Kernza®CAP

Year 4 Annual Report

Prepared December 2024

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For more information, visit www.kernza.org/kernzacap

Cover photo by Josh Kielsmeier-Cook
Following page: Kernza field photos by Josh Kielsmeier-Cook; puffed Kernza photo by Evelyn Reilly

KernzaCAP year four by the numbers

800
plants in UMN Cycle 8 breeding population

3,408
total grain and forage data points collected

11
new breweries partnering with Patagonia to brew Kernza beers

3
industry toolkits created

~1.5x
increase in total acres of Kernza in the field

35+
presentations by KernzaCAP collaborators

13
Kernza-focused field days

1343
kg/ha: max grain yield in fertilization trials

88,254
SNPs identified for use in genomic selection models

70
% of grain yield variance explained by soil and cliamte factors

7
seminars hosted

0.80
calibration r-squared value for modeling net radiation from Kernza systems with NOAH-MP

7
peer-reviewed papers published

74
Kernza in Context companion boxes sent out

101
KernzaCAP collaborators

Key Market Developments

Supply Review

- 3,000+ acres in the ground as of January 1, 2024
- Acreage roughly increased by 50% in 2024
- Average yield of 300 bin run lbs/acre on farm for 2023 harvest
- High inventory of conventional Kernza, low inventory of organic and Regenerative Organic Certified Kernza nation-wide

New Products on the Market

- Patagonia Provisions pasta line expanded to three shapes
- 23 breweries now in Patagonia Provisions Kernza beer partnership, more than double from 2023
- Deschutes Brewery released the first nationally-distributed canned beer (Kernza lager) and first non-alcoholic Kernza beer, both in partnership with Patagonia Provisions
    - NA beer won a gold medal at the 2024 Great American Beer Festival
- Haggard Barrel Brewing released Glonky, a Smoothie-Style Fruited Sour beer brewed with Kernza, and won a gold medal at the 2024 US Open Beer Championship
- The Farm & The Odd Fellows released “10ft Roots” golden-style blonde Kernza beer, the first Kernza beer in the central Great Plains to be canned and distributed in liquor stores across Kansas.
- Perennial Pantry CSA continues to see success and has begun featuring Kernza products sold alongside other pantry staples
- Minnesota Landscape Arboretum uses Kernza in a grain bowl on their cafe menu
- Sustain-A-Grain launched a retail-sized rolled Kernza product
- Gramercy Tavern (NYC) made Kernza sweet potato dinner rolls for a special event

Market Observations

- Regenerative Organic Certified and certified organic demand and pricing remain strong
- Demand for conventional is weak, despite prices moderating by 40% in 2023
- Arcola Farms entered the market as a Kernza supplier and seed producer
- Coalition led by Clean WI undertook extensive supply chain development in Wisconsin
- Continued grain surplus is frustrating to farmers; some have exited Kernza production
- NRCS Conservation Stewardship Program incentive of $175+/acre is underutilized, due in part to 1.25 year timeline to enroll ahead of fall planting
- Additional cleaning, dehulling, and milling options are needed closer to growers

Key Barriers Identified and Being Addressed

- Large companies have carbon emissions reduction goals, but no standardized method for measuring Kernza's carbon impact has existed
    - A Life Cycle Analysis completed by Merge Impact, with a second in progress by the University of Minnesota and a private company
    - USDA Kernza Carbon Planner tool launched
- Despite high conventional Kernza inventories, consumers and companies still report difficulty sourcing Kernza due to a lack of clear, accessible sourcing information and a mismatch between the desired size and lead time of orders and the products available
    - New KernzaCAP marketing materials will include updated sourcing information
- Kernza has excellent product applications, but not enough people know about them
    - KernzaCAP is developing How to Use Kernza guides for restaurants, brewers, distillers, and CPG companies
- Grain grading and quality standards are still in development
    - An Annual Monitoring Program to test Kernza grain was designed and launched by The Land Institute (TLI)
    - The grain grading project is in progress with TLI in collaboration with the Northern Crops Institute.

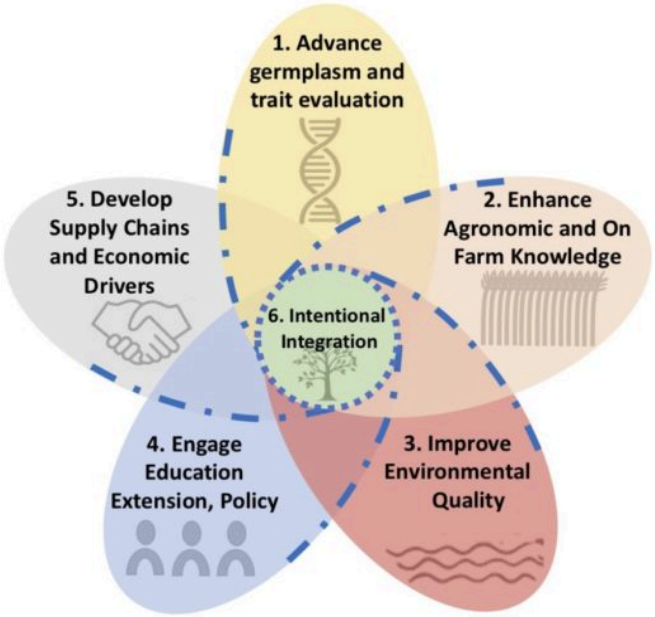
A Forever Green Institute display featuring a large variety of Kernza products at a FEAST local foods event in Rochester, MN. Photo credit: Katharine Chute

Project Overview

One of humanity's most urgent challenges is to provide food, feed, and fiber for a global population of 10 billion by 2050. This challenge is compounded by the fact that the world's current annual-based cropping systems are damaging the natural resource base necessary for agricultural productivity. In contrast, perennial crops can improve agricultural sustainability because their extensive root systems reduce soil erosion, nutrient runoff, and pesticide requirements, while potentially increasing farmer incomes through decreased annual inputs and costs. The domestication of the world's first commercial-scale perennial grain crop (intermediate wheatgrass), trade named "Kernza®," is underway in the United States. This project is leveraging and expanding a strong network of researchers, educators, farmers, businesses, non-profit leaders, and others to launch a perennial grain crop enterprise based on Kernza.

KernzaCAP was funded by the U.S. Department of Agriculture National Institute of Food and Agriculture (USDA NIFA) in 2020 and runs through August 2025. This project currently supports over 90 researchers, graduate students, business leaders, nonprofit professionals, and farmers across nine states (Appendix A). Collaborators are organized into six objective teams:

1. Advance germplasm & trait evaluation
2. Enhance agronomic & on-farm knowledge
3. Improve environmental quality
4. Engage education, extension, & policy
5. Develop supply chains & economic drivers
6. Intentional integration



Collectively, KernzaCAP aims to activate transformational change in agriculture that improves the environment and rural prosperity. Outcomes will include Kernza variety candidates for various regions of the United States; agronomic recommendations for optimizing yield, profitability, and environmental quality; expanded acreage in ecologically sensitive areas to protect drinking water from nitrate contamination; new Kernza supply chains and products; and an education and extension portfolio of tools and events to educate a broad range of students, agriculture professionals, and the public.

This report summarizes activities and outcomes from Year 4 of KernzaCAP (September 2023 through August 2024).

Project Organization & Management

In Year 4 of the project, there were two changes to the existing project organization: a data manager, Craig See, was hired to curate and analyze data across the project and Tara Ritter, former project manager, left for a new opportunity and Josh Kielsmeier-Cook was hired into the position in February 2024. The management team continued to meet weekly to ensure smooth grant operations and project execution. The Coordinating Team, made up of the project management team and co-leads of each objective team (Fig. 1), met bi-weekly to encourage integration across teams and provide high-level thinking and decision making for the project.

The 17-person Advisory Committee (Appendix A) is made up of individuals from 9 states and 3 countries. The Advisory Committee convened in November of 2024 to provide feedback and reflect on the first four years of the project and provide insight on what the future of collaborative Kernza work may look like. Advisory Committee members were also invited to the annual all-hands meeting and the KernzaCAP monthly lunchtime seminar series.

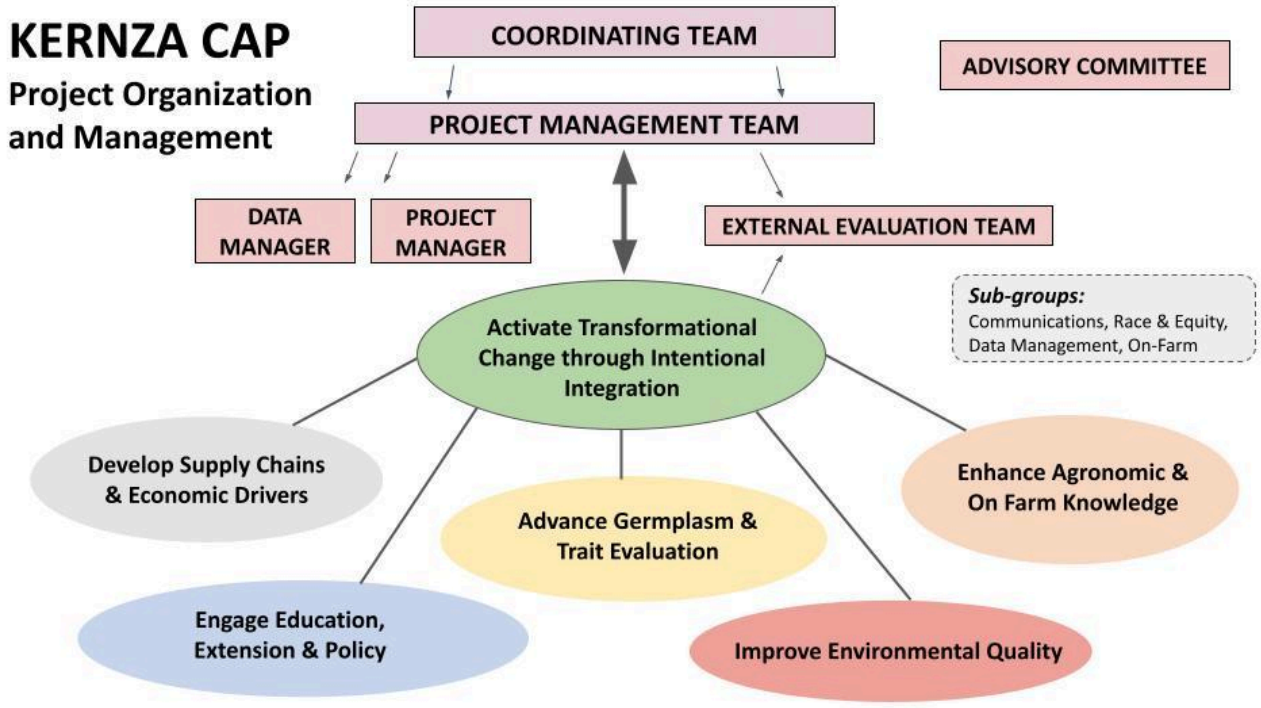


Figure 1: Project organization chart

The fourth annual all-hands meeting was hosted on October 29, 2024 with over 60 collaborators participating virtually (Appendix B). The all-hands meetings provide an opportunity for conversation, reflection, and updates across objective teams, which is critical to meet our integration goals. While the 4th Annual Meeting fell outside of the fourth project year, it is mentioned here as it covered year 4 activities and updates.

The data management team made significant progress in Year 4 toward implementing systems for data collection and analysis. This included onboarding a data manager to help ensure that KernzaCAP data are accessible to internal collaborators and the broader research community. Much of the year was spent producing scripts which combine, clean, and curate data produced by individual sites in a consistent and reproducible manner. As of December 2024, the experimental datasets from the first three project years have been internally finalized, with the exception of a few microbial datastreams still undergoing laboratory processing. These datasets are currently accessible to all Kernza CAP collaborators, and will be published as publicly available data products in Spring 2025, along with scripts documenting the steps that were taken during cleaning and processing. This will help ensure transparency, and that project data are used in a fair and consistent manner by both Kernza CAP collaborators and the broader research community.

Collaborators continued to use the reporting system designed at the beginning of the grant to track progress and outcomes across objective teams. All collaborators have access to a project CV and are responsible for adding their work to the CV on a regular basis. Annually, subaward institutions and objective team co-leads fill out a report that the project manager compiles and submits to USDA. Annual reporting also includes budget checks with objective teams and subaward institutions to ensure spending remains on track.

Project collaborators have access to a private Google Site with quick links to important documents and a project calendar. This internal site also links to the project's Google Drive, which hosts all project documents and objective team folders and allows team members to easily upload, share, and review documents.

To communicate with external stakeholders interested in the project, KernzaCAP sends a quarterly newsletter through MailChimp that had an audience of 216 at the end of Year 4. This newsletter provides project updates, collaborator introductions, and media stories highlighting Kernza. Newsletters are archived online and can be accessed on the project website (www.kernza.org/kernzacap), which is regularly updated to reflect progress.

Germplasm & Trait Evaluation

Advance intermediate wheatgrass (IWG) germplasm and trait evaluation for improving yield, economic viability, and ecosystem services as a perennial grain crop.

Year 4 Team members

- Dr. James Anderson (co-lead) - University of Minnesota
- Dr. George Annor (co-lead) - University of Minnesota
- Dr. Prabin Bajgain (co-lead) - University of Minnesota
- Dr. Lee DeHaan (co-lead) - The Land Institute
- Obed Aduama - University of Minnesota
- Dr. Jared Crain - Kansas State University
- Dr. Pam Ismail - University of Minnesota
- Cecia Flores Sanchez - University of Minnesota
- Coleman Selfridge - University of Minnesota

Team objectives

Objective 1: Improve IWG breeding populations and release varieties adapted to specific regions of the United States.

The University of Minnesota Kernza breeding program collected phenotypic data on the 6th and 7th cycle breeding populations in St. Paul and Lamberton in Summer 2024, the second year of evaluation for Cycle 6 and the first year of evaluation for Cycle 7. Based on these evaluations, four new crossing blocks were established in Fall 2024 to initiate the development of new candidate varieties. The new breeding population, Cycle 8, was selected using genomic prediction models and established at St. Paul and Becker in September 2024. The Cycle 8 population consists of approximately 800 plants as well as the parents of the Cycle 8 genotypes.

The team harvested variety trial plots at St. Paul and Lamberton in August 2024. Samples were cleaned and weighed in October-December 2024 to obtain performance data. Based on this data, a new University of Minnesota Kernza variety release was proposed to the Crop Variety Review Committee and approved in December 2024. Formal variety release will follow in 2025.

In the coming year, The University of Minnesota Kernza breeding program will continue to evaluate a subset of the Cycle 6 breeding population (mini-rhizotron study, Objective 5) at St. Paul, looking at root structure, grain yield, seed size, shatter resistance, free threshing, plant height, and disease resistance. Cycle 7 will be evaluated for the same traits in 2025 (second year evaluations) and Cycle 8 will be evaluated for these traits in 2025 and 2026. The best individuals and/or families will be selected as parents of new synthetic cultivars.

Objective 2: Develop a low cost genotyping approach that leverages recently completed intermediate wheatgrass genome sequencing to genotype larger breeding populations.

Over the past year, the team transitioned the skim sequencing approach from experimental to practical implementation (skim-sequencing is sequencing a small amount [5% or 0.05X coverage] of each plant's DNA, followed by estimating the remaining 95% of each plant's DNA sequence [genome] through computational methods). The Land Institute's breeding program implemented a full cycle of genomic selection using only skim-sequencing data in March 2024, including all training population data as well as newly genotyped breeding population data. During the breeding cycle, 4000 genetically unique individuals were genotyped with an average sequencing coverage of 0.05X. A total of nearly 200X sequence data was generated (equivalent to 200 times the entire intermediate wheatgrass genome). Once data was received, it was cleaned, filtered for bad/missing data, aligned to its position on the reference genome, and imputed (missing data is estimated using surrounding values and statistical methods) using the STITCH program, all in a short 5-day window. The team imputed approximately 2.5 million single nucleotide polymorphisms (SNPs) within the intermediate wheatgrass genome and filtered those down to a final data set of 88,254 SNPs for use in genomic selection models. This allowed the breeding program to go from starting seedlings to selecting breeding parents in 65 days. The Land Institute is currently using the same pipeline for the fall breeding cycle from August 2024-September 2024 (TLI-Cycle 16, Activity 1).

Plants in the Kernza breeding population at the University of Minnesota's St. Paul campus. Photo credit: Josh Kielsmeier-Cook

Future work will include completing TLI breeding Cycle 17 in the spring of 2025 and initiating Cycle 18 at the end of the grant period in July/August 2025. The development of a robust data pipeline has also led to efficient methods to process data including adding data to public repositories like the NCBI Sequence Read Archive (SRA). As genomic data is generated, it is stored on SRA for release, creating both a data backup and repository for public dissemination.

Objective 3: Expand the database of genotyped plants and associated phenotypes to improve accuracy of genomic selection models and increase breeding efficiency.

The University of Minnesota Kernza breeding program previously deposited genotypic and phenotypic data from breeding cycles 1-4 in the Kansas State University database. Cycle 5 and 6 data was deposited in October-December 2024. Genomic selection models are currently being trained and evaluated for both University of Minnesota and The Land Institute breeding programs and have been applied to select superior genotypes in the University of Minnesota breeding germplasm. In addition, The Land Institute has genetic and phenotypic data from Cycle 5 (prior to 2015) to 2022, which provides a substantial resource for developing genomic selection methods.

Objective 4: Evaluate breeding germplasm for the nutritional quality and storage stability of IWG ingredients and food products.

Graduate students Obed Aduama, Coleman Selfridge, and Cecia Flores Sanchez have been working on this aspect of the project. Obed and Cecia work with Dr. Annor while Coleman works with Dr. Ismail. In Year 4, Obed observed multiple impacts of nitrogen fertilization on Kernza properties, including higher amino acid content and a variety of changes in protein structure, some of which differed by location and fertilizer application timing. These characteristics affect things like water absorption, dough development time, dough stability, and bread loaf firmness. These changes, in turn, affect Kernza's end use properties in products like bread, pasta, and more. Providing this type of technical information is important for making Kernza accessible to food processors.

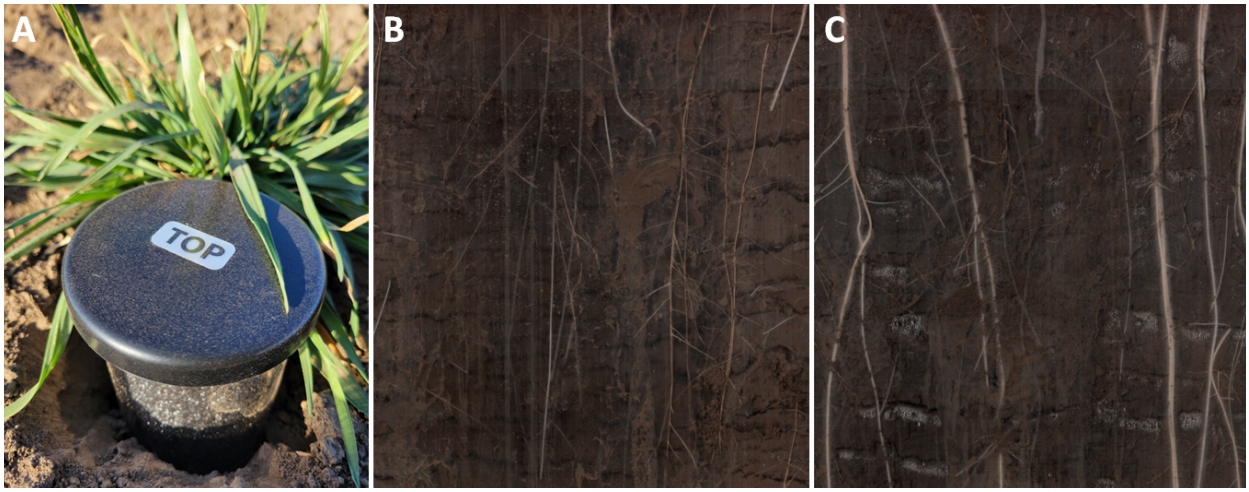
Cecia has focused on the impact of nitrogen fertilization on the starch properties of intermediate wheatgrass, finding that the effect of nitrogen application across different seasons on amylose content was insignificant, and the granular morphology of Kernza starch remained unchanged across varying locations and seasons. The thermal properties analyzed showed significant differences for gelatinization enthalpy (the heat required to change starch's crystalline structure to a more gel-like consistency, important for product end use considerations) with the impact of nitrogen applications in the spring being greater. For peak temperature, the impact was greater for Wisconsin than for Minnesota. In the coming year, Cecia will complete her work on the effects of nitrogen fertilization on the processing properties of Kernza.

Left: *grad student Obed Aduama puffs Kernza.* ***Right:*** *grad students Hazrat Usman and Cecia Flores Sanchez and Professor Johan Ubbink work on extrusion expanded products with Kernza flour and pea starch flour. Photo credits: Hazrat Usman and Drew Carter*

Coleman is currently working on the starch contents, antioxidant capacity, and enzyme activity of the samples. In the coming year, he will start working on storage, rancidity during storage, and flavor analysis of the samples.

Objective 5: Explore the impact of breeding on root architecture and subsequent effects on ecosystem services.

Mini-rhizotrons were used to take root images of the University of Minnesota Cycle 6 breeding population in St. Paul during May-November 2023. This data was summarized and published in *Crop Science* in 2024 (DOI: 10.1002/csc2.21315) in collaboration with the Agronomy team (Dr. Jake Jungers). A set of root images was taken in summer 2024, and additional sets will be taken in October/November 2024 and 2025. The team has a well-trained model in RootPainter, a machine-learning software to annotate and feature-select the collected images. The model will be re-trained and updated in late 2024 to identify roots from the soil and other non-root mass present in the soil. The processed images will then be analyzed using a feature-extraction program to obtain root properties. This project is being carried out in close collaboration with Dr. Jake Jungers.



Mini-rhizotron experiment in the University of Minnesota's Cycle 6 IWG selection nursery in St. Paul, MN, August 2023. ***Panel A****: a mini-rhizotron tube next to a Kernza plant;* ***Panels B*** *and* ***C****: root images captured by the mini-rhizotron camera. Photo credit: Prabin Bajgain, Alex Griffin*

Graduate student Brooke Bernhardt collects data from mini rhizotrons installed in a Kernza field. Photo credit: Jake Jungers

Agronomy & On-Farm Knowledge

Enhance agronomic and on-farm knowledge of IWG grain production systems.

Year 4 Team members

- Dr. Valentin Picasso (co-lead) - University of Wisconsin, Madison
- Dr. Nicole Tautges (co-lead) - Michael Fields Agricultural Institute
- Dr. Andrea Basche - University of Nebraska, Lincoln
- Dr. Steve Culman - Oregon State University
- Dr. Julie Dawson - University of Wisconsin, Madison
- Dr. Leonardo Deiss - Colorado State University
- Madeline DuBois - The Land Institute
- Carmen Fernholz - A-Frame Farm
- Dr. Jake Jungers - University of Minnesota
- Dr. Priscila Pinto - University of Wisconsin, Madison
- Dr. Manbir Rakkar - The Ohio State University
- Roberta Rebesquini - University of Nebraska-Lincoln
- Ben Robinson - The Ohio State University
- Mercedes Santiago - The Land Institute
- Dr. Dave Stoltenberg - University of Wisconsin, Madison
- Dr. Laura Van der Pol - The Land Institute

On-farm partners

- Whilden Hughes - W. Hughes Farms, Wisconsin
- Dustin Johnsrud - Johnsrud Farms, North Dakota
- Kurt Kimber - Kimber Farms, Minnesota
- Dorothy and John Priske - Fountain Prairie Farm

Team objectives

Objective 1: Evaluate variety candidates and their response to growing conditions and agronomic practices across the United States.

The team completed the third year of data collection in the GEM trial across five locations (Ohio was dropped from the experiment due to unsuccessful establishment). The GEM trial was established in September 2021 to evaluate the effect of Genotype, Environment, Management, and their interactions on Kernza grain and forage yields. “Genotype” includes four new breeding lines and the industry-standard variety (MN-Clearwater). Two of the lines were selected for significant gains in seed size and, by extension, grain yields (MN1603 and MN1802). One line

was selected for significantly improved threshability (TLI704), and one line displayed uniquely high rhizome production (TLI703). “Environment” consists of five locations in the Midwestern United States: Salina, Kansas (KS); Mead, Nebraska (NE); Saint Paul, Minnesota (MN); Arlington, Wisconsin (University of Wisconsin-Madison, WI-UW) and Troy Center, Wisconsin (Michael Fields Agricultural Institute, WI-MFAI). “Management” includes narrow (12” or 15”) and wide (24” or 30”) row spacings and legume intercropping treatments with red clover or alfalfa planted between wide rows of Kernza.

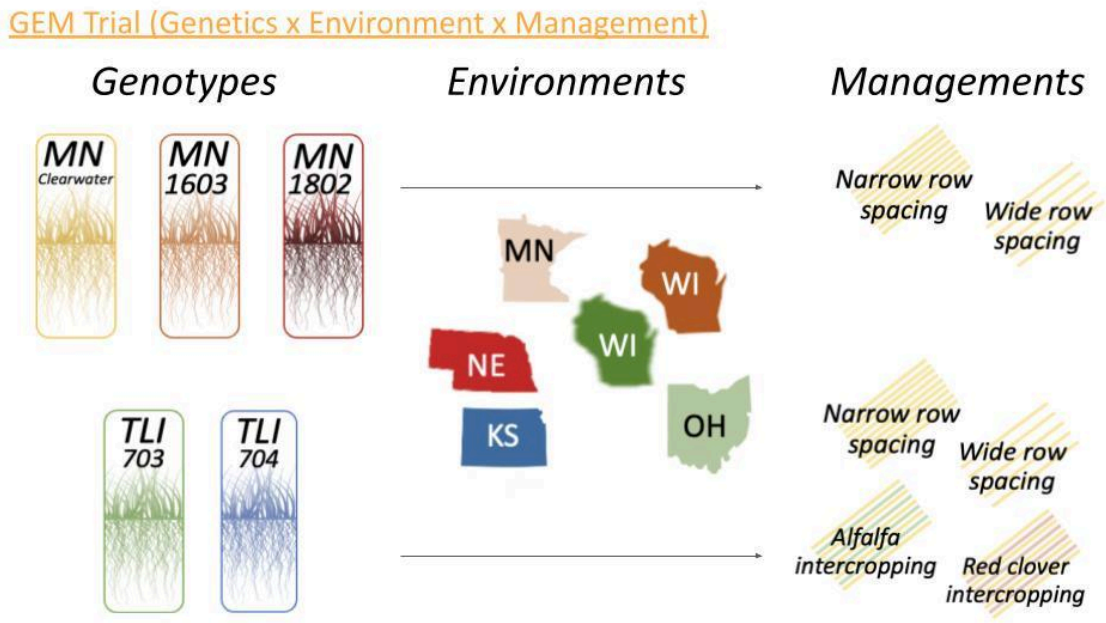


Diagram of the G x E x M experiment. Credit: Priscila Pinto

Preliminary analysis from the first grain production year shows that Kernza grain yield is strongly affected by the environment. Grain yields were higher at UW-Wisconsin and Nebraska than at Minnesota, Kansas, and MFAI-Wisconsin. Row spacing only affected grain yields in the highest yield environments (UW-Wisconsin and Nebraska) where narrow spacing had higher grain yield than wide spacing (Figure 1). Differences among genotypes were higher at wide than narrow row spacing. Most genotypes showed a similar response to the environment (Figure 2). However, the highly rhizomatous genotype (TLI703) showed high plasticity with higher grain yield in the highest-yield environments (WI-UW and NE, Figure 2). In most of the environments (KS, NE, and WI-UW), legume intercropping with alfalfa had lower grain yield than Kernza monoculture planted both at narrow or wide row spacing. In Minnesota, legume intercropping with alfalfa had lower grain yield than Kernza monoculture planted at wide row spacing but at narrow row spacing, grain yields were no different to intercropping with alfalfa or red clover. At the WI-MFAI site, there was no legume intercropping effect on Kernza grain yields. Results were presented in late 2024 at the 2024 ASA, CSSA & SSSA International Annual Meetings and the manuscript will be submitted at Field Crop Research at the end of the year. In 2025, the team will collect a fourth year of data and complete analyses and publications in 2026.

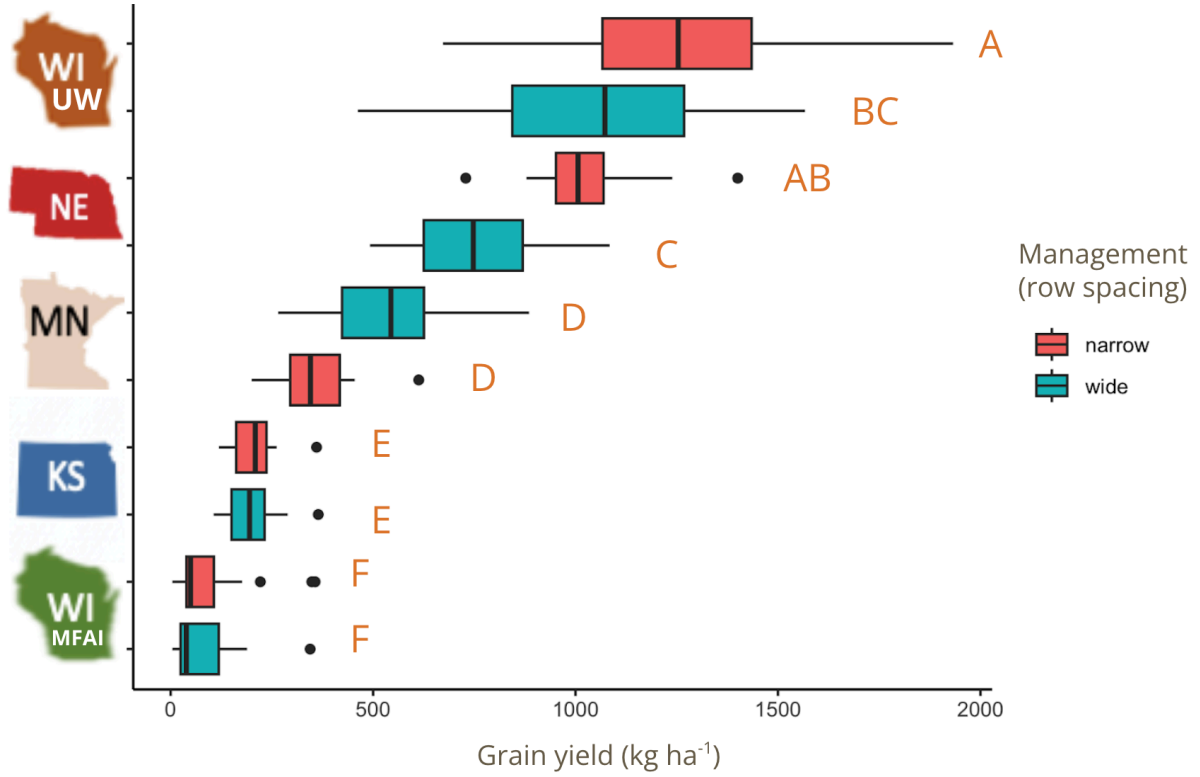


Figure 1: Environment by management (row spacing) effect on Kernza grain yield, sorted from low to high grain yield by environment: Michael Fields Agricultural Institute (WI-MFAI), Kansas (KS), Minnesota (MN), Nebraska (NE), and University of Wisconsin-Madison (WI-UW). Different letters show significant differences.

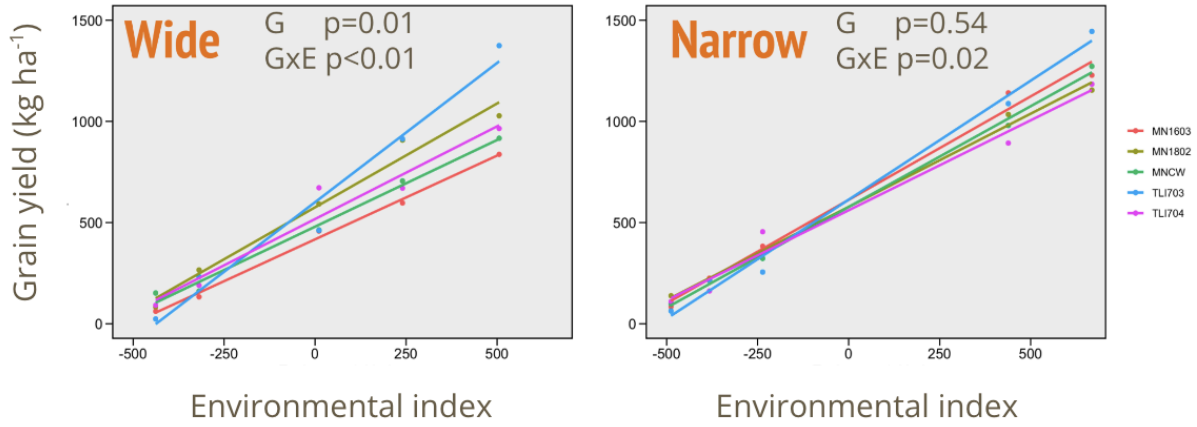


Figure 2: Genotype by environment effect on Kernza grain yield when Kernza was planted at wide (left) or narrow row spacing. Each uniquely colored line represents a different Kernza genotype (variety). The environmental index provides a relative ranking of each site-year combination, so points to the right of 0 (positive environmental index values) on the x axis are yields from relatively good environments, while points on the left (negative values) indicate yields in poorer environments.

Objective 2: Optimize nitrogen (N), phosphorus (P) and potassium (K) management for Kernza grain and forage production across US environments.

The team completed the third year of data collection of FERT (fertility treatment) trials across six locations. Plot size, management operations, and timing of activities were replicated as closely as possible across sites. The selected treatments allow the team to address the following research questions:

1. What rate of nitrogen (N) application (between 0 and 160 pounds of nitrogen per acre) applied in spring maximizes grain yields and minimizes nitrate loss?
2. What timing of nitrogen application (fall, spring, or split) maximizes yields and minimizes nitrate loss?
3. Is annual phosphorus (P) and potassium (K) application necessary to maintain high grain yields?
4. How do conventional and organic sources of fertility compare, in terms of ability to maximize and sustain grain yields while minimizing nitrate losses?

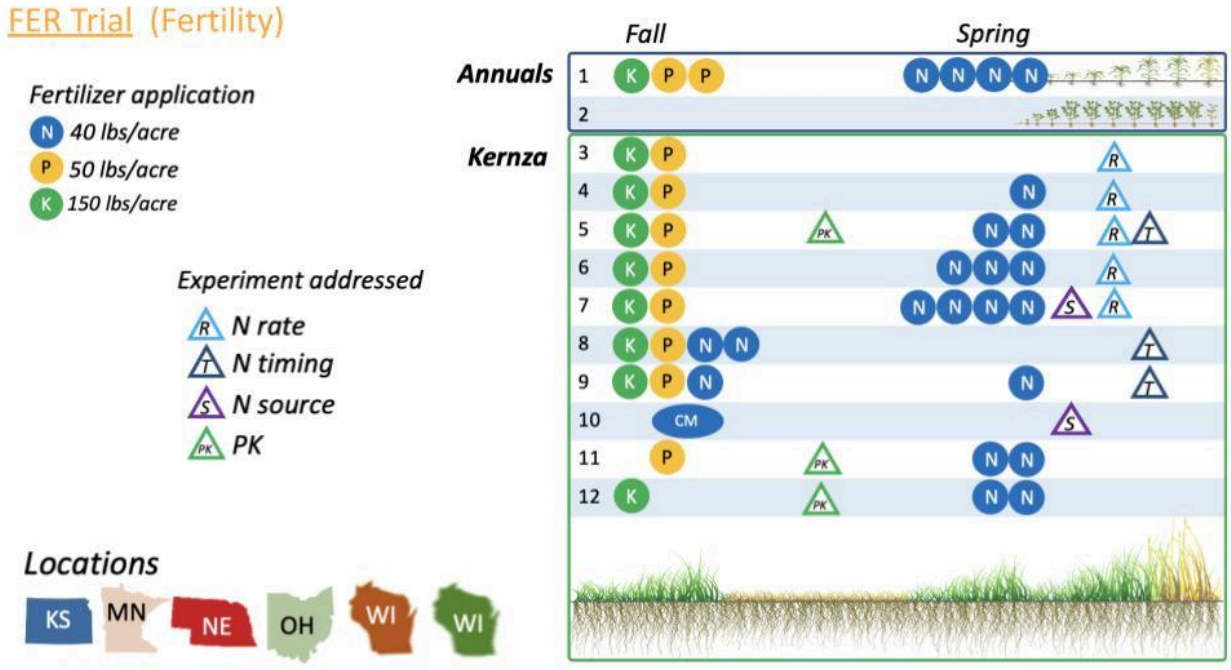


Figure 3: Diagram of the fertility trial showing the locations, treatments, and crops. Credit: Priscila Pinto

The first-year FERT manuscript, which describes the experimental design and first year of harvest data for the fertility trial, will be submitted to the journal *Agriculture, Geoscience, and Environment*. The objective of this study was to evaluate how Kernza establishment and first-year grain and forage yields varied across soil types, climate conditions, and in response to

ten fertilization treatments at six locations in the Midwestern USA. The 10 treatments included N fertilizer application at five rates; N application with or without P or K; varied timing of N application, and varied N fertilizer source (organic versus conventional).

So far, data show that fertilization influenced summer and fall forage yields but not grain yields. Grain and forage yields varied greatly between locations, ranging from 556-1343 kg ha^{-1} for grain, 3732-8930 kg ha^{-1} for summer forage, and 927-3561 kg ha^{-1} for fall forage. A multiple linear regression approach showed that a combination of local soil and climate factors explained over 70%, 92%, and 69% of variance in grain, summer forage, and fall forage yields, respectively. Of climate parameters assessed, accumulated precipitation in the 60 days before anthesis (flowering) explained the most variance in grain and summer forage yields, while the accumulated precipitation from May through October explained the greatest variation in fall forage yields. The team will collect a fourth year of data in 2025, and complete analyses and publications in 2026.

Objective 3: Conduct participatory on-farm research to leverage grower experience and knowledge to inform research strategies and address regionally specific management practices to support the grower's network.

An on-farm trial was established on the Hughes Farm south of Janesville, Wisconsin, to replicate a subset of the research trial treatments and to investigate additional management techniques with farmer input. The trial was established in Fall 2021 in field-scale plots (40 x 250 ft) with four treatments: N only, NPK, NPK + calcium sulfate ($CaSO_4$), and a no-fertility control. The collaborating grower was eager to try application of sulfur (S) as he had noticed yield gains in his wheat crops from the addition of $CaSO_4$. N was applied at 80 lb N/acre as urea in the spring at the time of new growth; P was applied at 50 lb P_2O_5/acre as diammonium phosphate in October; K was applied at 150 lb K_2O/acre as potassium chloride in the same pass as P; $CaSO_4$ was spread in May at 115 lb/acre. The first fall applications were performed in fall of 2021 concurrent with seeding, and the first spring applications were performed in spring of 2022. All fall/spring applications were continued annually thereafter.

Kernza establishment was mostly successful, but the stand was dominated by foxtail-type weeds in Year 1, likely exacerbated by a bad drought in 2022, which led the Kernza to produce few seedheads and therefore very low yields that did not merit harvesting in Year 1. In Year 2, the Kernza began to outcompete winter and summer annual weed species and produced a crop.

The NPK+$CaSO_4$ treatment produced greater yields than the N only and the unfertilized treatments in Year 2 (Figure 4). Application of N alone did not raise grain yields significantly, relative to the unfertilized control. Grain yields in the NPK treatment were not significantly different from yields in the N only and NPK+$CaSO_4$ treatments.

Similar to grain yields, application of N alone did not raise summer straw yields relative to the unfertilized treatment. Straw yields produced by the NPK and NPK+$CaSO_4$ treatments were similar to each other but significantly greater than those in the N only and unfertilized treatments. Notably, NPK+$CaSO_4$ addition resulted in a 24% increase in grain yield compared to NPK. For summer straw, $CaSO_4$ in addition to NPK increased yields by 12%; therefore, the yield gain provided by $CaSO_4$ seemed to advantage grain over straw. Year 2 observations suggest that $CaSO_4$ addition may aid with grain fill or resource allocation to grain production, and therefore may increase the harvest index of Kernza.

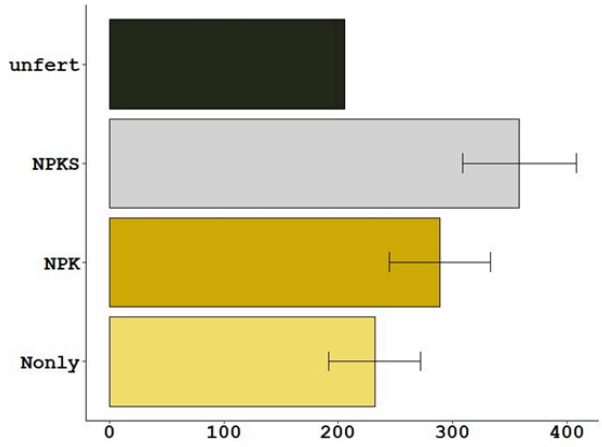


Figure 4. Kernza grain yields (kg/ha) from the Hughes Farm trial (harvested August 2023).

Unfert = nonfertilized control
NPKS (NPK+$CaSO_4$) = 80 lb N/acre plus 115 lb $CaSO_4$ in spring and 50 lb P_2O_5 and 150 lb K_2O/acre in fall
NPK = 80 lb N/acre in spring and 50 lb P_2O_5 and 150 lb K_2O/acre in fall
Nonly = 80 lb N/acre spring

The team harvested research plot samples and Hughes Farm trial samples in 2024; sample weighing and data analysis are in progress. The team also collected grain spike and grain size data, including number of spikes per harvested area, thousand kernel weight, and grain length and width, and will continue processing 2023 grain quality data and all 2024 harvest data.

A Field Day at Kimber Contours Farm on August 22, 2024 highlighted soil health benefits of Kernza. Photo credit: Josh Kielsmeier-Cook

Environmental Quality

Measure the environmental outcomes and benefits of IWG production systems for strategic deployment across the US.

Year 4 Team members

- Dr. Jessica Gutknecht (co-lead) - University of Minnesota
- Alyssa Hartman (co-lead) - Artisan Grain Collaborative
- Dr. Nathaniel Brunsell - University of Kansas
- Dr. Tomás Cassani - The Land Institute
- Dr. Laura Van der Pol - The Land Institute
- Soudeh Ghasemian - University of Kansas
- Wonsook Ha - United States Geological Survey
- Gurparteet Singh - University of Minnesota
- Jared Trost - United States Geological Survey

Team objectives

Objective 1: Quantify the potential of Kernza to improve water quality through a combination of field measurements and modeling on plot and landscape scales.

During the past project year, the United States Geological Survey (USGS) team focused on two objectives for simulating water and nitrate fluxes below Kernza and business-as-usual crops: (1) preparing observed experimental data for use with the Root Zone Water Quality Model (RZWQM) and (2) preparing scripts and required files for model calibration with an automated parameter estimation software (PEST++; White et al., 2020). The Root Zone Water Quality Model simulates the growth of the plant and the movement of water, nutrients, and pesticides over, within, and below the crop root zone. The team is taking a stepwise modeling approach and during the past year, they focused on developing data and program scripts for the Rosemount, Minnesota site. Large observed data sets that are prepared for the model include continuous and discrete soil moisture and soil physical properties. Data organization and script development are being done such that the workflows can be applied to other sites in the project with a goal of having calibrated applications of the RZWQM at multiple field sites.

A short-term goal for the USGS team is to have a series of model runs completed by the end of 2024 to inform how well model fits can be improved through the calibration process. By the end of the next reporting period, model calibration and simulations will be completed for the Rosemount, Minnesota site. The team will organize experimental data and begin applying the automated calibration workflow to other Kernza-CAP field sites.

Soil moisture and lysimeter sample data from 2022 and 2023 have been processed and cataloged, and 2024 lysimeter samples were sent to the Gutknecht lab in September 2024. Weekly meetings of the USGS team and regular correspondence with the University of Minnesota team facilitate data transfer and information from the field into the model.

Objective 2: Quantify the potential of Kernza to reduce GHG emissions by reviewing field observation data and by improving models to include parameters specific to Kernza.

Modeling efforts for water and carbon fluxes in Kernza fields have focused on the parameterization of the NOAH-MP model. Initial efforts have included incorporating phenological parameters related to growing degree days (GDD) and associated parameters governing above-ground biomass from published literature. Calibration of these parameters has been focused on the The Land Institute (Salina, KS) site using remotely sensed estimates of Leaf Area Index for assessing timing and magnitude of above-ground biomass allocations. Model mass and energy fluxes (evapotranspiration, carbon dioxide, heat fluxes, etc.) are being compared against historical eddy covariance measurements collected at the site.

A research plot at The Land Institute in Salina, Kansas. Photo credit: Laura van der Pol

A small subset of observed data is being used for the calibration. Preliminary results show that the model is currently acceptable at modeling net radiation ($r^2 = 0.80$), with less acceptable performance for sensible heat flux ($r^2 = 0.54$) and an underestimation of evapotranspiration ($r^2 = 0.39$) and net ecosystem exchange ($r^2 = 0.20$). This suggests that the radiative environment is more adequately parameterized, while the allocation of that energy requires more effort.

In the upcoming project year, the plan is to complete the NOAH-MP parameterization and calibration using the existing eddy covariance data. Current efforts are focused on stomatal

conductance and root zone biomass and associated water uptake to improve water and carbon fluxes. Following the calibration, the model will be run for the KernzaCAP sites to examine geographic and associated meteorological variability on the mass and energy fluxes.

Objective 3: Quantify soil health changes under Kernza cropping systems, including soil physical characteristics, as potential drivers of other ecosystem services.

The soil health team has made substantial progress in the past year, with soil C, N, POX-C (carbon actively involved in carbon cycling), and fertility analyses complete. Microbial fumigation biomass (CFE), extracellular enzyme, and N mineralization analysis of the 2022-2023 data was completed in late 2024. N mineralization from 2022 is complete for both the GEM and FERT experiments. Soil samples were taken from research sites in 2024 with 0-20 cm depth increments with the intention of archiving them so that resources can be invested in the final analysis in summer 2025, after 4 years of Kernza growth. Soil samples were also taken at all three farm partner sites in 2024. Processing and analysis of those samples is underway.

The team is working to complete existing datasets and curate them into a primary datasheet with the assistance of the CAP data manager. Final sampling, including for bulk density, aggregate stability, and 90 cm depth (as in the first sampling), will take place in 2025. The team is still deciding whether to sample for root biomass in the final project year, and whether to repeat the water infiltration campaign.

Research technicians in the field at The Land Institute. Photo credit: Laura van der Pol

Education, Extension, & Policy

Engage education, extension, and policy to deploy Kernza production and support perennial crops.

Year 4 Team members

- Erin Meier (co-lead) - Green Lands Blue Waters
- Dr. Aubrey Streit Krug (co-lead) - The Land Institute
- Amy Bacigalupo - Land Stewardship Project
- Dr. Cynthia Bartel - C. Bartel Inc.
- Dr. Michael Bell - University of Wisconsin, Madison
- Steve Culman - Oregon State University
- Confidence Chimerika John - University of Wisconsin, Madison
- Dr. Clair Keene - North Dakota State University
- Jonathan Kilpatrick - Sustainable Farming Association of Minnesota
- Peter LaFontaine - Friends of the Mississippi River
- Dr. Diane Mayerfeld - University of Wisconsin, Madison
- Steffen Mirsky - University of Wisconsin, Madison
- Steve Morse - Minnesota Environmental Partnership
- Sienna Nesser - University of Minnesota Forever Green Initiative
- Lydia Nicholson - The Land Institute
- Trevor Russell - Friends of the Mississippi River
- Hannah Stoll - University of Minnesota
- Lucinda Winter - Sustainable Farming Association of Minnesota

Team objectives

Objective 1: Develop, deploy, and distribute modular educational curricula targeted at students and teachers from middle school through graduate level education.

One of the biggest accomplishments was the publication of the Kernza in Context curriculum, comprising 29 lessons in 13 subject areas. Lessons were revised based on feedback gathered during the beta testing process, and formatting and visual design were harmonized across all lesson components to organize them into an accessible web format. Curriculum materials are available online. To support the launch of Kernza in Context, the team:

- Grew and supported the network of teachers who use Kernza in Context educational lessons via newsletters, classroom visits, field trips, and community events.
- Disseminated the curriculum via email newsletters to a network of ~17,000 people.
- Sent out 74 “companion boxes” that included information about the curriculum, a poster,

and Kernza products. Most of the educators who signed up for a companion box were high school agriculture teachers who had not previously been part of the network.
- Collaborated with colleagues at The Land Institute to engage an estimated 300 students and interested individuals from area schools and organizations through field trips and activities featuring hands-on activities from the Kernza in Context educational lessons.

In the coming year, the team will seek feedback to understand the use and impact of the curriculum, both for project reporting and for future model development. They will also continue to update lessons based on feedback and scientific results, create additional multimedia educational resources, and engage in outreach to share the curriculum. In addition, the team will identify insights, lessons learned, and recommendations for future educational efforts in support of new crop development.

Objective 2: Develop Extension capacity and technical assistance for farmers.

The Extension cohort met in April and collaborated with project researchers to organize three field days featuring Kernza. The cohort also worked with project partners to identify and address information needs around post-harvest handling and marketing of Kernza. Two projects are near completion: a series of grower-focused videos on planting, harvest, and dual-use, and a post harvest toolkit. In addition, the Sustainable Farming Association led a *Kernza in the Kitchen* video featuring Chef Beth Dooley and SFA Executive Director, Lucinda Winter. The video provides a quick introduction to cooking with Kernza that extension and other educators can use with various audiences. The video and recipes are available at kernza.org/kernza-in-the-kitchen/.

Objective 3: Develop a Kernza Grower-Researcher Network focused on current Kernza growers linked with established markets.

The winter webinar series hosted by Forever Green and KernzaCAP presented up-to-date research to Kernza growers and technical service providers along with in-depth information on breeding, licensing, planting, management, harvesting, marketing, and dual use. The Technical Assistance (TA) providers monthly meeting will continue to offer opportunities for knowledge sharing between researchers and TA providers, who then share updated information with growers. A number of field days featuring Kernza were hosted by KernzaCAP collaborators and others. A Kernza Field Days press release was updated throughout the season. Field day resources collected in a Field Day Toolkit (public version here) provided promotional photographs, a press release template, digital assets list, field sign templates, various factsheets and post cards with QR codes to Minnesota Kernza and source water protection project information, MN EECO program information for farmers, and the Kernza Grower Guide.

The Clean River Partners Kernza field day on August 6, 2024. Farmers, local policy makers, and other attendees heard presentations from Dr. Jake Jungers on agronomy, Christopher Abbott of Perennial Pantry on producing Kernza products, and insights from Kernza growers Bill and Dana Jokela. Photo Credit: Colin Cureton

Objective 4: Raise awareness and deepen understanding about the transformative power of perennials with public decision makers.

Completed in previous years.

Objective 5: Construct a national framework for Kernza adoption opportunities through state and federal conservation programs.

Project contractor lead Dr. Cynthia Bartel (C. Bartel Inc.), continues to contact and engage USDA staff including Farm Service Agency (FSA), Natural Resources Conservation Service (NRCS), and Risk Management Agency (RMA) for program points of entry. She also identifies documentation and research needs, coordinates with the Kernza Technical Assistance team to

provide answers about Kernza production to NRCS staff, and communicate with the Supply Chain and Economics team to align efforts around seed demand and supply, including the processes in place by the University of Minnesota and The Land Institute to work with and approve new growers.

Within the last year, USDA announced that perennial grains were formally adopted into the NRCS Environmental Quality Incentives Program (EQIP) in Minnesota and Wisconsin, which complements the adoption of perennial grains into the Conservation Stewardship Program (CSP) Practice E328O in 2022. This new national standard opens doors not only for potential cost-share opportunities for farmers, but also provides a new baseline for increasing adoption of Kernza and other Continuous Living Cover strategies through more CSP and EQIP practices. These achievements are an extension of previous work by Green Lands Blue Waters, Forever Green Initiative, and other Kernza collaborators.

The team received two requests to provide more information to USDA audiences and provided two presentations, one for a USDA Natural Resources Conservation Service Tech Talk and another to the Agricultural Research Service with attendees from the Farm Service Agency, NRCS, and Risk Management Agency.

Working with the USDA, Dr. Bartel developed a comprehensive primer for farmers and NRCS staff that includes information on USDA incentives for Kernza, the Kernza Grower Guide, and Kernza acreage and planting information. The goal of this effort is to streamline the USDA CSP and EQIP application process for NRCS staff and farmers alike, especially given the newness of the enhancements and practices. This primer was made available both during presentations and online, with a potential reach of 1,000+, as well as to county and state NRCS offices in Kernza-growing regions. Dr. Bartel will continue outreach to NRCS offices in each state and county in which there is a Kernza grower to provide educational materials to USDA staff, specifically those who interact directly with farmers.

Dr. Bartel has also engaged the RMA to identify possible insurance products for Kernza, which will be informed by data over additional growing seasons. Dr. Bartel's KernzaCAP Lunchtime Seminar (November 28, 2023, ~25 attendees) also focused on USDA Risk Management for Kernza Growers to increase awareness and data needs. The KernzaCAP team has developed a framework for farmer data sharing and data collection relevant to developing RMA crop insurance products and will work to provide RMA with requested data, especially yield and locations for varieties where best management practices were employed, as well as proof of Kernza pricing.

Supply Chains & Economics

Develop supply chains and economic drivers for Kernza.

Year 4 Team members

- Colin Cureton (co-lead) - Forever Green Initiative, University of Minnesota
- Dr. Tessa Peters (co-lead) - The Land Institute
- Christopher Abbott - Perennial Pantry
- Alicia Baddorf - University of California, Davis
- Christie Biddle - Patagonia Provisions
- Katharine Chute - Forever Green Initiative, University of Minnesota
- Gwenael Engelskirchen - University of California, Davis
- Tannie Eshenaur - Minnesota Department of Health
- Hana Fancher - The Land Institute
- Shawn Gruenhagen - Sustain-a-Grain
- Alex Heilman - Perennial Promise Growers Cooperative
- Dr. Nicholas Jordan - Forever Green Initiative, University of Minnesota
- Andrew Leach - University of Minnesota Forever Green Initiative
- Ben Penner - Penner Farms

Team objectives

Objective 1: Develop a Kernza Business Association to be the voice for Kernza industry partners in a broader Kernza Consortium.

At the end of project Year 3, following the development of a strategic plan for a Kernza Stewards Alliance, Objective 1 has functionally been on hold. Incorporating a perpetual purpose trust entails legal costs, for which USDA funds cannot be used. Additionally, research for Objective 2 has shown that promotion of the grain is the most important work for the coming years, so the team decided not to reallocate funds from that objective to this work. In project Year 4, the team reconvened stakeholders for project and market updates, but no significant progress was made on this objective.

Objective 2: Perform foundational consumer research and market analysis to determine Kernza's profitability for producers, supply chain actors, and end-users.

Kernza enterprise budget case studies were developed for Kansas, including various opportunity cost analyses. These will be published by NRCS and then in a joint paper authored by the University of Kansas, Hana Fancher, and NRCS economists. This work was supported primarily through Land Institute funds, but supports the work of KernzaCAP broadly.

Objective 3: Research, develop, and solidify Kernza supply chains and markets.

The Perennial Percent initiative was launched as a label-based program to encourage companies to include small percentages of perennial grains in their best-selling products. Read more about the Perennial Percent program in this case study from Green Lands Blue Waters, written by KernzaCAP collaborators.

The team onboarded a full time Product and Market Development Specialist at the University of Minnesota Forever Green Initiative. Katharine Chute will bring significant and dedicated capacity to Kernza market development work from her hiring in October 2023 through the end of the project. The team also used the above mentioned consumer research as well as new marketing materials to advance market development, and examined ways to rebudget and invest more directly in our supply chain and market partners.

Katharine Chute and Matt Leavitt (Forever Green) talk to Kernza business end users at Artisan Grain Collaborative's Minnesota "Barnstormer" event. Photo credit: Elena Byrne

Sour ales brewed with fruit and Kernza from Haggard Barrel Brewing and a new shape of pasta made with Kernza were among the new Kernza products released in 2024. Photo credit: Haggard Barrel Brewing, Patagonia Provisions

Objective 4: Evaluate models for valuing and promoting the diverse environmental, social, and health benefits of Kernza.

Merge Marketplace, which ties on-farm soil carbon sampling and biodiversity measurements to the grain, was launched with Kernza listings. New growers will be able to enroll acres in the coming year. The team also finalized the supply dashboard pilot and expanded it to all Kernza grain growers, conducted grain monitoring from 2023 harvest, and created three industry kits targeting brewing, baking, and consumer packaged goods companies.

Integration

Activate transformational change through intentional integration.

Year 4 Team members

- Dr. Jacob Jungers (co-lead) - University of Minnesota
- Josh Kielsmeier-Cook (co-lead) - University of Minnesota
- Dr. Tessa Peters (co-lead) - The Land Institute
- Aaron Reser (co-lead) - Green Lands Blue Waters
- Dr. Aubrey Streit Krug (co-lead) - The Land Institute
- Greta Landis - University of Wisconsin-Madison
- Amber Mase - University of Wisconsin-Madison
- Erin Meier - Green Lands Blue Waters
- Evelyn Reilly - University of Minnesota
- Craig See - University of Minnesota
- Dr. Amy Teller - University of Minnesota
- Co-leads of all other objective teams participate on the integration team

Team objectives

Objective 1: Project-wide integration and activity tracking through the design of our objectives and engagement with our project partner network.

The Integration Team continued to use tools and strategies from previous years to support project activities. **Communications, project tools, and tracking infrastructure** built at the start of the project to encourage project norms and cohesion remained valuable, including the collaborator site, project CV, and annual reporting forms, Rules & Tools document, data sharing & co-authorship policy (encouraged use of manuscript proposal form), internal talking points, shared photo album, shared values and principles (no updates, but did refer to them often), and the race and equity framework (updated and referred to the workplan). The team also sent quarterly newsletters and more regular communications to our collaborator listserv.

The team facilitated regular meetings to encourage project-wide integration, including:

- Weekly management team meeting
- Bi-weekly Coordinating Team meeting
- Integration team meeting ad-hoc, between monthly to quarterly
- Evaluation team meeting ad-hoc, between quarterly to bi-annually (currently bi-weekly)
- Shared leadership ad-hoc meetings
- Standing meetings for objective teams
- Monthly seminars with built in Q&A time for collaborators to engage across teams

Biweekly coordination team meetings anchor objective group collaborations, and **outputs from various objective groups continue to serve as inputs for others**, such as market talking points (Supply Chain and Economics team) based on findings from environmental quality team research. In addition, participating in the SAS CAP project managers' community of practice helped KernzaCAP integrate with the broader community of CAPs across the country.

Increasingly in this past year, KernzaCAP leadership **engaged with other SAS CAPs and similar large-scale, transdisciplinary projects** to explore ways to have collective voice and impact and to professionalize and legitimize this work, including through potentially building and piloting a professional development training for transdisciplinarity.

In the coming year, the team will continue effective strategies, including the communication tools, seminars, and meetings. The team will also continue engagement and relationship building with Kernza stakeholders and other leaders across agriculture and food systems beyond project collaborators, including the SAS CAP PMs group, Perennial SAS CAP working group, advisory committee members and other entities. Finally, the team will continue to foster communication and integrative thinking across the project.

Objective 2: Co-create and actualize a Kernza Consortium to serve as a multi-stakeholder leadership body.

Contracted work with Terra Soma continued from Year 3, building on stakeholder feedback from the previous year, with the development of a desk audit of operating consortium models that might meet the goals of a non-licensee Kernza Consortium. The audit provided recommendations for consortium revenue structure, governance, daily activities, and the relationship between a Kernza Steward Alliance and Kernza Non-licensee Consortium.

Leaders from key stakeholder organizations were convened in November 2023 with Terra Soma facilitating an audit review and group exploration/decision-making process. Participants indicated continuing interest in developing a non-licensee consortium or similar organizational structure. Attendees included representatives of UMN Forever Green Initiative, The Land Institute, Green Lands Blue Waters, Artisan Grain Collaborative, University of Wisconsin, and Michael Fields Agricultural Institute. The team continues to discuss consortium development, interim steps as KernzaCAP sunsets, and questions about structure, staffing, funding, and objectives. Consortium conversations will continue to be a focus of coordinating team meetings and all project meetings in Year 5 and during the no-cost extension, and coordinating team meetings will shift their purpose to act as a Kernza Consortium. The team will explore how the participants and structure should change to add and/or roll-off partners and create working groups or sub-committees, as appropriate. The team incorporated pre-meeting surveys, exercises, and discussions into the 2024 All-Hands meeting to start this process.

Objective 3: Lead the way for the next generation of perennial cropping systems.

Team members carried out diverse activities that support ongoing development of perennial crops. Based on interviews with the Kernza community, including many KernzaCAP collaborators, Evelyn Reilly compiled reflections that can guide development of future perennial crops. Data manager Craig See is developing a suite of resources and tutorial regarding KernzaCAP's approach to data management which will be a resource for future perennial crop projects, and is already being used by international perennial grains collaborators. KernzaCAP, particularly via Aaron Reser's time, continues to lead engagement on cross-CAP collaboration with other perennial-focused CAPs. This work includes coalescing around shared impact and voice in academic, policy, and community partner settings, as well as exploration of development of transdisciplinarity training tools, core competencies and other professionalization of the field of transdisciplinarity, systems thinking, and academic to community bridging necessary to the success of SAS CAPs and similar large scale agricultural change initiatives. Some of this work will be directly in collaboration with NIFA staff, and some of this work is being planned for in person engagement at an April 2025 Green Lands Blue Waters conference.

> *There's a sense from central project staff and leaders across SAS CAP grants that we're all learning as we go in terms of working in a transdisciplinary, systems-thinking way, and an excitement around growing this field together. How do we support each other to increase skills, impact and even our own understanding and language around what it means to work in a holistic, many-partner, integrative way to create change together?*
>
> *- Aaron Reser*

Objective 4: Catalyze new network reach and effectiveness through accessible data and shared learnings.

With the onboarding of a data manager, the focus this year was on ensuring that KernzaCAP data are accessible to both collaborators and the broader research community. The team worked to ensure that decisions around data cleaning and curation occurred consistently and reproducibly across sites. Finalized datasets are now accessible to all KernzaCAP collaborators, and will be published in summer 2025 along with scripts documenting the workflow from "raw" to "final" data. The team used existing forums to disseminate data and shared learnings and to catalyze new network reach, including the website (updating field notes, team progress, collaborators, etc.), newsletters (audience up to 216), and the SAS CAP Project Managers Community of Practice, which KernzaCAP collaborators co-hosted. In addition, the team encouraged use of the manuscript proposal form, resulting in five submissions in the reporting period. In 2025, the team will produce a "how-to" guide for data management of large, multi-institutional

collaborative experiments, with protocols for data collection, merging, and quality control, and guidelines for using freely available software (R, Google Suite tools) for collaboration. It will also include basic tutorials with modifiable example scripts.

Objective 5: Evaluate for impact, systems change and emergent learning.

The University of Wisconsin Madison evaluation team continues to assist KernzaCAP project leads with reflective assessment of the KernzaCAP project, the broader Kernza network, and with identifying future collaborative priorities. Within this reporting period, the UW evaluation team has helped bridge from the first Social Network Analysis (SNA) to discussions about a second SNA during the final year of the project. At the beginning of Year 5, they hosted an activity at the 2024 All-Hands meeting (October 2024), and in the final project year, the UW Madison evaluation team will continue to support reflection, assessment, and priority determination, including through a document review and informational interviews across the project and developing guidance around shared leadership priorities.

Measuring Kernza fall regrowth.
Photo credit: Laura Van der Pol

Of particular note, KernzaCAP was highlighted in the USDA NIFA Climate Change Priority Team 2024 Accomplishments and Action Agenda Report. The KernzaCAP team is honored to have been featured in this agency-wide report and will continue to pursue excellence through the remaining time of the grant.

Race and Equity Subgroup

The KernzaCAP grant aims to improve the environmental sustainability of food production and demonstrate the viability of new perennial crops as real economic opportunities for farmers and rural communities. The purpose of the race and equity work in this project is to expand perennial agriculture in a way that is fair, inclusive, and benefits all people and communities equitably. The Integration Team advanced KernzaCAP Race and Equity work in a variety of ways, including exploring the possibility of hosting a DEI workshop for KernzaCAP collaborators in Year 5 through the University of Minnesota Office for Inclusive Excellence.

The team will continue to identify tangible ways to communicate the importance of equity work to all collaborators, explore how to communicate more publicly about this work, and reflect on how the outcomes will be applied to create an equitable model for future perennial crops.

Products

Peer Reviewed Publications

- Bajgain, P., Jungers, J. M., & Anderson, J. A. (2024). Genetic constitution and variability in synthetic populations of intermediate wheatgrass, an outcrossing perennial grain crop. *G3: Genes, Genomes, Genetics*, *14*(9), jkae154. https://doi.org/10.1093/g3journal/jkae154
- Bajgain, P., Stoll, H., & Anderson, J. A. (2024). Improving complex agronomic and domestication traits in the perennial grain crop intermediate wheatgrass with genetic mapping and genomic prediction. *The Plant Genome*, e20498. https://doi.org/10.1002/tpg2.20498
- Crain, J., Wagoner, P., Larson, S., & DeHaan, L. (2024). Origin of current intermediate wheatgrass germplasm being developed for Kernza grain production. *Genetic Resources and Crop Evolution*, *71*(8), 4963–4978. https://doi.org/10.1007/s10722-024-01952-1
- Griffin, A. J., Jungers, J. M., & Bajgain, P. (2025). Root phenotyping and plant breeding of crops for enhanced ecosystem services. *Crop Science*, *65*(1), e21315. https://doi.org/10.1002/csc2.21315
- Jungers, J., Runck, B., Ewing, P. M., Maaz, T., Carlson, C., Neyhart, J., Fumia, N., Bajgain, P., Subedi, S., Sharma, V., Senay, S., Hunter, M., Cureton, C., Gutknecht, J., & Kantar, M. B. (2023). Adapting perennial grain and oilseed crops for climate resiliency. *Crop Science*, *63*(4), 1701–1721. https://doi.org/10.1002/csc2.20972
- Loehr, L. A., Bajgain, P., Selfridge, C., Annor, G., & Ismail, B. P. (2024). Impact of processing and storage on rancidity markers in commercial and novel cultivar candidates of intermediate wheatgrass (*Thinopyrum intermedium*). *Cereal Chemistry*, *101*(3), 594–610. https://doi.org/10.1002/cche.10763
- Pinto, P., Cartoni-Casamitjana, S., Stoltenberg, D. E., & Picasso, V. D. (2024). Forage boost or grain blues? Legume choices shape Kernza intermediate wheatgrass dual-purpose crop performance. *Field Crops Research*, *316*, 109522. https://doi.org/10.1016/j.fcr.2024.109522

Conference Papers and Presentations

- Aduama, O., Annor, G. (2023). The effect of nitrogen treatment dough rheology and protein aggregation kinetics of Intermediate wheatgrass (Thinopyrum intermedium). [Abstract]. Cereal and Grains Association Annual Meeting, Schaumburg, IL. https://events.rdmobile.com/Lists/Details/2050095
- Aduama, O., Annor, G. (2024). Effect of Nitrogen Fertilizer on the Amino Acid Profile of Intermediate Wheatgrass. [Abstract]. University of Minnesota CFANS Research Symposium, St. Paul, MN.
- Bajgain, P. (2024). Domesticating a perennial grass crop in the era of modern genomics. [Abstract]. Plant and Animal Genome Conference/PAG 31, San Diego, CA. https://pag.confex.com/pag/31/meetingapp.cgi/Paper/53988

- Bajgain, P. (2024). Genomics-driven domestication of the perennial grass Intermediate Wheatgrass (Kernza). [Symposium Presentation]. University of Minnesota Center for Precision Plant Genomics 2024 Symposium, St. Paul, MN. https://cppg.umn.edu/cppg-2024-symposium
- Brunsell, N., Ghasemian, S., Ring, N. (2023). Assessing the environmental benefits and resiliency of Kernza Intermediate Wheatgrass to drought and changing climatic conditions. [Abstract]. American Geophysical Union Annual Meeting, San Francisco, CA. https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1417664
- Ghasemian, S., Brunsell, N. (2023). Quantifying the Environmental Benefits of Perennial Agriculture: A Case Study of Kernza Intermediate Wheatgrass and NOAH-MP. [Abstract]. American Geophysical Union Annual Meeting, San Francisco, CA. https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1415449
- Olugbenle, O., & Picasso, V. D. (2023). Yield and Forage Quality of Dual-Use Populations of Intermediate Wheatgrass Intercropped with Legumes [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/149197
- Pinto, P., & Picasso, V. D. (2023). Intercropping Legumes and Intermediate Wheatgrass Increases Forage Yield, Nutritive Value, and Profitability without Reducing Grain Yields. [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/149133
- Ritter, T., Gutknecht, J. L., & Jungers, J. M. (2023). Kernza CAP: Developing and Deploying a Perennial Grain Crop Enterprise to Improve Environmental Quality and Rural Prosperity [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/151819
- Shoenberger, E., Stoltenberg, D. E., & Picasso, V. D. (2023). Managing Stand Density Reduction and Nitrogen Fertility in Dual-Use Kernza Intermediate Wheatgrass to Sustain Grain Yield over Time [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/148559
- Singh, G., Gutknecht, J. L., Jungers, J. M., Trost, J., & Ha, W. (2023). Nitrate Leaching and Crop Yield for Intermediate Wheatgrass (Kernza®) in the US Midwest. [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/149223

Other Publications

- Bartel, C. (2024). *A Step-by-Step Guide to United States Department of Agriculture Farm Program Enrollment & Incentives for Kernza®*. KernzaCAP extension primer. https://kernza.org/wp-content/uploads/Kernza-USDA-incentives-11.21.24.pdf
- The Land Institute (2024). *Annual Kernza® Perennial Grain Supply Report.* https://kernza.org/wp-content/uploads/2023-Kernza-Supply-Report.pdf

- Reilly, E. (2024). *KernzaCAP Year 3 Annual Report.* https://hdl.handle.net/11299/260330
- Tautges, N., Detjens, A., Jungers, J. (2024). *Kernza® Grower Guide - Ukrainian Translation* (Veklenko, Y. & Dmytruk, Y., trans.) The Land Institute/KernzaCAP (Original work published in 2023). https://hdl.handle.net/11299/265256
- Terra Soma (2023). *Kernza® Non-Licensee Consortium Desk Audit.* https://hdl.handle.net/11299/263921
- Terra Soma (2023). *Methodology Memo: Organizational Models Research Kernza® Non-Licensee Consortium.* https://drive.google.com/file/d/1-SoAtRD2pqYGdJGsHlDzYcSxtyLghAHG/view?usp=drive_link
- Terra Soma (2023). *Kernza® Non-Licensee Consortium Synthesis Memo.* https://hdl.handle.net/11299/263923

Presentations

- David, C. (2023, September 26). *Kernza Initiative in Western Europe: From Research to Agriculture and Food Development, an Illustration from France.* Presentation at monthly KernzaCAP seminar. Virtual. https://mediaspace.umn.edu/media/t/1_6vpvyp28
- Callis-Duehl, K., Mayerfeld, D., Meier, E., Spratt, E. (2023, October 24). *Incorporating Equity into Funding Proposals.* Presentation at monthly KernzaCAP seminar. Virtual. https://mediaspace.umn.edu/media/t/1_g6lygqwt
- Nicholson, L. (2023, November 2-3). *Meeting Perennials.* 2023 Kansas Environmental Education Conference. Wichita, KS.
- Bajgain, P. (2023, November 30). *Breeding Intermediate Wheatgrass (Kernza®) for Perennial Agricultural Systems.* Presentation to University of Minnesota Sustainable Agriculture Colloquium. St. Paul, MN.
- Jungers, J., Bartel, C., Peters, T., Curenton, C., Wiltse, K., & Meier, E. (2023, December 5). *Kernza: Multipurpose Perennial Cover Crop.* Presentation to the Minnesota NRCS/Board of Water and Soil Resources Virtual Tech Talk. Virtual.
- DeHaan, L., Bajgain, B., & Cureton, C. (2024, January 17). *Intro to Kernza Breeding and Licensing.* Forever Green Initiative Kernza Cafe Chat. Virtual.
- Jungers, J. (2024, January 24). *Kernza Planting and Management.* Forever Green Initiative Kernza Cafe Chat. Virtual.
- Streit Krug, A. (2024, January 31). *Realizing Roots.* Presentation to Environmental Studies Undergraduate Capstone Class at University of Kansas. Lawrence, KS.
- Nicholson, L. (2024, February 5). *A Taste of the Perennial Future: Perennial Grains and Kernza Introduction.* Presentation at a "Salina Reads" program at Salina Public Library. Salina, KS.
- Kimber, K., Penner, B., & Fernholz, C. (2024, February 7). *Kernza Harvesting.* Forever Green Initiative Kernza Cafe Chat. Virtual.

- Jungers, J. (2024, February 21). *Intercropping Alfalfa & Kernza for Dual-Use Forage & Grain.* Presentation at the Midwest Forage Association Annual Symposium. Wisconsin Dells, WI.
- Peters, T. & Tautges, N. (2024, February 21). *Kernza Marketing.* Forever Green Initiative Kernza Cafe Chat. Virtual.
- VanderKooi, S. (2024, March 6). *Kernza Forage.* Forever Green Initiative Kernza Cafe Chat. Virtual.
- Cassani, T. (2024, March 18-22). *Perennial Crops for Sustainable Agriculture.* Invited lecturer at University of the Republic of Uruguay. Punta del Este, Uruguay.
- Nicholson, L. (2024, April 10). *Storytelling with Kernza Perennial Grain.* Webinar at Kernza for Kansas event. Virtual.
- Nicholson, L. (2024, April 13). *Kernza and Its Benefits.* Presentation at Kernza for Kansas event. Salina, KS.
- Nicholson, L. (2024, April 17). *Domestication, Soil, and Perennial Grains.* Field Trip for Environmental Studies class from Hays High School. Salina, KS.
- Chute, K. & Fancher, H. (2024, April 23). *Kernza Market Update and 2023 Kernza Supply Review.* Presentation at monthly KernzaCAP seminar. Virtual. https://mediaspace.umn.edu/media/t/1_i8wvt0rn
- Bajgain, P. (2024, April 25). *Breeding and Domestication of Intermediate Wheatgrass (Kernza®).* Lecture to Applied Plant Breeding and Genetics course at University of Nebraska-Lincoln. Virtual.
- Jungers, J. (2024, April 26). *Agronomic Evaluation of Perennial and Annual Winter Crops to Diversify Agriculture.* Presentation to Minnesota Agricultural Experiment Station. St. Paul, MN.
- Gutknecht, J. (2024, May 1). *Perennial Grain Systems as a Pathway to Improved Soil Functioning and Climate Resiliency.* Invited Seminar, Department of Microbiology, North Dakota State University. Fargo, ND.
- Nicholson, L. (2024, May 3). *What is a Grain?* Presentation at MillFest. Lindsborg, KS.
- Streit Krug, A. (2024, May 9). *Toward a Perennial Future for the Prairie Region*. Public presentation at Hays Public Library. Hays, KS.
- Nicholson, L. (2024, May 22). *Care and Breeding of Perennial Grains.* Presentation for Master Gardeners Group at The Land Institute. Salina, KS.
- Nicholson, L. (2024, May 28). *Kernza in Context Curriculum Launch.* Presentation at monthly KernzaCAP seminar. Virtual. https://mediaspace.umn.edu/media/t/1_487ynkvu
- Nicholson, L. (2024, May 30). *Prairies, Perennials, and Grains.* Presentation to Salina 4-H. Salina, KS.
- Nicholson, L. (2024, June 4). *Kernza in Systems.* Presentation at Fort Hays State University. Hays, KS.
- Nicholson, L. (2024, June 24). *Domestication, Soil, and Perennial Grains.* Presentation to group from Green Teams Internship program. Salina, KS.

- Penner, B. (2024, June 25). *Perennial Promise Growers' Cooperative.* Presentation at monthly KernzaCAP seminar. Virtual. https://mediaspace.umn.edu/media/t/1_sy4v1bve
- Jungers, J. (2024, July 10). *Novel Perennial Crops.* University of Minnesota Extension Field Day Tour. St. Paul, MN.
- Nicholson, L. (2024, July 19). *Intro to Perennial Grains and Kernza.* Presentation at Sustain-A-Grain Farmer Tour. McPherson, KS.
- Nicholson, L. (2024, July 27). *What is a Grain? What is Kernza?* Activity Station at Nicodemus Homecoming and Emancipation Celebration. Nicodemus, KS.
- Gutknecht, J., Jungers, J., Cureton, C., & Leavitt, M. (2024, August 21). Field Tour with General Mills Research Scientists. St. Paul, MN.
- Wiley, Z. & Karkle, E. (2024, August 27). *Student Research and Kernza Sourdough Fermentation.* Presentation at monthly KernzaCAP seminar. Virtual. https://mediaspace.umn.edu/media/t/1_0ps80t0q
- Nicholson, L. (2024, October 11). *What are the Benefits of Perennial Agriculture?* Presentation at The Land Institute. Salina, KS.

Field Days

- Kernza Field day toolkit. Online toolkit with information about Kernza production to facilitate information sharing at field day events. https://drive.google.com/drive/u/0/folders/18Wywm4EShLP5jiwRo1Dc3P0Mk5UFLLeG
- KernzaCAP. (2024, June 21). *2024 Field Day Press Release.* https://kernza.org/wp-content/uploads/August-2024-KernzaCAP-Field-Day-Press-Release-1.pdf
- 2023, October 11. Fall Grazing on Kernza Demonstration at White Barn Acres, hosted by Clean River Partners and Sustainable Farming Association. Kellogg, MN.
- 2024, June 13. Weatherproofing Your Farm Field Day featuring Kernza presented by Nicole Tautges and hosted by the Michael Fields Agricultural Institute. East Troy, WI.
- 2024, June 27. Grass Seed Field Tour. Jacob Jungers presented on Kernza variety development. Hosted by the University of Minnesota Magnusson Research Farm. Roseau, MN.
- 2024, July 9. Organic Cereals Field Day at the UW-West Madison Ag Research Station. Verona, WI.
- 2024, July 10. American Society of Agronomy Board Meeting Field Tour. UW-Madison Arlington Research Station. Arlington, WI.
- 2024, July 12. Great River Greening Continuous Living Cover Field Day. Colin Cureton presented on water quality impacts of Kernza. St. Peter, MN.
- 2024, July 18-19. Kernza in Kansas Field Experience hosted by Sustain-A-Grain. Multiple Locations, KS.
- 2024, August 2. Emerging Crops Field Day hosted by the Michael Fields Agricultural Institute. Steffen Mirsky presented on Kernza. East Troy, WI.

- 2024, August 6. Kernza Field Day hosted at Ross Bishop's farm and led by Valentin Picasso and Erica Shoenberger. Jackson, WI.
- 2024, August 6. Kernza Field Day hosted by Clean River Partners at Sogn Valley Farm. Cannon Falls, MN.
- 2024, August 22. Perennial Farm Systems Field Day featuring Kernza and hazelnuts. Farmington, MN.

Project Tools and Protocols

- KernzaCAP collection on the University of Minnesota Digital Conservancy - Permanent online location for KernzaCAP products. https://conservancy.umn.edu/handle/11299/255777
- Year 4 KernzaCAP Quarterly newsletters https://kernza.org/field-notes/?category=kernza-cap-newsletter
- Kernza in Context monthly newsletters - 12 issues sent to teacher-researchers and others interested in the Kernza in Context curriculum development.
- Kernza in Context educational lessons - 29 lessons organized in 10 modules with supporting instructions were completed and published open access. April 2024. http://kernza.org/kernza-curriculum
- Perennial Percent program webpage - The Perennial Percent program webpage was created by Supply Chains & Economics objective team members based at The Land Institute. The web page provides information on the newly-launched Perennial Percent program, a marketing program for perennial grains that will help companies highlight their inclusion in products. The webpage also houses the program application and the request form for the brand guide. August 2024. https://kernza.org/perennial-percent/
- Annual Kernza Perennial Grain Supply Report - The Annual Kernza perennial grain supply report was compiled by Supply Chains & Economics objective team members based at The Land Institute. The report provides planting and harvest data, which is important information for commercialization staff, technical service providers, and Kernza end users. February 2024. https://kernza.org/2023-kernza-supply-review-now-available/
- A Step-by-Step Guide to United States Department of Agriculture (USDA) Farm Program Enrollment & Incentives for Kernza. KernzaCAP extension primer. Dr. Cynthia Bartel. August 2024. https://kernza.org/wp-content/uploads/Kernza-USDA-enrollment-and-incentives-2024.pdf
- New webpage on Kernza.org explaining the E3280 Perennial Grain enhancement available to Kernza producers through the EQIP and CSP programs. The webpage explains the application timeline, CSP and EQIP program deadlines, provides examples of applicable scenarios, and provides a step by step guide to USDA Farm Program Enrollment and Incentives for Kernza. https://kernza.org/nrcs-programs-available-now-for-perennial-grains-enhancement-e3280/

Appendix A: Collaborator List & Advisory Committee

Collaborator List

- Christopher Abbott, Co-Founder, Perennial Pantry
- Obed Aduama, Masters Student, University of Minnesota
- Jim Anderson, Professor, University of Minnesota
- George Annor, Assistant Professor, University of Minnesota
- Amy Bacigalupo, Program Director, The Land Stewardship Project
- Alicia Baddorf, Sustainable Supply Chain Coordinator, University of California-Davis
- Prabin Bajgain, Research Assistant Professor, University of Minnesota
- Cynthia Bartel, Principal, C. Bartel Inc.
- Andrea Basche, Associate Professor, University of Nebraska-Lincoln
- Michael Bell, Professor, University of Wisconsin-Madison
- Christie Biddle, Supply Chain Manager, Patagonia Provisions
- Nathaniel Brunsell, Professor, University of Kansas
- Tomás Cassani, Postdoctoral Researcher, The Land Institute
- Katharine Chute, Product & Market Development Specialist, Forever Green Initiative
- Whitney Clark, Executive Director, Friends of the Mississippi River
- Jared Crain, Postdoctoral Fellow, Kansas State University
- Tim Crews, Director of Ecological Intensification, The Land Institute
- Steve Culman, Professor, Oregon State University
- Colin Cureton, Director of Adoption and Scaling, UMN Forever Green Initiative
- Julie Dawson, Professor, University of Wisconsin-Madison
- Lee DeHaan, Lead Scientist, The Land Institute
- Leonardo Deiss, Assistant Professor, Colorado State University
- Madeline DuBois, Research Technician, The Land Institute
- Gwenael Engelskirchen, Sustainable Supply Chain Analyst, University of California-Davis
- Tannie Eshenaur, Planning Director, Minnesota Department of Health
- Hana Fancher, Market Stewardship Specialist, The Land Institute
- Cecia Flores Sanchez, Masters Student, University of Minnesota
- Soudeh Ghasemian, Masters Student, University of Kansas
- Shawn Gruenhagen, Sales Associate, Sustain-A-Grain
- Jessica Gutknecht, Associate Professor, University of Minnesota
- Wonsook Ha, Hydrologist, United States Geological Survey
- Alyssa Hartman, Executive Director, Artisan Grain Collaborative
- Alex Heilman, Co-Founder & CEO, Mad Markets
- Whilden Hughes, Farmer, W. Hughes Farms
- Pam (Baraem) Ismail, Professor, University of Minnesota
- Allegra Johnson McKee, Physical Scientist, United States Geological Survey

- Dustin Johnsrud, Farmer, Johnsrud Farms
- Madeline Johnston, Graduate Student, University of Nebraska-Lincoln
- Nicholas Jordan, Professor, University of Minnesota, Forever Green Initiative
- Jacob Jungers, Associate Professor, University of Minnesota
- Clair Keene, Extension Specialist, Cropping Systems, North Dakota State University
- Josh Kielsmeier-Cook, KernzaCAP Project Manager, University of Minnesota
- Jonathan Kilpatrick, Soil Health Specialist, Sustainable Farming Association
- Kurt Kimber, Farmer, Kimber Farms
- Tammy Kimbler, Director of Communications, The Land Institute
- Peter LaFontaine, Agricultural Policy Manager, Friends of the Mississippi River
- Greta Landis, Evaluation Specialist, University of Wisconsin-Madison
- Andrew Leach, Sustainable Commercialization Associate, Forever Green Initiative
- Matt Leavitt, Perennial Grains & Winter Annuals Agronomist, Forever Green Initiative
- Amber Mase, Evaluation Specialist, University of Wisconsin-Madison
- Diane Mayerfeld, Sustainable Agriculture Coordinator, Extension, UW-Madison
- Erin Meier, Director, Green Lands Blue Waters
- Steffen Mirsky, Emerging Crops Outreach Specialist, Extension UW-Madison
- Steve Morse, Executive Director, Minnesota Environmental Partnership
- Sienna Nesser, Commercialization Research Specialist, Forever Green Initiative
- Lydia Nicholson, Research Technician, Educational Design, The Land Institute
- Ben Penner, Farmer, Penner Farms
- Justin Peschman, Hydrologic Technician Assistant, United States Geological Survey
- Tessa Peters, Director of Strategy, The Land Institute
- Luke Peterson, Farmer, Peterson Farms
- Valentin Picasso, Associate Professor, University of Wisconsin-Madison
- Priscila Pinto, Postdoctoral Researcher, University of Wisconsin-Madison
- Samuel Pratsch, Evaluation Specialist, University of Wisconsin-Madison
- Dorothy and John Priske, Farmers, Fountain Prairie Farm
- Manbir Rakkar, Assistant Professor, The Ohio State University
- Roberta Rebesquini, Masters Student, University of Nebraska-Lincoln
- Evelyn Reilly, Research Project Specialist, KernzaCAP and Green Lands Blue Waters
- Aaron Reser, Associate Director, Green Lands Blue Waters
- Ben Robinson, Research Assistant, The Ohio State University
- Trevor Russell, Water Program Director, Friends of the Mississippi River
- Mercedes Santiago, Research Technician, The Land Institute
- Craig See, KernzaCAP Data Manager, University of Minnesota
- Coleman Selfridge, Masters Student, University of Minnesota
- Gurparteet Singh, PhD Student, University of Minnesota
- Hannah Stoll, Teaching Specialist, University of Minnesota
- Dave Stoltenberg, Professor, University of Wisconsin-Madison

- Aubrey Streit Krug, Director of Ecosphere Studies, The Land Institute
- Nicole Tautges, Agroecologist, Michael Fields Agricultural Institute
- Amy Teller, Social Sustainability Researcher, University of Minnesota
- Jared Trost, Hydrologist, USGS, Upper Midwest Water Science Center
- Laura van der Pol, Lead Soil Scientist, The Land Institute
- Claire Wineman, Post-Baccalaureate Researcher, The Land Institute
- Lucinda Winter, Executive Director, Sustainable Farming Association

Advisory Committee

- Liz Carlisle, Associate Professor, University of California-Santa Barbara
- Constance Carlson, Assistant Statewide Director, UMN RSDPs
- Christophe David, Executive Director, ISARA
- Lydia English, Strategic Initiatives Coordinator, Practical Farmers of Iowa
- Carmen Fernholz, Farmer, A-Frame Farms
- Laura Hansen, Retired Research and Development lead, General Mills
- Mitch Hunter, Co-Director, Forever Green Initiative
- Bonnie Keeler, Assistant Professor, University of Minnesota
- Emily Luscombe, Natural Resources Director, Intertribal Agriculture Council
- Juli Obudzinski, Policy Consultant, Independent Consultant
- Korede Olugbenle, PhD Student, University of Wisconsin-Madison
- Hikaru Peterson, Professor, University of Minnesota
- Matt Ryan, Associate Professor, Cornell University
- Craig Sheaffer, Professor, University of Minnesota
- Rachel Stroer, President, The Land Institute
- Omar Tesdell, Associate Professor, Birzeit University
- Peggy Wagoner, Retired Project Leader, Rodale Institute

Appendix B: Year 4 All-Hands Meeting Agenda

Kernza®CAP

Year 4 All-Hands Meeting Agenda

Tuesday, October 29th, 2024 // 1:00-5:00 pm CT

1:00-1:15 Welcome and announcements

1:15-2:10 Objective team updates

- Germplasm and Trait Evaluation
- Education, Extension, and Policy
- Agronomy

2:10-2:20 Break

2:20-3:15 Objective team updates

- Supply Chains and Economics
- Environmental Quality
- Integration

3:15-3:20 Break

3:20-3:25 Instant KernzaCAP

- Objective teams will share 30 sec elevator speeches collaborators can use when speaking about our work to colleagues, farmers, and other stakeholders.
    - Germplasm and Trait Evaluation
    - Education, Extension, and Policy
    - Agronomy
    - Supply Chains and Economics
    - Environmental Quality
    - Integration

3:25-4:50 Growing a Kernza Consortium from roots to shoots!

- We will spend time in breakout groups participating in an activity developed by Greta Landis and Amber Saylor-Mase (University of Wisconsin-Madison) meant to help us identify and prioritize activities and goals of a consortium of Kernza working groups. Results from this activity will be used in developing next steps in shared leadership conversations and outcomes.

4:50-5:00 Closing