

Kernza[®]CAP

Year One Annual Report

Prepared December 2021



kernza.org/kernzacap

Photo Credit: The Land Institute

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

YEAR ONE TIMELINE

SEPT - DEC 2020

- Project launch
- Planning meetings and initiation of each objective group

JANUARY 2021

- Project manager hired
- Data management subgroup first convenes

FEBRUARY 2021

- Interviews completed for educational curriculum design process
- Kernza call series hosted for growers and market partners
- Kernza hits grocery shelves for the first time

APRIL 2021

- Selection of field sites for Agronomic trials
- Establishment of oat as previous crop in all sites

MAY 2021

- KernzaCAP newsletter launch
- Request for Proposals to support the formation of a Kernza Stewards Alliance
- 78 Kernza samples DNA sequenced for development of imputation methods

JULY 2021

- First advisory committee meeting
- Field days hosted across Minnesota and Wisconsin
- Field day and educational session for Minnesota legislators and agency leads

AUGUST 2021

- Kernza established at experiment sites
- Kernza research trials planted at 4 on-farm sites
- Baseline soil sampling at experiment sites
- Shared values and principles finalized

SEPTEMBER 2021

- Lysimeter installation at experiment sites
- Final planning for KernzaCAP's first all-hands meeting in October 2021

Kernza®CAP year one by the numbers

16

teacher-researchers, educators, and students interviewed to inform educational module development

603,864

pounds of Kernza harvested in 2021



623

experimental research plots established across 5 states

52 Kernza growers with active trademark licenses



8 new Kernza variety candidates in year one state-wide yield trials

133,000

genetic data points collected and stored in the intermediate wheatgrass database



3,951

active acres of Kernza in production

2

outreach events for legislators and advocates across the nation

25 food products using Kernza

501

soil samples taken



5 KernzaCAP-sponsored field days with 400+ attendees



6

additional Kernza variety candidates established in St. Paul in fall 2021

Groundwork laid for a next-generation business association that will steward and advance Kernza on the landscape and in the market

120

lysimeters installed to monitor water quality

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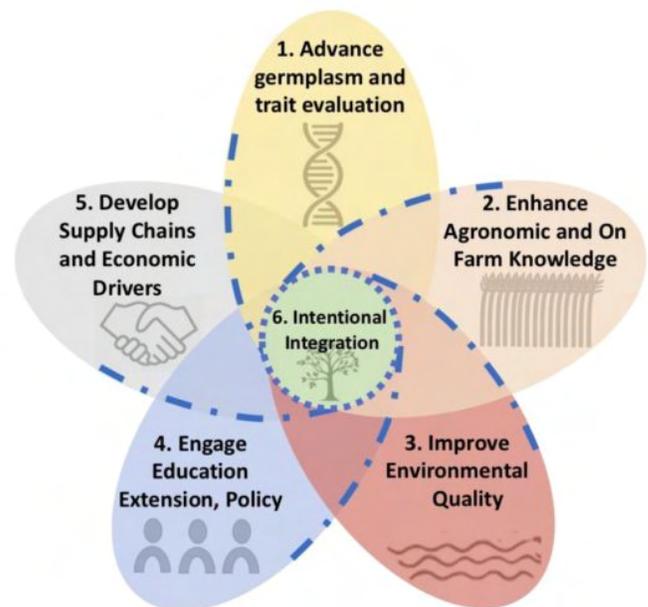
Project Overview

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 deteriorating the essential 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 simultaneously increasing farmer incomes due to decreased annual inputs and costs. The domestication of the world's first commercial-scale perennial grain crop (intermediate wheatgrass) is underway in the US, trade named "Kernza®". **This project aims to leverage and expand a strong existing collaborative, cross-sector team of researchers, educators, farmers, businesses, non-profit leaders, and others to integrate recent efforts and advance new efforts to launch new perennial grain crop enterprises based on Kernza.**

KernzaCAP was funded by the U.S. Department of Agriculture National Institute of Food and Agriculture (USDA NIFA) in 2020 and will run for five years, through August 2025. This project currently supports over 75 researchers, graduate students, business leaders, nonprofit professionals, and farmers across nine states (Appendix A). Collaborators are organized into six objective teams:

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

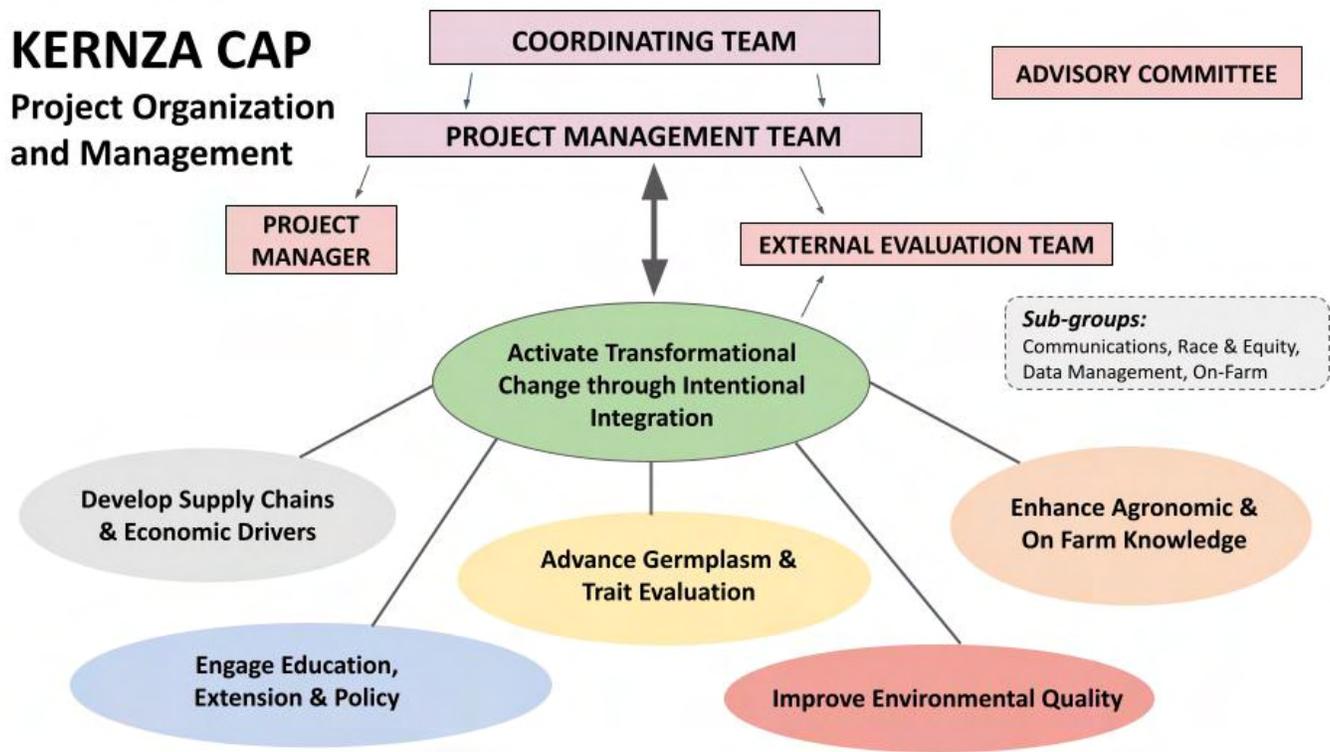
Collectively, KernzaCAP aims to activate transformational change in agriculture that improves the environment and rural prosperity. Outcomes will include Kernza variety candidates for various regions of the US; best agronomic recommendations for optimizing yield, profitability, and environmental quality; 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 and agriculture professionals.



This report summarizes activities and outcomes from year one of KernzaCAP (September 2020 through September 2021).

Project Organization & Management

In year one, KernzaCAP established an organizational structure to carry out everyday operations, disseminate information and resources to team members, and encourage efficient use of time and resources. The chart below shows how the project is structured.



A project manager was hired in January 2021. The management team met weekly to ensure smooth grant operations and project management. The Coordinating Team, made up of the project management team and co-leads of each objective team, met bi-weekly to encourage integration across teams and provide high-level thinking and decision making for the project.

An Advisory Committee was identified in the original grant proposal, and the management team expanded it to include a broader range of expertise. The 17-person Advisory Committee (see Appendix A) spans nine states and three countries and provides guidance on project goals. The Advisory Committee convened for their first meeting in July 2020.

Soon after the grant began, a data management subgroup formed. An early activity was creating a data sharing and authorship policy (Appendix B), which is intended to give proper attribution and credit to individuals involved in data collection, management, and analysis. The policy also includes a manuscript proposal system to track proposed publications across the grant and identify possible areas of overlap.

The data management subgroup began looking into long-term platforms for data storage and created a system for early data entry.

A reporting system was designed and implemented to track progress and outcomes across objective teams. All collaborators have access to a project CV and are responsible for adding their own work to the CV on a regular basis. Annually, subaward institutions and objective team co-leads fill out an annual report that the project manager compiles and submits to NIFA. Annual reporting also includes budget checks with objective teams and subaward institutions to ensure spending remains on track.

To encourage communication among collaborators, email listservs were created for all collaborators, the Coordinating Team, and the Advisory Committee. 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, review, and revise documents.

In October 2021, collaborators came together for the project's first all-hands meeting (Appendix C). This half-day virtual meeting brought together over 60 attendees to share team updates, listen to keynote presentations, and engage with one another in breakout sessions. We hope to host future all-hands meetings in person to encourage more integration and cross-project communication.

To communicate with external stakeholders interested in the project, KernzaCAP launched an external newsletter through MailChimp with an audience of 140 at the end of year one. This newsletter is sent approximately quarterly and provides project updates, collaborator introductions, and media stories highlighting Kernza. The project's website (www.kernza.org/kernzacap) was created at the start of the project and is regularly updated to reflect progress.

In year two, KernzaCAP will increase opportunities for collaborative work. Members of the team will host the annual Kernza Conference in April 2022 in Salina, Kansas, which will bring KernzaCAP collaborators together with the broader Kernza community. The Advisory Committee will meet again in early 2022, and the second all-hands meeting will take place in late 2022. In addition, the project management team is exploring a seminar series that will encourage greater communication and integration across objective teams.



The team at University of Wisconsin installs lysimeters to monitor water quality. Photo Credit: Priscila Pinto

Germplasm & Trait Evaluation

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

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
- Dr. Jared Crain - Kansas State University
- Dr. Pam Ismail - University of Minnesota

Team objectives

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

The University of Minnesota (UMN) breeding program phenotyped the Cycle 5 breeding population at St. Paul, MN and Lamberton, MN. Based on plant performance, a large population was selected to be sequenced and from that about 100 candidates will be selected using genomic selection and used as parents for the next breeding cycle (Cycle 6). In year two, the breeding team will evaluate the Cycle 5 population and establish Cycle 6 materials at the same two locations (St. Paul and Lamberton, MN). Six new synthetic (S0) variety candidates were established in St. Paul in fall 2021. The Land Institute (TLI) completed Cycle 11 using genomic selection.



Kernza fields in St. Paul, MN. Photo credit: Prabin Bajgain



Objective 2: Develop a low-cost genotyping approach that leverages recently completed IWG genome sequence to genotype larger breeding populations.

The draft genome vastly improved in year one. The team is considering skim sequencing, or sequencing at extremely low coverage, for the new genotyping approach. Information from the parent plants is used to do an imputation method. This costs less while still maintaining genome coverage. In year two, we will do skim sequencing of more than 100 breeding lines and up to about 1,000 plants from the training population. The team will develop imputation models based on the data. Sequence data from 78 individuals was generated to begin developing the new imputation method.

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

Both TLI and UMN breeding programs deposited genetic data into the Kansas State University wheatgrass database. UMN deposited cycles 3 and 4 into the database, and cycle 5 will be deposited in the database at the end of 2022. More than 133,000 data points were collected in 2021. All the data in the database is used to update the genomic selection model.

In year two, the team will train and update the genomic selection models using this data.

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

This objective relies on populations established in fall 2021. Analysis will begin in 2022.

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

This objective relies on populations established in fall 2021. Analysis will begin in 2022.



Dr. James Anderson, germplasm & trait evaluation co-lead, and farmer Carmen Fernholz speak at a field day in July 2021.

Agronomy & On-Farm Knowledge

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

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 - The Ohio State University
- Dr. Julie Dawson - University of Wisconsin, Madison
- Carmen Fernholz - A-Frame Farm
- Dr. Carrie Laboski - University of Wisconsin, Madison
- Dr. Priscila Pinto - University of Wisconsin, Madison
- Dorothy and John Priske - Fountain Prairie Farm
- Dr. Dave Stoltenberg - University of Wisconsin, Madison

On-farm partners

- Whilden Hughes - W. Hughes Farms, Wisconsin
- Dustin Johnsrud - Johnsrud Farms, North Dakota
- Kurt Kimber - Kimber Farms, Minnesota
- Luke Peterson - A-Frame Farm, Minnesota



Dr. Nicole Tautges plants the fertility trial at Michael Fields Agricultural Institute

Team objectives

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

The team planned and implemented a Genotype by Environment by Management (GEM) trial to explore how genotypes managed in identified environments interact. In collaboration with the germplasm and trait evaluation team, four Kernza genotypes of interest were identified for planting. Selection was based on improved traits of interest, including higher yields, larger seed size, increased rhizomatous growth, and high threshability. The trial was planted at six collaborating research sites in Wisconsin, Minnesota, Ohio, Nebraska, and Kansas. The layout was replicated at each of the six research sites, with four replications per site. The experiment is evaluating Kernza planted in narrow (12-15") vs. wide (24-36") rows and includes alfalfa and red clover intercrops with two of the varieties in order to test the response of different varieties to intercropping with legumes.

GEM Trial (Genetics x Environment x Management)

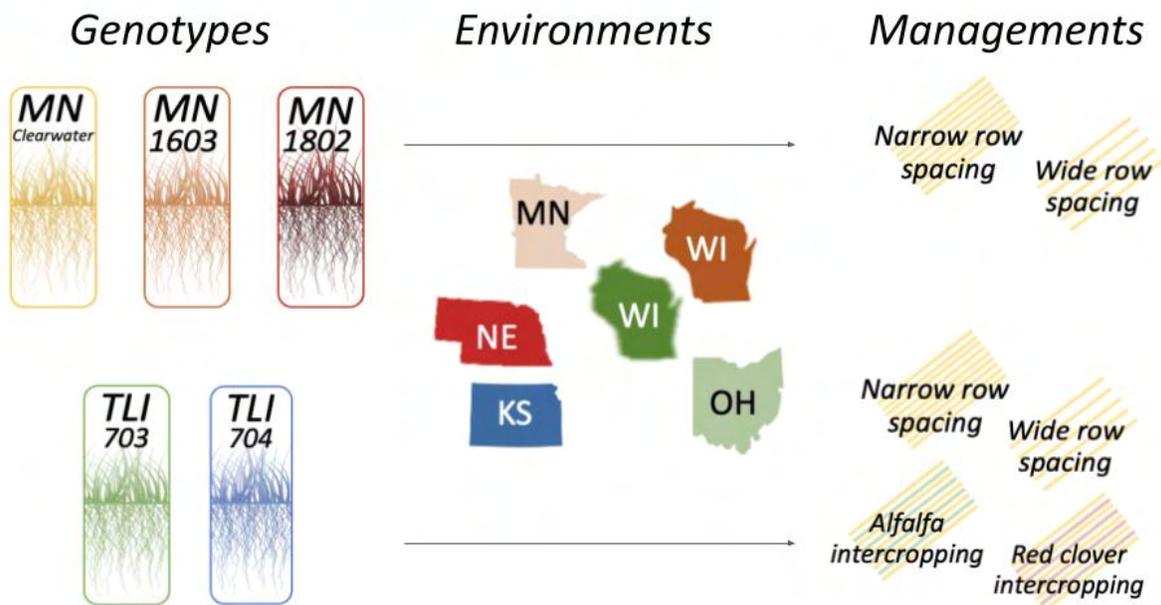


Diagram of the Genotype x Environment x Management experiment. Credit: Priscila Pinto

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

The team planned and implemented a fertility trial to study different fertilizer management practices for Kernza compared with annual cropping systems (corn and soy). A detailed protocol was designed for field selection, previous crop (oat), baseline soil sampling, tillage, plot fertilization, seeding, and installation of lysimeters. The experiment features 12 treatments, replicated four times in six locations (the same locations as the GEM trial). The treatments include different nitrogen application rates, timing, and source, and different phosphorus and potassium rates. This experiment will provide needed fertilizer recommendations for Kernza farmers.

FER Trial (Fertility)

Fertilizer application

- N 40 lbs/acre
- P 50 lbs/acre
- K 150 lbs/acre

Experiment addressed

- △ R N rate
- △ T N timing
- △ S N source
- △ PK PK

Locations

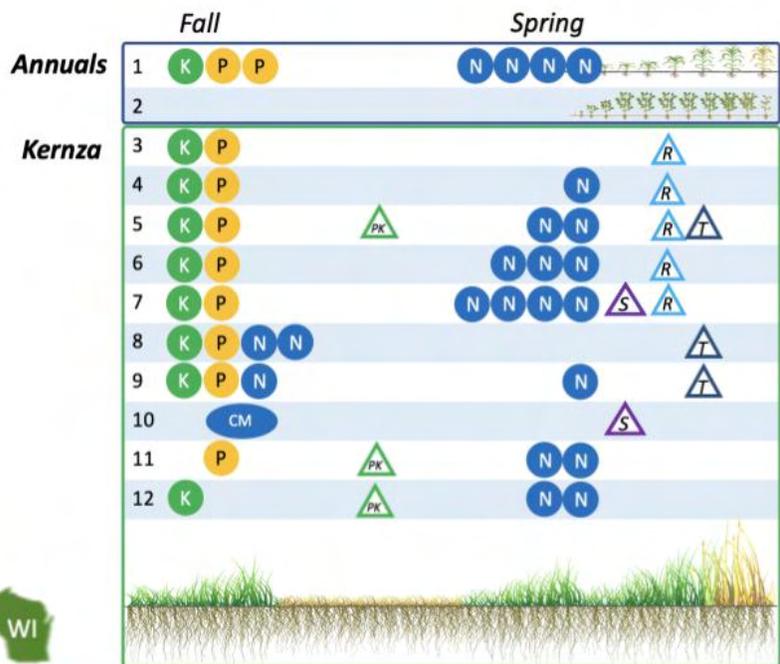


Diagram of the fertility trial. Credit: Priscila Pinto

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.

Agronomy team members worked with four farmers (Kurt Kimber and Luke Peterson in Minnesota, Whilden Hughes in Wisconsin, and Dustin Johnsrud in North Dakota) to plant four on-farm replicated Kernza trials with two treatments mimicking treatments in the fertility trial and two treatments identified by growers as management interests. Management interests include sulfur fertilization (in addition to NPK), legume and multi species intercropping, companion seeding with a “nurse” crop, and livestock grazing integration. The team took baseline soil samples and generated maps for each trial. Data collection will begin on these trials next year.



The team at the Ohio State University prepares their fields for planting.



The team at University of Nebraska-Lincoln does baseline soil sampling in August 2021.

Environmental Quality

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

Team members

- Dr. Jessica Gutknecht (co-lead) - University of Minnesota
- Alyssa Hartman (co-lead) - Artisan Grain Collaborative
- Dr. Nathaniel Brunsell - University of Kansas
- Dr. Tim Crews - The Land Institute
- Jared Trost - United States Geological Survey

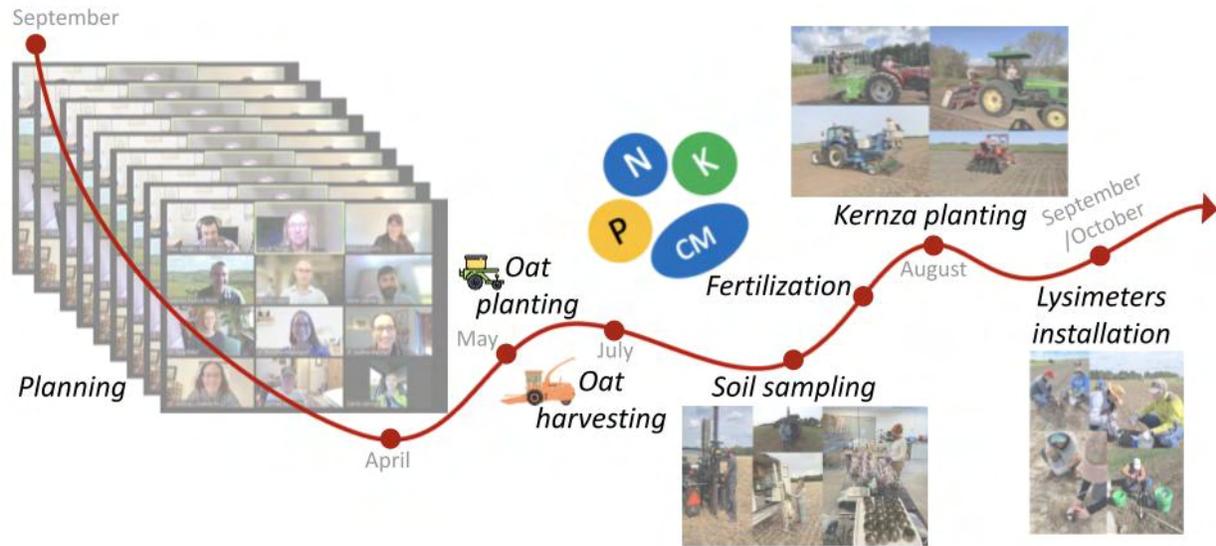
Team objectives

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

The team will measure soil moisture and water quality outcomes on the same plots as the agronomy team's fertility trial. Layering these experiments will show how environmental outcomes are impacted when Kernza is managed in different ways for fertility. In year one, the team planned, developed protocols, and built lysimeters to take empirical measurements throughout the rest of the project. The lysimeters were installed in September 2021 to match the deepest depth of soil sampling. A graduate student was hired at the University of Minnesota to analyze water quality data and model Kernza's water quality impacts. A camera system was beta-tested to monitor surface runoff and will be deployed in year two of the project.



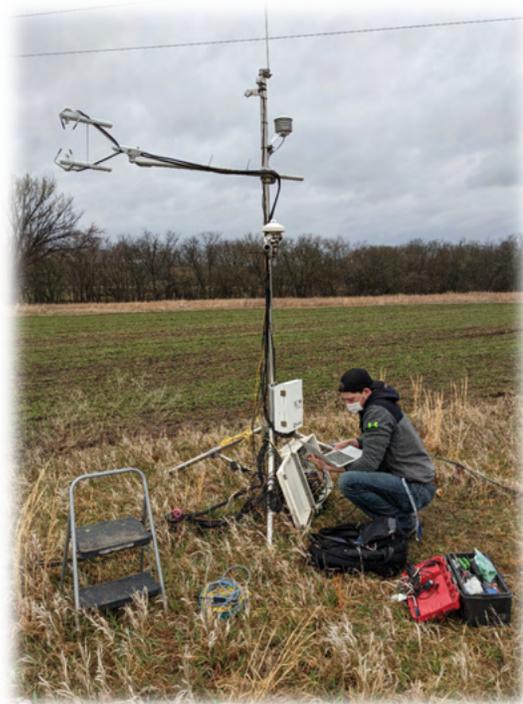
The team at The Land Institute installed lysimeters in September 2021 to collect water for nitrate sampling. Photo credit: Tim Crews



A timeline of the agronomy and environmental quality teams' work from September 2020 - September 2021. Credit: Priscila Pinto

Objective 2: Quantify the potential of Kernza to reduce GHG emissions by synthesizing field observations with biophysical, predictive models in relation to cropping practices and climate forcings.

Covid-19 prevented access to many eddy flux tower sites, so most of the year was spent recalibrating existing models, beginning to calibrate new models, and doing other background preparation work. A graduate student was hired at the University of Kansas to lay the groundwork for predictive models that will be used in future years of the project. Access to eddy flux towers has been restored and work will continue as planned in year two.



The team at University of Kansas installs a weather station to model hydrologic and other impacts of Kernza on the landscape. Photo credit: Nate Brunsell

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

In summer and fall of 2020, the environmental quality team worked with the agronomy team to collect data on soil type, soil characteristics, and weather station availability at all sites that would host CAP field trials. The team planned a protocol and strategy for soil measurements and collected baseline soil samples in July 2021. In the fertility experiment, samples were taken at three depth increments (0-20 cm, 20-50 cm, and 50-90 cm) to help understand how the full depth profile is changing in terms of carbon accrual, fertility, and other soil health metrics. In the GEM experiment, soil samples were taken by block. Analysis is currently in progress.



The team at University of Wisconsin-Madison installed lysimeters in September 2021.

Education, Extension, & Policy

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

Team members

- Constance Carlson (co-lead) - Forever Green Initiative, University of Minnesota
- Erin Meier (co-lead) - Green Lands Blue Waters
- Dr. Aubrey Streit Krug (co-lead) - The Land Institute
- Dr. Cynthia Bartel - C. Bartel Inc.
- Dr. Michael Bell - University of Wisconsin, Madison
- Whitney Clark - Friends of the Mississippi River
- Dr. Steve Culman - The Ohio State University
- Megan Gladbach - The Land Institute
- Theresa Keaveny - Sustainable Farming Association of Minnesota
- Dr. Clair Keene - North Dakota State University
- Peter LaFontaine - Friends of the Mississippi River
- Jared Luhman - Sustainable Farming Association of Minnesota
- Dr. Diane Mayerfeld - University of Wisconsin, Madison
- Robin Moore - Land Stewardship Project
- Steve Morse - Minnesota Environmental Partnership
- Trevor Russell - Friends of the Mississippi River
- Hannah Stoll - University of Minnesota

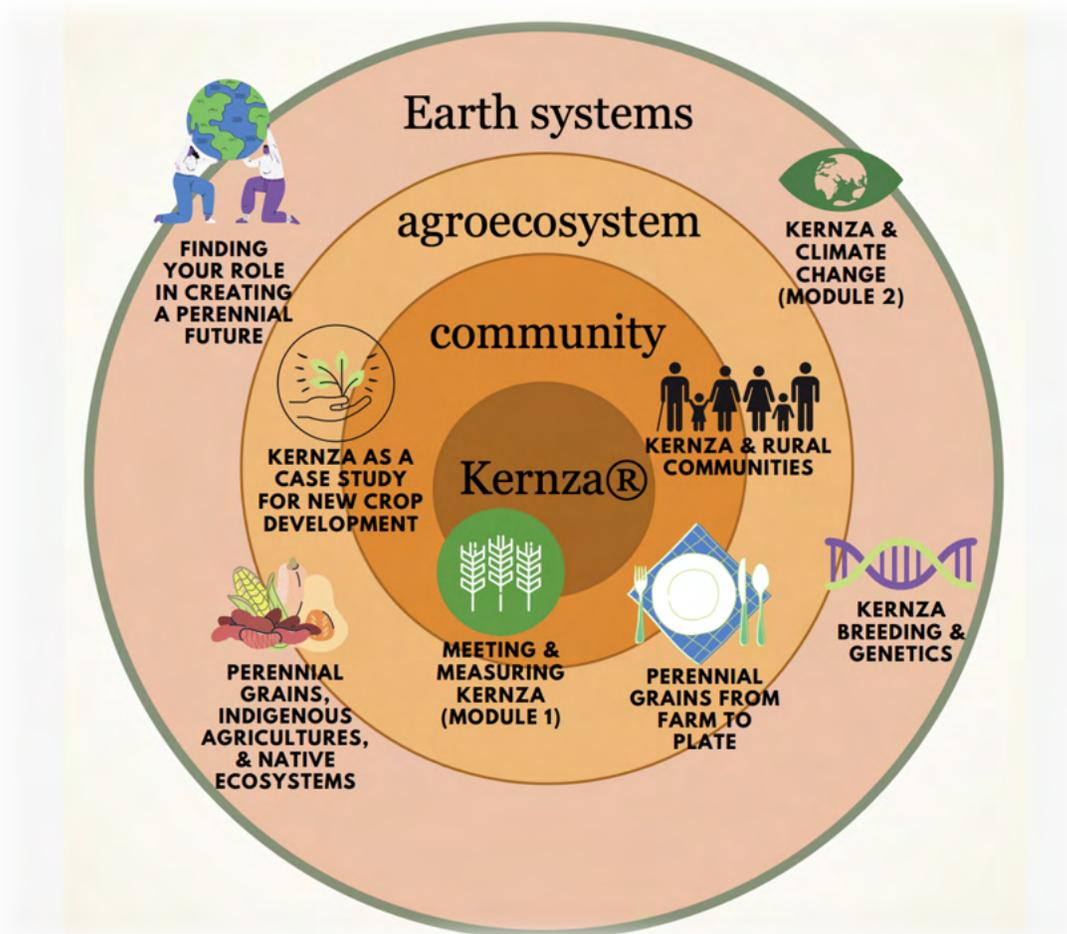


Field day at A-Frame Farm in July 2021. Photo credit: Karl Hakanson

Team objectives

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

The education team conducted and analyzed interviews and researched content and pedagogy to create the “Kernza in Context” educational framework. A draft design of the first module, “Meeting and Measuring Kernza,” was completed and provides an introduction to Kernza and perennial grains. The module was informed by interviews with 16 teachers, researchers, and past and current students. “Meeting and Measuring Kernza” is ready for beta testing, and the team has been growing connections and fielding inquiries from teachers and schools interested in beta testing.



A visual of the “Kernza in Context” educational framework

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

The extension team organized five KernzaCAP field days in summer 2021 in partnership with regional organizations, including the Perennial Promise Growers Co-op, the Sustainable Farming Association of Minnesota, Land Stewardship Project, Midwest Organic Sustainable Education Services (MOSES), Great River Greening and Clean River Partners. Events attracted over 400 attendees to learn about Kernza, including growers, researchers, Extension educators, policymakers, food and consumer goods industry representatives, processors, and consumers. The team attended many more Kernza field days not sponsored by KernzaCAP to disseminate information and learnings from this project. MOSES developed a series of videos from one of the field days, which can be found on the Forever Green Initiative's YouTube site. A series of planning meetings were held to chart out extension activity and identify extension educator participants for year two.



Kernza grower Stan Vander Kooi shares his experience growing Kernza on his farm in Buffalo, MN in July 2021. Photo credit: Connie Carlson

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

The field days in summer 2021 supported the development of a Grower-Researcher Network. Audiences for the field days included researchers, industry representatives, and growers. Several food companies and processors attended the field days, which resulted in new connections made between growers and markets. The extension team developed and deployed needs assessment surveys to help understand what growers and researchers need, including target audiences and the best ways to communicate with one another. An electronic co-learning platform was identified for development and will be built out next year to encourage communication between growers and researchers. A collaborative process is underway to update the Kernza Growers Guide.



Growers connect with a grain cleaner at a KernzaCAP field day.

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

The policy team designed and hosted a field day for policymakers in July 2021 with over 70 participants representing the Minnesota state legislature, state agencies, and nonprofits. The event, hosted on the University of Minnesota's St. Paul campus, featured a field tour and presentations on the economic and environmental context of perennial agriculture. Design is underway for a follow-up educational classroom session. The team also designed a regional briefing event that was held virtually in November 2021 with over 80 registrants. This two-hour event targeted Upper Midwest and national organizations and coalitions that engage in agricultural and environmental public policy on state and federal levels.

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

The policy team spent year one contacting NRCS staff and partners in Minnesota, North Dakota, and Wisconsin to explore program points of entry for Kernza, including updating technical notes and practice standards and collaborating to create interim practice language. Project contractor Dr. Cynthia Bartel identified documentation and research needs and engaged with the Kernza technical assistance team to act as a liaison and provide answers about Kernza production to NRCS staff.



Policy contractors Trevor Russell & Peter LaFontaine from Friends of the Mississippi River attended a KernzaCAP field day at A-Frame Farm

The policy team coordinated and wrote a response on behalf of KernzaCAP to the USDA request for comment on Tackling the Climate Crisis at Home and Abroad, emphasizing the promise of Kernza and perennial grains.



KernzaCAP PI Dr. Jake Jungers presents at the field day for policymakers in July on the University of Minnesota's St. Paul campus.

Supply Chains & Economics

Develop supply chains and economic drivers for Kernza.

Team members

- Colin Cureton (co-lead) - Forever Green Initiative, University of Minnesota
- Dr. Tessa Peters (co-lead) - The Land Institute
- Christopher Abbott - Perennial Pantry
- Christie Biddle - Patagonia Provisions
- Dr. Gwenael Engelskirchen - University of California, Davis
- Tannie Eshenaur - Minnesota Department of Health
- Dr. Gail Feenstra - University of California, Davis
- Dr. Nicholas Jordan - University of Minnesota
- Ben Penner - Penner Farms
- Tracy Singleton - Birchwood Cafe
- Chris Wiegert - Healthy Food Ingredients

Team objectives

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

The team solicited RFPs and executed contracts with two companies that will provide education and strategic planning for the development of a steward-owned organization to manage Kernza. This organization, tentatively called the Kernza Stewards Alliance, will help streamline communication along



Supply chains & economics team co-lead Tessa Peters presents at a field day at A-Frame Farm in July 2021. Photo credit: Karl Hakanson

the supply chain and make sure relevant players are involved in making decisions about how Kernza should be stewarded. Alternative Ownership Advisors provided two educational sessions in late 2021 that provided initial education on steward ownership. In 2022, Terra Soma will guide strategic planning, development of shared values, and creation of bylaws for this organization.

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

The work for this objective is scheduled for later years of the project and will be conducted under the umbrella of the Kernza Stewards Alliance.

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

The team continued management of the Kernza trademark (currently administered by The Land Institute) and vetted new growers. In year one, there were 134 new grower submissions. Regional value-based supply chains have advanced; over 25 products use Kernza, and Kernza is now sold in co-ops throughout Minnesota as well as select Whole Foods stores. In response to Kernza's growth, a new growers cooperative (Perennial Promise Growers Cooperative) was incorporated and the team supported enterprise development and business planning. The team also worked with the Farm Service Agency to get Intermediate Wheatgrass listed as a crop.

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

The team evaluated and researched various methods of business association incorporation including cooperatives, LLCs, and steward ownership, and selected steward ownership as the model to pursue. The objective team met quarterly to develop buy-in around common values. Dialogue started with internal and external stakeholders on ecosystem service valuation models, which will continue into later years of the project.



Christopher Abbott of Perennial Pantry delivered Kernza to the co-op in St. Peter, MN in September 2021. Photo credit: Ben Penner



The Birchwood Cafe in Minneapolis, MN served Kernza karamelita bars at their Juneteenth event.

Integration

Activate transformational change through intentional integration.

Team members

- Dr. Jacob Jungers (co-lead) - University of Minnesota
- Aaron Reser (co-lead) - Green Lands Blue Waters
- Dr. Tessa Peters (co-lead) - The Land Institute
- Tara Ritter (co-lead) - University of Minnesota
- Dr. Aubrey Streit Krug (co-lead) - The Land Institute
- Members of the coordinating team make up the full 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 team developed communications infrastructure, including an internal collaborator website and a public-facing website, internal and external newsletters, and a structure for reporting activities and outcomes. The data management subgroup created a data sharing and co-authorship policy (Appendix B) to track manuscripts and data across the project. Throughout year one, the project management team met weekly, the Coordinating Team met bi-weekly, the Advisory Committee had their first meeting in July 2021, and over 60 collaborators came together in October 2021 for the first annual all-hands meeting (Appendix C). These tools and meetings were the foundation for communication and integration across KernzaCAP collaborators and the broader Kernza network.

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

Kernza leadership is developing through the Kernza Stewards Alliance, farmer leadership such as the Perennial Promise Growers Co-op, and other collaborative leadership entities being launched by close partners, including the Forever Green Partnership, The Land Institute's New Roots International Initiative, and other collaborative groups. The KernzaCAP team is in good communication with all of these entities and will continue to explore what needs exist for shared leadership for Kernza broadly, including potentially launching a Kernza Consortium, as the grant proceeds.

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

The team created reporting infrastructure to capture learnings from each objective team that will inform a model for future perennial crops. An evaluation team from the University of Wisconsin Madison is working closely with the integration team to design evaluative tools, including a Social

Race & equity subgroup:

When funding for KernzaCAP was announced, several collaborators formed a race and equity subgroup to better incorporate justice, equity, diversity and inclusion into the project. 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 subgroup identified four ways, based on activities that are already embedded within the project, to pursue this work.

- Empower individual learning and development amongst KernzaCAP project collaborators
- Build mutually beneficial, long-term relationships beyond the current white-dominant networks
- Leverage project resources, processes and decisions we have at hand
- Reflect and report openly on our process and results

In year one, the subgroup worked to embed a race and equity lens into our evaluation tools, including the project's shared values and principles. The October 2021 all-hands meeting (Appendix C) featured a race and equity breakout session with five concurrent discussion sessions. The subgroup began compiling a hiring toolkit and forming a young professionals cohort, with the goal to attract, support, and help build careers of a more diverse group working on Kernza. This work will continue in year two and throughout the grant.

Conclusion

The KernzaCAP team reached all year one project goals and is entering year two on track. The Covid-19 pandemic limited the ability to travel and required meeting virtually instead of in-person in many cases, but it was a highly productive year of relationship development, launching research, and building a foundation for the remaining years of the project.

We spent less than what was budgeted for year one; travel budgets were largely unused and some experiments were delayed due to lack of access to necessary sites and tools. We have reviewed year one budgets with all teams and created a plan to spend the funds in year two and beyond to complete work as planned.

The integrative focus of this project is key to developing and launching a new crop. While progress can be made in isolated teams, coordination across disciplines is necessary for the greatest impact. KernzaCAP collaborators learned how to coordinate field trials closely across sites (matching layouts, inputs, field preparation, timing, etc.), plan for management of experiments over time, collaborate with growers and businesses to approach market planning, and understand the priorities unique to early Kernza adopters. This type of integrative communication and planning is what makes this project unique and what will help us create a model for future perennial cropping systems.



KernzaCAP collaborators Aaron Reser, Dr. Jake Jungers, Dr. Jessica Gutknecht, and Dr. James Anderson.
Photo Credit: Jessica Gutknecht

Products

Peer-reviewed publications

Pinto, P., De Haan, L., & Picasso, V. (2021). Post-harvest management practices impact on light penetration and Kernza intermediate wheatgrass yield components. *Agronomy*, 11(3), 442.

DOI:10.3390/agronomy11030442

Duchene, O., Dumont, B., Cattani, D., Fagnant, L., Schlautman, B., DeHaan, L.R., Barriball, S., Jungers, J., Picasso, V., David, C., Celette, F. (2021). Process-based analysis of *Thinopyrum intermedium* phenological development highlights the importance of dual induction for reproductive growth and agronomic performance. *Agricultural & Forest Meteorology*, 301-302(108341). DOI:10.1016/j.agrformet.2021.108341

Olugbenle, O., Pinto, P., and Picasso, V. (2021). Optimal planting date of Kernza intermediate wheatgrass intercropped with red clover. *Agronomy*, 11(11), 2227. <https://doi.org/10.3390/agronomy11112227>

Dai, Y., Bharathi, R., Jungers, J., Annor, G. A., & Tyl, C. (2021). Effect of bran pre-treatment with endoxylanase on the characteristics of intermediate wheatgrass (*Thinopyrum intermedium*) bread. *Foods*, 10(7), 1464.

Bharathi, R., Muljadi, T., Tyl, C., & Annor, G. A. (2021). Progress on breeding and food processing efforts to improve chemical composition and functionality of intermediate wheatgrass (*Thinopyrum intermedium*) for the food industry. *Cereal Chemistry*. <https://doi.org/10.1002/cche.10482>

Bharathi, R., Dai, Y., Tyl, C., Schoenfuss, T., & Annor, G. A. The effect of tempering on protein properties and arabinoxylan contents of intermediate wheatgrass (*Thinopyrum intermedium*) flour. *Cereal Chemistry*. <https://doi.org/10.1002/cche.10505>

Franco, J.G., Berti, M.T., Grabber, J.H., Hendrickson, J.R., Nieman, C.C., Pinto, P., Van Tassel, D., & Picasso, V. (2021). Ecological intensification of food production by integrating forages. *Agronomy* 2021, 11(12), 2580. <https://doi.org/10.3390/agronomy11122580>

Selected media and podcasts

KernzaCAP press release. Improving the environment, igniting rural prosperity. September 2020.

<https://kernza.org/improving-the-environment-igniting-rural-prosperity/>

The Cutting Edge: A Podcast in Search of New Crops for Wisconsin. Episode #4 - Kernza. University of Wisconsin, Madison. August 2020. <https://dodge.extension.wisc.edu/2020/08/the-cutting-edge-podcast-episode-4-kernza/>

Dirt Rich Podcast. The Potential of Perennial Crops and Kernza. Sustainable Farming Association of Minnesota. July 2021. <https://dirtrichmn.podbean.com/e/34-the-potential-of-perennial-crops-kernza/>

Ear to the Ground Podcast. Episode 259 - Kernza's Stress Test. Land Stewardship Project. September 2021. <https://landstewardshipproject.org/podcast/ear-to-the-ground-no-259-kernzas-stress-test>

Field Work Podcast. The Promise of Perennials. American Public Media. June 2021. <https://www.fieldworktalk.org/episode/2021/06/02/the-promise-of-perennials>

Appendix A: Collaborator list & advisory committee

Collaborator list

- Christopher Abbott, Co-Founder, Perennial Pantry
- Jim Anderson, Professor, University of Minnesota
- George Annor, Assistant Professor, University of Minnesota
- Prabin Bajgain, Research Assistant Professor, University of Minnesota
- Cynthia Bartel, Principal, C. Bartel Inc.
- Andrea Basche, Assistant 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
- Constance Carlson, Market Development, University of Minnesota Regional Sustainable Development Partnerships and 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, Associate Professor, The Ohio State University
- Colin Cureton, Director of Adoption and Scaling, University of Minnesota Forever Green Initiative
- Julie Dawson, Associate Professor, University of Wisconsin-Madison
- Lee DeHaan, Lead Scientist, The Land Institute
- Emily Elder, Masters Student, University of Kansas
- Gwenael Engelskirchen, Sustainable Supply Chain Analyst, University of California-Davis
- Tannie Eshenaur, Planning Director, Minnesota Department of Health
- Gail Feenstra, Deputy Director, University of California Agriculture and Natural Resources
- Carmen Fernholz, Farmer, A-Frame Farms
- Jessica Gutknecht, Associate Professor, University of Minnesota
- Alyssa Hartman, Executive Director, Artisan Grain Collaborative
- Alex Heilman, Marketing Contractor, Perennial Promise Growers Cooperative
- Whilden Hughes, Farmer, W. Hughes Farms
- Pam (Baraem) Ismail, Professor, University of Minnesota
- Dustin Johnsrud, Farmer, Johnsrud Farms
- Nicholas Jordan, Professor, University of Minnesota, Forever Green Initiative
- Jacob Jungers, Assistant Professor, University of Minnesota
- Clair Keene, Extension Specialist, Cropping Systems, North Dakota State University
- Kurt Kimber, Farmer, Kimber Farms
- Carrie Laboski, Professor, University of Wisconsin-Madison
- Peter LaFontaine, Agricultural Policy Manager, Friends of the Mississippi River
- Greta Landis, Evaluation Specialist, University of Wisconsin-Madison
- Jared Luhman, Soil Health Lead, Sustainable Farming Association of Minnesota
- Diane Mayerfeld, Sustainable Agriculture Coordinator, Extension, University of Wisconsin-Madison
- Erin Meier, Director, Green Lands Blue Waters
- Peter Miller, Chief Operating Officer, Sustain-a-Grain

- Robin Moore, Managing for Stewardship Organizer, Land Stewardship Project
- Steve Morse, Executive Director, Minnesota Environmental Partnership
- Lydia Nicholson, Post-Baccalaureate Researcher, The Land Institute
- Ben Penner, Farmer, Penner Farms
- Tessa Peters, Commercialization Manager, The Land Institute
- Luke Peterson, Farmer, Peterson Farms
- Valentin Picasso, Assistant Professor, University of Wisconsin-Madison
- Priscila Pinto, Postdoctoral Researcher, University of Wisconsin-Madison
- Samuel Pratsch, Evaluation Specialist and Unit Coordinator, University of Wisconsin-Madison
- Dorothy and John Priske, Farmers, Fountain Prairie Farm
- Aaron Reser, Associate Director, Green Lands Blue Waters
- Tara Ritter, KernzaCAP Project Manager, University of Minnesota
- Trevor Russell, Water Program Director, Friends of the Mississippi River
- Amber Saylor Mase, Evaluation Specialist, University of Wisconsin-Madison
- Gurpartee Singh, PhD Student, University of Minnesota
- Tracy Singleton, Owner, Birchwood Café
- Sophia Skelly, Research Technician, The Land Institute
- Hannah Stoll, Graduate Research Assistant, University of Minnesota
- Dave Stoltenberg, Professor, University of Wisconsin-Madison
- Aubrey Streit Krug, Director of Ecosystem Studies, The Land Institute
- Nicole Tautges, Agroecologist, Michael Fields Agricultural Institute
- Jared Trost, Hydrologist, United States Geological Survey, Upper Midwest Water Science Center
- Chris Wiegert, Chief Soil Health and Sustainability Officer, Healthy Food Ingredients
- Claire Wineman, Post-Baccalaureate Researcher, The Land Institute

Advisory committee

- Liz Carlisle, Assistant Professor, University of California-Santa Barbara
- 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
- Bonnie Keeler, Assistant Professor, University of Minnesota
- Emily Luscombe, Natural Resources Director, Intertribal Agriculture Council
- Virginia Nazarea, Professor Emerita, University of Georgia
- 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
- Don Wyse, Professor, University of Minnesota, Forever Green Initiative

A slideshow with more information on year one collaborators is available at:

<https://bit.ly/3sqfr7T>

Appendix B: Data sharing & authorship policy

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Data Sharing and Authorship Policy

The sharing and dissemination of data is essential to conduct, verify and replicate science. It is also necessary to acknowledge the time and effort that is required by individuals to collect, process, quality control and prepare high quality data for dissemination. We will attempt to balance the desire to fully share and disseminate the data collected during this project with the need to give proper attribution and credit to individuals involved in data collection, management, and analysis. The typical reward structure of academic and research positions is based on conference presentations, peer reviewed publications, and grant proposals. These efforts take considerable time, particularly for less experienced team members such as students, post-doctoral researchers, and junior professors, as well as for professional non-academic staff. It is essential that these individuals be provided every reasonable opportunity to complete and disseminate their research as their career aspirations may be significantly impacted by the ability to publish their contributions to this research project. To that end, we suggest the following practices as part of this research endeavor: 1) the identification and acknowledgement of data authors, 2) a manuscript proposal system for data sharing, 3) best practices for identifying co-authors, 4) best practices for data sharing.

These are living documents and subject to change if problems arise. The KernzaCAP management team will address conflicts and revise these documents as necessary.

1. Data Authors

In order to acknowledge the significant efforts made by the individuals generating data during the course of the project, we have adopted a Data Author model in which the individuals who generated the data are acknowledged in manuscripts that use their data. To be acknowledged in a manuscript as a data author, an individual must have made substantial contributions to the original acquisition, quality control, and curation of the data and be accountable for all aspects of the accuracy and integrity of the data provided. Being acknowledged as a data author does not limit the individual from being invited into manuscript authorship. The data author for any individual data stream will be named in the metadata for that data. It is our hope that by acknowledging individuals for their contributions to the data that this will encourage the involvement of data authors in manuscripts. Manuscript authors are encouraged to offer data authors the opportunity to review the analyses, providing at least 1 week for review. Manuscript authors must be transparent about the authorship role that the data authors will play, and data authors can accept or decline any authorship offers.

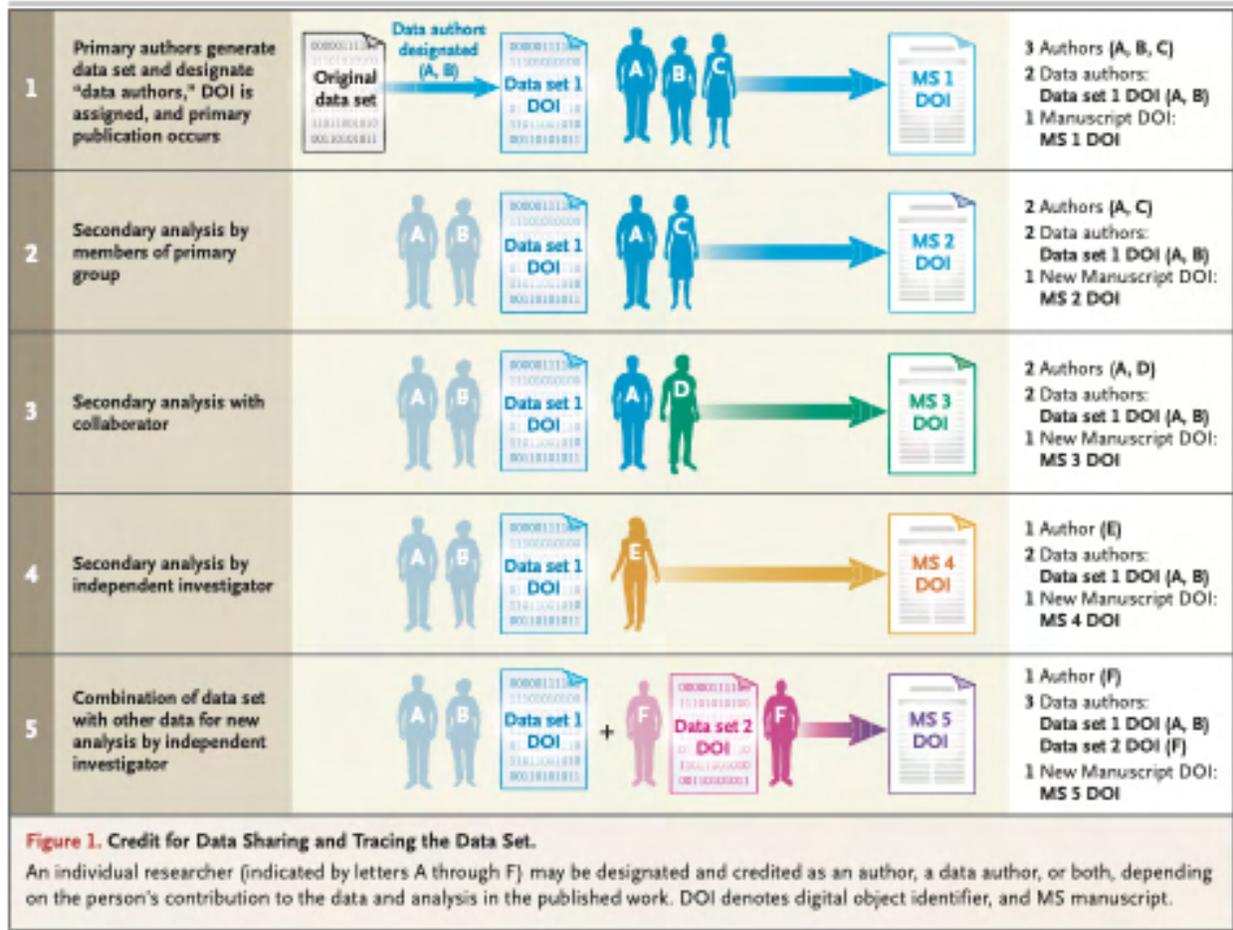


Figure 1 from Bierer et al. 2017, visualizing a data authorship model

2. Manuscript Proposals

It is important that we provide individuals with adequate time for data analysis and dissemination in the form of conference proceedings and peer reviewed literature. Therefore, KernzaCAP collaborators must fill out a manuscript proposal form ([link here](#)) when using project data during the course of the project. The goal of the manuscript proposal form is to identify possible areas of overlap between projects/manuscripts and previously approved manuscript proposals. The manuscript proposal form asks for a proposed manuscript title, scientific objectives/hypotheses, timeline for manuscript submission, journal where the manuscript will be submitted, identification of data necessary from the team, identification of proposal members, and how co-authorship will be addressed.

The [manuscript proposal form](#) will be reviewed by the KernzaCAP data management subgroup, who will assess the proposed research for overlap, duplication, and/or potential conflicts with previously submitted proposals. If an issue arises, the data management subgroup will work to find a solution with the individual who submitted the manuscript proposal form. Authors should inform the data management subgroup of progress on an annual basis. If the proposed manuscript will not be completed, the data management subgroup should be notified as soon as reasonably possible so that future proposals are not impacted.

3. Practices for Defining Co-authorship

Co-authorship should be based on the individual making a significant contribution to the manuscript. This can include being a data author, particularly in cases where that data has not been previously published, the manuscript would not have been possible without the inclusion of that data, or the manuscript would have significantly different results if that particular data were not included. Other significant contributions include (but are not limited to): project conception/design, manuscript conception/design, analysis and interpretation of results, and drafting or revising the manuscript. All authors should approve the final manuscript prior to submission and should agree with all aspects of the work.

If there are questions regarding whether an individual should be offered co-authorship, we suggest that the team err on the side of inclusion and offer the individual a co-author role. That individual should then evaluate their contributions in light of the above and either accept or decline the invitation to be co-author. In cases where the individual declines co-authorship, their contributions should be noted in the acknowledgements of the manuscript. Where authors request special handling or modification of data from data authors, the data authors also should be considered for manuscript authorship.

4. Data Sharing

In order to encourage data flow, successful collaboration, and to respect the turnaround time required to complete the publication process, project team members are expected to deposit data within a reasonable timeframe after collection to the project's data catalog and to the KernzaCAP Google Drive when applicable. Data authors are expected to ensure that their data are of high quality, with no further changes expected to occur (understanding that analysis often brings errors to light that must be corrected), and that relevant metadata is included with their uploaded datasets. The KernzaCAP project manager will act as data curator and will oversee this process and have high level oversight of data quality and organization, but data authors are ultimately responsible for ensuring data quality and reporting of metadata.

Appendix C: All-hands meeting agenda

All-Hands Meeting

October 29th, 2021 / 10:00am - 3:00pm central

10:00-10:15: Welcome

10:15-10:30: Introductory activity

- Small group introductions and Kernza timeline activity.

10:30-11:15: “Slide and a Story”

- Objective team updates to share year 1 accomplishments and a story from the past year.

11:15-11:45: “Rules and Tools”

- Overview of KernzaCAP tools and policies for data management, reporting, and funding.

11:45-12:30: Break

12:30-1:15: Keynote presentations

- Peggy Wagoner, KernzaCAP advisory committee member and former project leader at the Rodale Institute - *Research history of Intermediate Wheatgrass*
- Omar Tesdell, KernzaCAP advisory committee member and Associate Professor at Birzeit University in Palestine - *Cultural history of Intermediate Wheatgrass*

1:15-2:00: Race and equity focused interactive breakout sessions

- Further detail on the breakout sessions on page 2 of this agenda

2:00-2:45: Topic-specific working sessions

- Further detail on the breakout sessions on page 2 of this agenda

2:45-3:00: Closing

Breakout session detail

Race and equity focused interactive breakout sessions

Session A: Research Focus

- Discuss opportunities to address race and equity within large grants and institutions, including recruiting personnel, building antiracist labs, & sharing what other projects/institutions are doing.

Session B: Supply Chain Focus

- Discuss building better partnerships and increasing access to participate in Kernza work. This includes trademark management, auditing and accepting new applicants, and informing the development of the Kernza Stewards Alliance.

Session C: Community Partners Focus

- Discuss where you and your organization are in your race and equity work and share good starting points for entering into race and equity work as a nonprofit or community organization.

Session D: Kernza in Cultural Context

- Discuss how the "Kernza in Context" educational modules can include and engage cultural dimensions of agriculture.

Session E: Grant Development with the Intertribal Agriculture Council

- IAC staff will join to discuss barriers and opportunities to Indian producers beginning to grow Kernza, strategize about ways to co-develop funding proposals to reach these producers, and start to identify open RFPs and receptive funders.

Topic-specific working sessions

Communications and messaging

- Co-develop shared talking points on the environmental and social benefits of Kernza. This messaging may be used for signs, websites, menus, and other products that need accurate and concise messaging to communicate the benefits of Kernza to the consumer.

Policy needs

- Discuss how to get policymakers what they need to support farmers and researchers. Connect and learn across policy platforms, including NRCS standards, state-level initiatives, and federal approaches.

Translating research into technical assistance

- Translate research outcomes and on-farm research into TA documents and support.

Commercialization

- Kernza licensees are developing the Kernza Stewards Alliance to be the voice of the Kernza industry to society. How do researchers, NGOs, and community partners envision collaborating with the KSA, and how can the KSA contribute to cross-sector Kernza efforts?

Synthesis across research disciplines and objective teams

- Plan ahead for future synthesis papers and discuss how we can encourage integration across objective teams.

Developing a young professionals cohort

- How can we use KernzaCAP to help support students and early career professionals?

Participatory breeding work

- Connect bakers to variety selection by developing a process for testing which Kernza varieties (as they become available) function well in bread making, quick breads, and pastries.

Race and equity continued

- Open session to continue the earlier race and equity discussions.

Appendix D: Shared values & principles

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Shared Values and Principles

These five core principles and descriptive operating principles summarize attributes that the Kernza CAP team specifically wants to bring to the broader Kernza network. The network already strives to be systems- and farmer-focused, focused on long-term sustainability and prosperity across regions, with a culture of co-creation, curiosity, care, and humility. The coordinating team, collaborators, and advisory committee all had input on these principles.

1. **Support a long-term, transformative vision of agriculture** that is shared and just.
 - a. Foster inspiration, hope, and creativity in conversations about future agroecological systems in a changing climate.
 - b. Document and model creative strategies for other transdisciplinary research, extension, and education initiatives.
 - c. Facilitate coordination and build capacity across agricultural sectors to support ongoing efforts beyond the project timeline.
2. **Scale Kernza research and activities responsibly** to fit a wide range of contexts and needs.
 - a. Increase dialogue about access to land, capital, opportunities, and education for Kernza.
 - b. Consider implementation across systems big and small, urban and rural, and a range of farm and business models. Collaborate with farmers to understand how Kernza can be implemented sustainably and profitably across contexts.
 - c. Incorporate diverse management practices and financial valuation strategies in research, drawing from local and global efforts.
3. **Promote an open team culture** that is supportive, creative, and learning-focused.
 - a. Encourage innovative ideas and scientific rigor, while naming and addressing mistakes, tensions, and difficult choices as they arise.
 - b. Acknowledge and celebrate accomplishments.
 - c. Support rest, focus, and care.
4. **Prioritize racial and gender equity** throughout project research, activities, and processes.
 - a. Empower learning and development amongst Kernza CAP project collaborators.
 - b. Build mutually beneficial, long-term relationships beyond the current white-dominant networks.
 - c. Leverage project resources, processes and decisions we have at hand to promote racial and gender equity.
 - d. Reflect and report openly on our process and results.
5. **Build shared leadership and agency into collaborations** that are mutually beneficial.
 - a. Seek out and value nonacademic knowledge, perspectives, and cultural expertise.
 - b. Engage in deep listening with partners and hold one another accountable in allyship.
 - c. Cultivate transparency, honesty, and accessibility in communication.