,000

Project Manager Information

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Project Reporting

Final Report Approved: October 23, 2024

Reporting Status: Project Completed

Date of Last Action: October 23, 2024

Project Completion: June 30, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 04i

Appropriation Language: \$485,000 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 evaluate the effectiveness of aging Kernza stands on water quality and to continue to develop a sustainable supply chain with a focus on post-harvest processing of Kernza for water protection and local economies.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: Long-term nitrate mitigation by maintaining profitable Kernza production will evaluate the effectiveness of aging Kernza stands on water quality. Continue to develop a sustainable supply chain, focusing on post-harvest processing.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Nitrate leaching from crop fields to groundwater pollutes natural habitats and threatens human health. A new perennial grain crop called Kernza® can reduce nitrate leaching and provide other ecosystem services such as carbon sequestration, wildlife habitat, and soil conservation, all while keeping farmland in production. However, Kernza grain yields decline in the 3rd year, reducing profitability. This project will continue monitoring existing LCCMR Kernza plantings and determine how yields can be maintained while still preventing nitrate leaching.

This opportunity is critical for two reasons: 1) It is very rare to be able to monitor water quality in a novel crop like Kernza for more than three years, and this project would provide the first long-term dataset of its kind in the world. 2) Markets and supply chains for Kernza are emerging in Minnesota faster than anywhere in the USA, thus our state is poised to show our country how a perennial crop that protects drinking water can also improve the agricultural economy. This project would both contribute to and take advantage of the emerging Kernza market.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

The State of Minnesota has a rare and valuable opportunity to enhance the protection of drinking water and the environment for citizens. A previous LCCMR grant (details below) successfully established and instrumented three Kernza fields – one in a replicated experiment in Pope County and two in large-scale research and demonstration fields in Stearns County – both areas with elevated groundwater nitrate levels. It has also developed Kernza product specifications and processing procedures to ensure that grain harvested from these fields can be safely and economically incorporated into various food and beverage products to stimulate local economies. The previous project is set to end on June 30, 2022 (extension requested), and this project would extend monitoring and commercialization activities for years 2021 – 2024.

Specifically, this project will measure nitrate leaching below aging Kernza stands (years 3-5), test different methods of stimulating grain yields in aging stands, and determine the effects of those methods on water quality. This project will also continue to research and develop sustainable supply chains with an emphasis on post-harvest handling and processing optimization for various food and non-food products. Results will be disseminated to a wide range of stakeholders through extensive outreach events and networks.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state’s natural resources?

Minnesota’s current agriculture is dominated by annual crops like corn and soybean that grow during the summer, leaving land bare and brown for much of the year. Without active plant root systems to hold soil in place and absorb water, fields are much more vulnerable to wind and water erosion, and nutrient leaching; both major contributors to non-point source pollution. By adding perennial, like Kernza, improvements to water quality, such as drinking water, can be achieved because these crops are active during most of the year, including the fall, winter and spring when summer annual crops are absent.

Project Location

What is the best scale for describing where your work will take place?

Region(s): Central

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Identify stand renovation methods to increase nitrate leaching mitigation and grain yield in ageing Kernza stands.

Activity Budget: \$270,000

Activity Description:

Continue monitoring existing Kernza research plots as they age at the Rosholt Research Farm using lysimeters and soil water sensors to measure water quality and nitrate leaching in years 3-5. Tasks include collecting soil water samples from lysimeters every two weeks during three growing seasons, 2021, 2022 and 2023, analyzing nitrate concentration in all soil water samples, measuring soil moisture at various depths every three weeks, applying irrigation to half of the plots, monitoring soil conditions, and measuring biomass and grain yields annually. Field work will be completed by Pope SWCD in coordination with researchers from University of Minnesota.

We will impose two yield renovation treatments in year four (year two of this project) to established Kernza stands managed with and without irrigation at the Rosholt Research Farm. The two renovation treatments will include one organic option using strip tillage and one conventional option using herbicides. Both treatments will strive to terminate 8” wide strips while maintaining 24” wide rows of Kernza. Based on preliminary data, the tillage treatments will be imposed in the fall and the herbicide treatments will be imposed in the spring. These treatments will be applied as a split-plot factor to the existing experiment at Rosholt.

Activity Milestones:

Description	Approximate Completion Date
Impose renovation treatments to four-year-old Kernza stands	September 30, 2022
Report first-year grain yield responses to renovation treatments	December 31, 2023
Recommend practices to enhance mitigation of nitrate leaching and Kernza yields in ageing stands	June 30, 2024
Report changes in nitrate leaching and yields beneath Kernza over a 5-year production system.	June 30, 2024

Activity 2: Support local grower adoption of Kernza production through outreach and networking

Activity Budget: \$55,000

Activity Description:

Technical and financial (incentive payment) support will be provided to growers in the Cold Spring watershed to plant additional Kernza acreage to provide perennial cover in sensitive and near drinking water source management areas (DWSMAs) in the region with the intent to prevent nitrate leaching to groundwater and bolster local economies. The incentive payment (similar to cover crop incentive payments) will hopefully encourage farmers to plant an additional 100 acres Kernza in the DWSMA and adjacent areas. Results from activities 1 and 3 will be disseminated to various stakeholders including growers, concerned citizens, agencies, non-profits, businesses, and others working to protect Minnesota drinking water. A special session on Kernza production and water quality will be held at the annual Rosholt summer field day, which attracted 100 participants in 2019. Dissemination and outreach will also occur through other activities supported by Pope and Stearns County SWCDs, including events focused on drinking water quality.

Activity Milestones:

Description	Approximate Completion Date
Coordinate Annual Rosholt Field Day to share information on Kernza study and opportunities	September 30, 2022
Coordinate Annual Rosholt Field Day to share information on Kernza study and opportunities	September 30, 2023

Share information developed during project through events, publications, and other outreach activities.	June 30, 2024
Support growers by providing technical assistance and incentives for Kernza production	June 30, 2024
Coordinate project activities	June 30, 2024

Activity 3: Build sustainable supply chains, enhance utilization, and assess storage and handling techniques for Kernza

Activity Budget: \$160,000

Activity Description:

Work on this activity will support the development of sustainable supply chains for Kernza® through technical assistance, commercialization, and stakeholder engagement. Technical work is focused on the evaluation of post-harvest handling, cleaning, drying, and storage of Kernza®. Tests will be conducted to evaluate the effectiveness of different grain drying technologies. We will select conditions and technologies that will result in minimal grain damage from harvest while maximizing yield and quality. We will also assess the optimal harvest and storage conditions (moisture, drying temperature, duration) to enable effective on-farm storage of Kernza® grain, providing recommended technologies and process operating conditions. Supply chain development efforts will be aimed at expanding uses and markets for Kernza®, with a special focus on the advancement of ecosystems services models that will provide additional economic returns to growers and increase market viability. AURI staff will also work with Minnesota businesses on pilot projects to test and demonstrate market-ready Kernza® food and non-food products. AURI’s outreach component will include organizing an annual field day and inclusion of Kernza®-related programming at annual AURI “Fields of Innovation” events to further awareness, knowledge-sharing, and action planning and build stronger commercialization and supply chain networks for Kernza®.

Activity Milestones:

Description	Approximate Completion Date
Identify and evaluate methods for post-harvest handling, cleaning, drying, and storage of Kernza®.	September 30, 2023
Provide technical assistance to Minnesota businesses developing Kernza®-based products and processing capacity	December 31, 2023
Disseminate information developed during project through events, publications, and other outreach activities.	June 30, 2024
Support grower profitability and sustainability through ecosystem services markets and continued supply chain development.	June 30, 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Michael Stutelberg	Agricultural Utilization Research Institute	Lead supply chain activities	Yes
Holly Kovarik	Pope County Soil and Water Conservation District	Manage Rosholt research plots	Yes
Margaret Wagner	Minnesota Department of Agriculture	Oversee deliverables on water quality	No
Jacob Jungers	University of Minnesota	Lead Kernza research	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

Research results will be summarized and presented in the LCCMR final report document. Communication of study results and best practices through field days, events, publications, and presentations will also be employed during the project to support adoption of Kernza to achieve water quality, soil improvement and other environmental benefits in Minnesota.

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.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

This work is part of the Forever Green Initiative, a coordinated effort to develop the next generation of perennial crops to protect Minnesota's environmental resources. Clean Water Funds allocated to the Forever Green Initiative are used for the basic research needed to develop new crops. LCCMR funds are crucial for studying the environmental aspects of these new crops and supporting field-scale deployment of new crops – which we have demonstrated from previous LCCMR appropriations below. LCCMR funds help Minnesota citizens realize the environmental and economic benefits of new Forever Green crops. Related projects are supported by federal grants and industry.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Accelerating Perennial Crop Production to Prevent Nitrate Leaching	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04k	\$440,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount	\$ Amount Spent	\$ Amount Remaining
Personnel										
Grants Administration Coordinator		Coordinate grant reports and budgets			30%	0.09		\$12,000	-	-
Project Coordinator		Coordinate project			30%	0.06		\$7,000	-	-
							Sub Total	\$19,000	\$10,285	\$8,715
Contracts and Services										
University of Minnesota	Sub award	(Activity 1) Identify stand renovation methods to increase nitrate leaching mitigation and grain yield in aging Kernza stands. Personnel = \$166,578; Sampling equipment, lab analysis = \$46,248; Research rental fee = \$1,500; Travel = \$5,674 (numbers rounded to approximate value)				6		\$220,000	\$220,000	-
Ag Utilization Research Institute (AURI)	Sub award	(Activity 3) Build sustainable supply chains, enhance utilization, and assess storage and handling techniques for Kernza; and support local grower adoption of Kernza production through outreach and networking. Personnel = \$128,000 Supplies = \$7,000 Contracts = \$16,500 Field Days = \$3000 Travel = \$5500 (Approximate values due to rounding)				1.5		\$160,000	\$160,000	-
Pope County SWCD	Sub award	(Activity 1 & 2) Implement field work on research plots at Rosholt Research Farm and assist with networking and outreach to farmers.				1.38		\$61,000	\$44,478	\$16,522
							Sub Total	\$441,000	\$424,478	\$16,522

Equipment, Tools, and Supplies										
							Sub Total	-	-	-
Capital Expenditures										
							Sub Total	-	-	-
Acquisitions and Stewardship										
							Sub Total	-	-	-
Travel In Minnesota										
							Sub Total	-	-	-
Travel Outside Minnesota										
							Sub Total	-	-	-
Printing and Publication										
							Sub Total	-	-	-
Other Expenses										
		Incentive payment to farmers to grow 100 additional acres of Kernza in Cold Spring's DWSMA.	(Activity 2) Incentives will help with goal of additional acres of Kernza in DWSMA, improving drinking water quality.	X				\$25,000	\$1,000	\$24,000
							Sub Total	\$25,000	\$1,000	\$24,000
							Grand Total	\$485,000	\$435,763	\$49,237

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Other Expenses		Incentive payment to farmers to grow 100 additional acres of Kernza in Cold Spring's DWSMA.	All farmers in the Cold Spring DWSMA with row-crop production fields 10 acres or greater in size would be contacted. A sign-up deadline would be established. If more that 100 acres, fields would be scored and ranked. Approved farmers would be required to have Kernza in production for 3 years.

Non ENRTF Funds

Category	Specific Source	Use	Status	\$ Amount	\$ Amount Spent	\$ Amount Remaining
State						
			State Sub Total	-	-	-
Non-State						
			Non State Sub Total	-	-	-
			Funds Total	-	-	-

Attachments

Required Attachments

Visual Component

File: [c7e938ef-01a.pdf](#)

Alternate Text for Visual Component

As Kernza stands age, they produce fewer seeds but more plants. Preventing yield decline with inter-row cultivation or herbicide - but does this affect nitrate leaching?...

Board Resolution or Letter

Title	File
Stearns SWCD Letter	41a9b446-66e.pdf

Supplemental Attachments

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

Title	File
Background check	40978ad5-33d.pdf
2022-12-01 Figure 1	13e50579-5f0.jpe
2022-12-02 Figure 2	7794ef2b-46a.jpe
2022-12-01 Figure 3	c4e6e2a3-310.jpe
2023-06-01 Figure 1	30e0f0ad-99e.jpe
2023-06-01 Figure 2	076f5347-1fb.jpe
2023-06-01 Figure 3	0cfa9dde-ee5.jpe
2023-06-01 Table 1	7cc3b038-99e.jpe
2023-12-01 Figure 1	4debf64d-236.jpe
2023-12-01 Figure 2	31e7a57d-a25.jpe
2023-12-01 Figure 3	8309933a-7d0.jpe
Final Report Activity 1 (UM)	2b78e90c-4c2.pdf
Final Report Activity 3 (AURI)	54c59135-450.pdf

Media Links

Title	Link
Rosholt Research Farm	https://popeswcd.org/program/rosholt-research-farm/
University of Minnesota Forever Green	https://www.forevergreen.umn.edu/crops-systems/perennial-grains-oilseeds-pulses/kernza

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Reduced budget for all activities by 15%. Activity 1: removed research activity on farm production fields. Research will be focused at Rosholt Research Farm. For activity 2 & 3 reallocated work load to meet reduced budget.

7/12/2021

Added "Other Expenses" Budget Item for incentive payment to farmers to grow Kernza in Cold Spring's DWSMA of \$25,000. Activity 2 goal is to encourage farmers to grow additional 100 acres of Kernza in the City of Cold Spring's DWSMA an incentive payment is necessary for this Activity to be successful. Currently there is no established market for Kernza and it will be the farmers' responsibility find a market for the harvested crop. Also, the current market is quite favorable for commodity crops (corn and soybeans) making it more difficult for farmers to take on the risk of growing a

new crop with limited markets and proven grower success.

To keep the proposal at the current funded level and to include a budget for incentives the project partners agreed to following reductions:

Activity 1. UMN reduced total budget \$5000 from \$225,000 to \$220,000 (sampling equipment, lab supplies budget reduced \$5000 from \$51,248 to \$46,248)

Activity 2. Pope SWCD reduced personnel budget \$10,000 from \$71,000 to \$61,000.

Activity 3. AURI reduced total budget \$10,000 from \$170,000 to \$160,000 (personnel from \$134,000 to \$128,000; supplies from \$9000 to \$7000, and travel from \$7500 to \$5500)

Also a portion of the Pope SWCD budget (\$61,000) was split between Activity 1 (\$50,000) and Activity 2 (\$11,000) to more accurately reflect contributions.

These budget modifications will not impact the overall goal of the project. Total budget remains at \$485,000.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

N/A

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

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	<ul style="list-style-type: none"> • Activities and Milestones 	<p>Modify Activity 2 to encourage farmers to plant an additional 100 acres Kernza in the Cold Spring DWSMA "and adjacent areas". With current high commodity crop prices, we have limited interest from farmers in the DWSMA to grow Kernza. A landowner with a 17 acre field just outside the DWSMA has been identified and is interested in establishing Kernza. This would be an excellent opportunity to get Kernza established near the DWSMA.</p>	August 10, 2022	Yes	August 16, 2022

Status Update Reporting

Final Status Update August 14, 2024

Date Submitted: August 14, 2024

Date Approved: October 15, 2024

Overall Update

The research conducted confirmed that the Kernza significantly reduces nutrient leaching to drinking water compared to annual cropping systems. The strip tillage and spraying treatments did not mitigate the Kernza yield declines as hoped, but they also didn't affect soil water nitrate.

Supply chain development activities assessed the storage, cleaning, and drying of Kernza, providing new information on post-harvest handling techniques to aid farmers and grain handlers. Assessment of value-added uses for Kernza was also pursued, developing new information on its use in food, beverage, and bio-industrial products. These efforts included product and process development trials, pilot projects, and collaboration with Minnesota businesses to assess the use of Kernza in their products. Networking with businesses, farmers, researchers, and other key stakeholders was also an area of focus, providing a valuable channel for information sharing and future collaboration.

Activity 1

Kernza and Alfalfa had extremely low levels of soil water nitrate throughout the duration of this experiment. The native prairie took a couple of years to establish but turned into a very diverse, lush stand. Soil water nitrate levels were often quite similar across all three perennial treatments (even though 100 pounds of N fertilizer was applied to the Kernza annually). Irrigation did not affect soil water nitrate, although it was a strange few years to test that effect. We also learned that the strip tillage and spraying treatments did not mitigate the grain yield declines as hoped, but they also didn't affect soil water nitrate. This null effect could have been related to the drought. We collected quite a bit of additional data that should explain this finding, which will be analyzed in the next few months by the PhD student on the project. At least one peer-reviewed journal article will come out of this study.

Overall, significant progress was made in determining how to manage perennial crops to protect drinking water supplies from nitrate contamination. Researchers found great value in interacting with growers and other stakeholders at the field days.

Final report from UM is included as attachment.

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

Activity 2

Stearns SWCD staff provided ongoing project management and grant reporting services for the partnership throughout the life of this grant. Additionally, Stearns SWCD staff worked directly with growers at the ROCORI school site to establish and manage a new Kernza stand. The Pope SWCD completed the field work at the Rosholt Research Farm. This work has been completed at the direction of Jacob Jungers from the University of Minnesota and his graduate students. Pope SWCD has continued to coordinate with our partners on the plot maintenance and management.

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

Activity 3

AURI's recent activities focused on completing multiple lines of process and technical research, continuing outreach to share information and build commercialization networks, and development of a final report compiling project results.

Over the past several months, activity on multiple pilots and trials has been finalized. These include malting research

with the Rahr Technical Center (RTC), grain flaking work with the Northern Crops Institute (NCI) and RTC, Kernza distilling and spirit aging trials, biocomposite molding trials, and Kernza flour and dough quality analysis. Samples of ingredients were shared with multiple Minnesota businesses for further assessment and feedback. The AURI technical team completed storage and drying trials during the first half of 2024.

Results from AURI's activities on this project have been compiled into a final report for submission to SCSWCD and LCCMR. Copies of the final version will be made available online at auri.org. Final report from AURI is included as attachment.

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

Dissemination

Outreach and dissemination efforts were active throughout the project and included multiple methods and mediums, including field days, in-person events, webinars, social media, and informational materials, such as reports, articles, and videos. These efforts engaged a wide variety of audiences, raising awareness of Kernza and the project.

In April, AURI hosted a Kernza-focused event as part of its Fields of Innovation webinar series on novel and specialty crops. The event featured an informational video produced by AURI on the cleaning and handling of Kernza. The video was posted online and will be shared as part of ongoing efforts to develop Kernza processing capacity.

Pope SWCD staff this year did update a display that includes information on the Kernza trial. This display was used at the Irrigation Clinic and Irrigation Association of Minnesota Conference this spring. It is the intent to use this display at the upcoming Rosholt Field Day and at the Pope County Fair.

Status Update Reporting

Status Update December 1, 2023

Date Submitted: December 1, 2023

Date Approved: December 13, 2023

Overall Update

The partnership implementing this project continues to make progress and is on track to complete all listed project deliverables by the appropriation end date. University of MN researchers directed field staff at Pope SWCD on implementing plot management and researchers collected data on soil moisture, root mass, and other items. 8 new acres of Kernza were seeded and were able to germinate during the growing season. Supply chain and marketing research from AURI has focused on storage and processing issues. Preliminary findings from these efforts were shared at field days and other events around the state.

Activity 1

The first alfalfa harvest occurred on 6/7/23 and the termination strips (tillage and herbicide) were reapplied to the strips initiated the previous year (Fig.1). Light quality and soil moisture data (Fig.2) were collected on 6/7/23, 6/21/23, 7/17/23, 8/9/23, & 8/15/23. The second alfalfa harvest occurred on 7/17/23. Kernza grain and biomass was harvested on 8/9/23, and alfalfa was harvested on 8/15/23. The fourth alfalfa and prairie plots harvests occurred on 10/25/23. All plots had soil samples collected for nutrient analyses and large-diameter cores pulled for quantifying root biomass on 11/18/23 (Fig.3). Throughout the growing season, lysimeter samples were collected approximately 23 days.

The Pope SWCD has been completing the field work at the Rosholt Research Farm. This work has been completed at the direction the University of Minnesota. Samples have been collected weekly by staff employed by Pope SWCD. Irrigation has been completed in coordination with the state irrigation specialist and the researchers. We have continued to coordinate with our partners on the plot maintenance and management.

Activity 2

Stearns SWCD contracted with ROCORI FFA Alumni Association to establish 8 acres of Kernza near the Cold Spring Drinking Water Supply Management Area which were planted in fall 2023 and certified by SWCD staff. Additionally Stearns SWCD has provided ongoing project coordination and grant administration efforts to ensure that the deliverables are completed within the project timeline. Pope SWCD has provided support for outreach and promotional efforts, including hosting a Kernza field day and other efforts (see Dissemination).

Activity 3

As part of its work to assess methods for post-harvest handling, the AURI technical team coordinated with a Minnesota-based grower to obtain 2023 new crop Kernza for use in storage and handling trials. Longitudinal data on storage conditions and grain quality will be collected over a multi-month period to provide guidance for producers and end users. Recent technical work also included dehulling trials and continued collaboration with the Rahr Technical Center on malting and distilling research. AURI shared samples of Kernza, including malted ingredients, with several businesses for evaluation and pilot development activities.

Dissemination

A field day at Rosholt Research Farm was held on August 17, 2023. Approximately 70 people attended the event, and a presentation was given by the UMN research team (Jason Hickman and Jake Jungers) where this project was highlighted.

Networking and outreach were a key focus for the AURI supply chain team which participated in multiple Kernza-focused field days and events, including the Rosholt Research Farm Field Day and Kernza Con 2023, hosted by the

University of Minnesota. In August AURI coordinated with partners including Renewing the Countryside to provide Kernza-focused demonstrations at the 2023 Minnesota State Fair. The team also continued to meet with potential end users and other supply chain stakeholders to share information and identify opportunities for collaboration.

Status Update Reporting

Status Update June 1, 2023

Date Submitted: June 1, 2023

Date Approved: June 26, 2023

Overall Update

Kernza stand renovations have been applied, yields are being analyzed, and preliminary results are mixed on the benefits of renovation on sustaining yields. Water monitoring using suction lysimeters continues with equipment being repaired and readied for another season of water sample collection and analysis. ROCORI FFA will establish 6 acres of Kernza adjacent to the Cold Spring Drinking Water Supply Management Area this summer. A variety of outreach presentations on the project were shared at events in 2022 and early in 2023, highlighting Kernza's agronomic principles, improved water groundwater quality in perennial production systems, and marketing opportunities. Post harvest handling and management of Kernza has been initiated. Coordination work has started with project partners and other stakeholders to coordinate a field day and make presentations at Kernza focused events throughout summer and fall 2023. Also, partners will be participating in the Kernza Con event in Minneapolis on June -21-23, 2023, showcasing Kernza project information with stakeholders from Minnesota and beyond.

Activity 1

UM began analyzing the 2021 and 2022 collected lysimeter samples for nitrate concentration. This process is still ongoing. Harvested IWG seedheads from 2022 were threshed and weighed. Grain yields from 2020, 2021, and 2022 are summarized (Fig.1, Table.1). In 2022 a renovation treatment was implemented in which plots were split into three subplots. One subplot had no management (control), the next had strips tilled through the middle of the plots (cultivate) and the third had strips of herbicide sprayed down the middle of the plots (spray).

Pope SWCD began fieldwork for the 2023 season, under direction of Dr. Jacob Jungers and others from UM, on May 10 when IWG plots were fertilized with urea at a rate of 100 kg N/hectare. Broken lysimeters were repaired or replaced, and suction was put on to begin sampling. Biweekly soil moisture sampling also began. On May 24 (Fig.2), light quality data (photon flux and red:far red light ratio) were collected in IWG subplots (Fig.3). The light parameters were collected in the middle of the kill strips, crown of plants adjacent to kill strips, in the inter-row space of intact rows, and the inter-row space of control subplots.

Activity 2

Stearns SWCD identified a parcel, owned and operated by the ROCORI FFA Alumni Association, near the Cold Spring Drinking Water Supply Management Area to establish new Kernza stands using the available funds to incentive production. With higher commodity prices and uncertain Kernza market, it has been more difficult than expected to get commitments from farmers within the limited geography.

The Pope SWCD and partners also presented on October 26th at BWSR Academy and shared information on the plots and research being conducted by the partnership. The Pope SWCD attended the Irrigators Association Annual Meeting February 16, 2023 and shared information about the Kernza trial with a booth and display. The Pope SWCD attended and shared information about the Kernza trial at the Irrigation Clinic held in Greenwald on March 6, 2023.

Activity 3

Agricultural Utilization Research Institute's (AURI) staff coordinated with project partners to finalize plans and prepare protocols for drying and post-harvest handling trials. These trials will be conducted with grain obtained from Minnesota producers during the upcoming 2023 harvest season, and results will be published as part of the final project report. AURI's technical team is also working with external research partners to trial extrusion of Kernza for use in food and

animal nutrition products. AURI's technical collaboration with Rahr Malting also continues to make progress. In May, AURI staff visited Rahr's Technical Center to receive updates on their work with Kernza malts, beer and distilled products. As part of this research, AURI is coordinating with Rahr to perform additional trials to produce Kernza malt for use in AURI-led pilot projects with Minnesota brewers and distillers.

Dissemination

As part of its outreach and supply chain development activities, AURI staff took part in multiple events over the past six months, sharing information and building connections with growers, researchers and industry. AURI is currently working with project partners and other stakeholders to coordinate a field day and make presentations at Kernza focused events throughout summer and fall 2023. AURI staff are also set to attend June's Kernza Con 2023 in Minneapolis to share information developed during the project with stakeholders from Minnesota and beyond.

Additionally, AURI researchers were asked to publish an article on Kernza in *Cereal Technology*, an international scientific journal. The article, published in March 2023, shared information about the crop and highlighted market development activities led by AURI.

Status Update Reporting

Status Update December 1, 2022

Date Submitted: December 1, 2022

Date Approved: December 16, 2022

Overall Update

Field work to test management practices to renovate existing Kernza stands began during the summer of 2022. This included harvest and measurement of grain and biomass yields on each subplot. Throughout, samples of soil water nitrate were collected. Further studies of marketing and alternative uses of Kernza continue, including analysis of Kernza grain for distilling (whiskey) and materials for use in bio-composites. Partners continue with ongoing efforts to support increased local grower adoption of Kernza, especially within the Cold Spring DWSMA.

Activity 1

Soil water nitrate sampling of research plots at the Rosholt Research Farm began on May 3, 2022. Lysimeters installed in the IWG, alfalfa, and prairie treatments were used to collect soil water samples. The stand renovation treatments were imposed on June 7, 2022. The existing IWG plots were split into three subplots. One subplot was used to test the effect of a between-row cultivation treatment (Fig. 1) to increase grain yields. The second subplot was used to test the effect of strip spraying of glyphosate to increase grain yields. The third subplot was not treated and used as a control. Soil moisture sensing equipment and lysimeters were installed in all the new IWG subplots. The graduate student and Rosholt Research Farm staff collected soil water samples from the lysimeters and soil moisture data throughout the growing season after stand renovation. Alfalfa was harvested on June 7, July 7, August 17, and September 30 (Fig. 2). IWG grain and biomass was harvested on August 17. Soil water samples are being analyzed for nitrate content in the lab. Harvested IWG seedheads are being threshed to determine grain yields. Alfalfa forage samples are being ground and analyzed to determine forage nutritive value.

Activity 2

Activity 3

The Agricultural Utilization Research Institute's (AURI) technical and commercialization staff continued to pursue development of bio-composite products from Kernza straw. AURI engaged C2Renew, a bio-composite and compounding company, to analyze the synthesis and chemistry of Kernza materials for use in alternative plastics. This includes production of pellets from straw and pilot development of molded products (including other inputs such as PLA resin and poly propylene).

AURI technical staff are also collaborating with Rahr Malting, who previously worked with AURI to create a comprehensive malting and brewing report for Kernza in beer applications, to develop a similar guide on the malting and distilling of Kernza into distilled alcohol products, including whiskey.

AURI is also developing plans to perform drying trials during the 2023 Kernza growing season, working with a local perennial agriculture cooperative to custom-harvest Kernza at various moisture levels to inform farmers and industry stakeholders on optimal practices and conditions for harvesting and storing Kernza. Data on the long-term storage of Kernza is being collected using stored grain from previous harvests.

Dissemination

AURI Connects: Fields of Innovation, an outreach platform focused on convening Minnesota's regional ag and food value-chains to build capacity and successfully commercialize emerging crops and innovation in livestock supply chains, hosted an in-person event in August 2022 to convene entrepreneurs in the value-added food and ag space to discuss how they encountered failures and the opportunities for success that unfolded from those learnings. AURI set up a

display of Kernza-related information for interested supply chain actors, Kernza-based foods were showcased and the crop was discussed as a case study for continued learning in value-chain development.

Kernza Con 2023 will be held in Minnesota during the spring. AURI sat on a panel of commercialization experts at the 2022 conference and will participate in the 2023 conference.

Status Update Reporting

Status Update June 1, 2022

Date Submitted: June 1, 2022

Date Approved: July 6, 2022

Overall Update

Work on this project began in early 2022, while the 2019 allocation for the first phase is still wrapping up. A final report of those findings and all related materials will be submitted during summer 2022. At that time progress and spending on this allocation is expected to increase.

Activity 1

University of Minnesota and Pope SWCD continue to conduct field work at the Rosholt Research Farm. Funding is provided under the 2019 allocation for the first phase of this project.

Activity 2

Stearns SWCD has begun reaching out directly to eligible farmers to assess interest in adding Kernza to their production. Higher commodity prices and limited market opportunities has increased the difficulty in recruiting new farmer participants but work will continue into the summer with hope to get new acres established in fall 2022. Stearns SWCD processed grant and project materials, including developing and executing sub-agreements with the three named subcontractors (University of Minnesota, AURI, and Pope SWCD).

Activity 3

Coordination with key partners, including the Forever Green Initiative, SCSWCD, University of Minnesota, the Land Institute and Minnesota-based Kernza® growers has been a key focus over the first several months of the project. AURI staff also participated in multiple events to share information, make presentations and develop connections to key supply chain and ecosystem marketplace stakeholders. The AURI supply chain team continues to build connections to end-users identified during previous LCCMR-funded research, providing additional technical support, and gathering feedback to guide future market development activities.

AURI researchers and market development specialists identified several potential pilot projects and are coordinating with Minnesota-based businesses and research partners to explore options for project development. Projects under consideration include pilots focused on malting, brewing, spirit distillation and development of biobased products made using Kernza® straw. Additional projects focused on other end uses, including food applications, are targeted for future development.

Preparation for technical work focused on post-harvest handling and storage is underway, and will begin following the 2022 Kernza® harvest as new crop grain becomes available for testing and analysis. Quality analysis of older grain samples stored at AURI is also underway, providing additional data on long-term storage of Kernza®.

Dissemination

No update.