



Kernza® Collaborators

In 2009, Kernza® domestication was the part-time project of one scientist at The Land Institute (TLI). It was, however, a surprisingly successful project given the limited resources invested to that point. Therefore, in 2010, Lee DeHaan, PhD, was assigned to the project full-time to accelerate the domestication work and expand it through collaborations with other institutions. Results at this point were showing great potential to increase the yield through plant breeding and to develop products with great flavor and nutritional properties. Furthermore, the potential of perennial crops to dramatically improve soil health and sustainability was becoming widely recognized. Therefore, many collaborators soon joined in the research effort. Expansion of the research was expedited by increasing investment in this area by private philanthropists, federal grant programs, and state/provincial funding.

Yield of Kernza is strictly limited by the genetic potential of the seed currently available. Breeding programs for diverse regions are therefore a top priority. Currently, four breeding programs are underway in Utah, Minnesota, and Manitoba, and Kansas. These programs collaborate, but they are developing plant types uniquely adapted to each of the different regions.

Techniques for growing Kernza that maximize both yield and sustainability are needed as farmers begin to plant expanded fields. Intercropping, grazing, burning, and thinning are being tested experimentally to determine their impacts on crop yield, profitability, and important sustainability metrics such as carbon sequestration in soils. Since management techniques have different impacts depending on soil and climate, these trials must be conducted across the full geographic range where Kernza will be grown.

Below, we have arranged the projects by topic area within each collaborating institution. The primary investigators leading the various project are listed.

The Land Institute (Salina, Kansas)

- **Plant Breeding and Genetics — Lee DeHaan, PhD**
Guided by [Lee DeHaan](#), multiple rounds of selecting and inter-mating the best Kernza plants based on their yield, seed size, disease resistance, and other traits have been performed, resulting in improved populations of intermediate wheatgrass that are currently being evaluated and further selected at The Land Institute and by collaborators in diverse environments.
<https://landinstitute.org/our-work/perennial-crops/kernza/>
- **Ecological Intensification — Tim Crews, PhD**
Kernza research at The Land Institute has focused for several years on nitrogen fertility in Kernza-alfalfa intercrop systems. Ecologist [Tim Crews](#) has led efforts to quantify nitrogen (N) fixation and transfer in the Kernza-alfalfa systems and longer-term changes in soil organic N reserves. Land Institute researchers are also looking at nitrous oxide trace gas fluxes in Kernza cropping arrangements as well as carbon sequestration following cessation of annual tillage.



Finally, the group is using isotopes to determine the depth at which nitrogen is taken up by deep-rooted Kernza in different seasons.

<https://landinstitute.org/our-work/ecological-intensification/>

Cornell University (Ithaca, New York)

- **Agroecology — Matthew Ryan, PhD**

[Matt Ryan](#), an agroecologist in Cornell's Soil and Crop Sciences Section, oversees multiple Kernza experiments in the [Sustainable Cropping Systems Lab](#). His projects include:

1. Effects of forage harvesting on intermediate wheatgrass
2. How harvesting for forage influences perennial grains
3. Perennial grain and legume polycultures
4. Survey: are farmers interested in perennial grains?

Ryan also facilitates four on-farm organic Kernza trials in Upstate New York.

<https://blogs.cornell.edu/scslab/perennial-grains/>

HudsonAlpha Institute for Biotechnology (Huntsville, Alabama)

- **Genome Sequencing — Jeremy Schmutz and Jane Grimwood, PhD**

HudsonAlpha researchers [Jeremy Schmutz](#) and [Jane Grimwood](#), along with support from the Department of Energy's Joint Genome Institute, have played a central role in obtaining and refining the intermediate wheatgrass genomic sequence. A good draft sequence is now available and being used by geneticists, but genetic resources are continually in need of development and improvement.

ISARA-Lyon (Lyon, France)

- **Agroecology — Christophe David, PhD**

A project has been initiated in France under [Christophe David](#) that will test the performance of Kernza in a wide array of different environmental settings. The intent is to understand potential range of adaptation and to begin developing management approaches and markets for the crop in France. Farmer and processor interviews have been conducted to understand constraints and opportunities for deploying new perennial grain crops in France. Collaborative plantings in Belgium have also begun.

Kansas State University (Manhattan, Kansas)

- **Plant Genetics — Jesse Poland, PhD**

[Jesse Poland's](#) group has been helping to coordinate the multi-institution project to sequence the genome of intermediate wheatgrass. Some of the critical steps in the genome assembly have been performed in his lab, and they are working to use the resulting data to improve our



understanding of the species and its relation to other similar grasses, such as wheat.

- **High-Throughput Accelerated Plant Breeding — Jesse Poland, PhD**

In the domestication of Kernza, time is our greatest enemy. Years of work are required to evaluate plants in the field and intermate the selected plants. Dr. Poland is helping to accelerate the process by developing techniques and instruments that will allow for rapid data collection on large numbers of plants. His group has also helped us to get started using the new technique known as genomic selection. With this method we grow seedlings in the greenhouse, collect their DNA, and use these samples to predict which plants would be the best when grown in the field. Then we can intermate the best plants without ever having to grow the plants in the field. We expect that this approach will dramatically accelerate our progress by reducing the time required for a breeding cycle in half and allowing us to select outstanding plants more accurately.

Lund University (Lund, Sweden)

- **Agroecology — Lennart Olsson, PhD**

[Lennart Olsson](#), Professor of Geography at Lund University and the founder of Lund University Centre for Sustainability Studies (LUCSUS), is helping to organize on-farm plantings of Kernza in Sweden for both commercial and research purposes. He is also convening groups of social scientists to explore the socio-economic implications of farmers shifting to Kernza production as well as other perennial grains.

Massachusetts Institute of Technology (Cambridge, Massachusetts)

- **Ecophysiology — David Des Marais, PhD**

[David Des Marais](#) and the [Des Marais Lab](#) seek to integrate plant ecology, evolution and physiology with genomics and agriculture. They are beginning to explore the impact of perenniality on plant responses to environmental stress. They will be making use of the intermediate wheatgrass genome and annual versus perennial model species to understand the physiological and genetic differences between perennial and annual life histories.

Perennial Agriculture Project (Lawrence, Kansas)

- The Perennial Agriculture Project (PAP) field station is host to several experiments involving Kernza by three University of Kansas post-docs. The 230-acre field station is owned and operated by the Malone Family Land Preservation Foundation as part of a joint project agreement with The Land Institute. In addition to hosting research plots, The Land Institute has established a 16-acre Kernza-alfalfa intercropped field at the PAP field station for commercial production. The field is also being used for a field-scale assessment of 1) net carbon balance of a Kernza-legume crop using an eddy co-variance tower and 2) seasonal livestock grazing management.



Swedish University of Agricultural Sciences (Alnarp, Sweden)

- **Agroecology — Erik Steen Jensen, PhD**

SITES (Swedish Infrastructure for Ecosystem Science) is a network of field stations supported by the Swedish Research Council for long-term studies of natural and managed ecosystems in Sweden. Lonnstorp is the SITES station dedicated to agroecology consisting of replicated blocks of conventional, organic, and innovative cropping systems (<http://www.fieldsites.se/en-GB/about-sites/field-research-stations/lonnstorp-32652365>). Kernza and Kernza-alfalfa bicultures are perennial grain treatments that have been included in the SITES Agroecology Field Experiment (SAFE). The project is overseen by Professor [Erik Steen Jensen](#) of the Swedish University of Agricultural Sciences.

<https://www.slu.se/en/departments/biosystems-technology/research-facilities/lonnstorp/safe-sites-agroecological-field-experiment/>

Tel Aviv University, (Tel Aviv, Israel)

- **Molecular Plant Ecology — Nir Sade, PhD**

[Nir Sade](#) has just accepted a position in Israel and is finishing a postdoctoral position at UC Davis. His research will focus on methods to improve agricultural sustainability under climate change scenarios. He has begun work with Kernza and other perennial grains, and, if funding allows, intends to continue to work with these new crops. He hopes to gain understanding about the differential response of annual and perennial plants to drought stress and hopes that perennial grains might be useful as dual-purpose crops in his country.

https://www.researchgate.net/scientific-contributions/15119630_Nir_Sade

The Ohio State University (Wooster, Ohio Extension)

- **Plant Breeding — Steve Culman, PhD**

The [Soil Fertility Lab](#), led by [Steve Culman](#), an Assistant Professor and State Specialist in Soil Fertility in the School of Environment and Natural Resources, plays a lead role in organizing multi-institutional experiments to examine the potential for Kernza to be used for grain production as well as a forage crop. Project objectives include:

1. Determine the effects of defoliation on Kernza grain yields and forage quality
2. Determine variation of Kernza grain yields and defoliation response over multiple environments
3. Evaluate potential for adding economic value to a perennial grain system through additional forage harvest

Researchers at the following institutions have participated in Culman's multi-use investigations: Colorado State University, The Land Institute, USDA Beltsville, University of Minnesota, Cornell University, Ohio State University, Iowa State University, University of Wisconsin, South Dakota State University, and Ag-Canada, Lethbridge.



<https://soilfertility.osu.edu/our-research/perennial-grains>

University of California, Davis (Davis, California)

- **Soil Microbial Ecology — Kate Scow**

Dr. Scow is currently advising a graduate student, [Kalyn Diederich](#), who is studying the potential adaptability of Kernza to a Mediterranean environment. They will be looking at the potential for Kernza to sequester carbon, and the impact of a perennial versus annual grain soil microbial community composition and biomass.

<http://scowlab.lawr.ucdavis.edu/>

University of Copenhagen and Aarhus University (Copenhagen, Denmark)

- **Agroecology — Kristian Thorup-Kristensen, PhD**

In 2015, [The Deep Frontier Project](#) was launched by [Kristian Thorup-Kristensen](#), professor of Crop Sciences at the University of Copenhagen, in partnership with Aarhus University and the International Center of Research in Organic Food Systems (ICROFS). The five-year project is designed to enhance our understanding of deep-rooted crop species. Kernza is one of the six primary crops chosen for extensive evaluation by the project. Using mini-rhizotrons (below ground clear tubes for imaging root activities) and four-meter tall above ground towers, researchers hope to answer questions such as:

1. At what soil depth does Kernza obtain specific nutrients and water?
2. How does the microbial community composition and function change with soil depth?
3. How much do Kernza roots die and re-grow in a year?

The Deep Frontier project involves a wide range of faculty specializing in soil microbiology, biogeochemistry and cropping systems.

<http://projects.au.dk/deepfrontier/research-deep-roots-and-crops/>

University of Kansas (Lawrence, KS)

- **Agroecology — Jim Bever, PhD; Ben Sikes, PhD; and Nathaniel Brunsell, PhD**

Three professors at the University of Kansas are collaborating with Land Institute researchers on Kernza-related research projects. [Jim Bever](#), distinguished professor in the Department of Ecology and Evolutionary Biology and world renown expert on mycorrhizal fungi, is advising a post doc working on mycorrhizal associations with Kernza grown in single and mixed species stands. [Ben Sikes](#), also a professor in Ecology and Evolutionary Biology, is broadly interested in soil fungal communities. Ben advises a post doc in the [Sikes Microbial Lab](#) who is investigating how the fungal community changes when soils that had been planted with annual grains are converted to single species stands of Kernza or high diversity cropping arrangements. The research will determine whether changes in the soil fungal community benefit or reduce Kernza productivity over time. [Nate Brunsell](#), professor of Geography and Atmospheric Sciences is interested in the water and carbon balances of perennial grain crops. He is advisor to a post doc



who analyzes data from the eddy co-variance towers at the PAP Field Station and The Land Institute.

<https://bensikes.wixsite.com/sikesmicrolab/research>

University of Manitoba (Winnipeg, Canada)

- **Plant Breeding — Doug Cattani, PhD**
Northern locations, such as Manitoba, will require unique varieties to cope with extreme environment. Therefore, [Doug Cattani](#) is working to develop varieties that will be productive and have the strength to avoid winterkill. He is particularly interested in the potential to breed for success as an intercrop grown with other species.
- **Agroecology — Martin Entz, PhD**
[Martin Entz](#) specializes in the study of organic cropping systems, particularly over the long-term. He is considering how Kernza could best fit into cropping systems using management tools available in organic production systems, such as grazing.
<http://www.umanitoba.ca/outreach/naturalagriculture/perennialgrain.html>

University of Minnesota (St. Paul, Minnesota)

- **Plant Breeding and Genetics — Jim Anderson, PhD**
Researchers are working to develop new varieties adapted to the Upper Midwest that have larger yields, larger seed size, and reduced shattering and lodging. [Jim Anderson](#) and his team are using advanced techniques to accelerate progress, such as genomic selection. They are also looking to identify genes that might help in the development of hard seed, which would improve bread making characteristics of the grain. A collaborative experiment in the field at The Land Institute and in Minnesota is searching to discover the locations of genes that influence important traits when grown in Kansas versus Minnesota.
- **Agronomy and Ecosystem Services — Jake Jungers, PhD; Craig Sheaffer, PhD; Don Wyse, PhD**
Led by [Craig Sheaffer](#) and [Jake Jungers](#), professors in the Department of Agronomy and Plant Genetics, this team is working to find techniques for growing Kernza that will boost and maintain yields while also maximizing ecosystem services from the crop. They are trying techniques such as legume intercropping, grazing, forage harvesting, and nutrient management, and stand renovation. They are measuring impacts of these management strategies on ecosystem services such as clean water, soil health, soil carbon sequestration, and climate change mitigation.
<https://agronomy.cfans.umn.edu/department-directory/donald-l-wyse>
<http://forevergreen-umn.info/17FG-IWg.pdf>
<https://perennialecology.com/research/perennial-grains/>



- **Food Science and Nutrition — Baraem Ismail, PhD; Tonya Schoenfuss, PhD; George Annor, PhD**
[Baraem Ismail](#), [Tonya Schoenfuss](#), and [George Annor](#) have been exploring a wide array of issues relating to end-use of Kernza grain in products. They have developed a nutritional profile and looked at detailed aspects of the grain chemistry, such as fiber and protein profiles. They have tried various proportions of Kernza flour in a range of products, explored the potential benefits from varying the bran portion, and observed differences between seed lots grown in different fields. They are continuing to look at different processing methods to enhance functionality and are considering the impacts that genetic changes in the crop in traits like seed size will have on end use.

University of Wisconsin (Madison, Wisconsin)

- **Agroecology — Valentin Picasso, PhD**
[Valentin Picasso](#) is an agroecologist in the Agronomy Department of the University of Wisconsin. Kernza research is central to his work in sustainable agriculture and grazing systems in the Midwest United States. Valentin oversees legume-Kernza intercrop plots both at U. Wisconsin experiment stations and on several farms. He is involved in Kernza grazing tolerance research, and he is also supervising graduate work evaluating weed establishment and competition in Kernza fields.
<https://cals.wisc.edu/>

USDA/Utah State University (Logan, Utah)

- **Genetics and Plant Breeding — Steve Larson, PhD**
As a forage, intermediate wheatgrass is well-adapted to regions such as Utah. [Steve Larson](#) has a USDA appointment to study perennial grasses adapted to the western USA, and intermediate wheatgrass is one of the species he is studying in detail. He has been collaborating with TLI to understand the genetic control of important traits, assist in the genome sequencing project, and is now beginning a breeding program to develop varieties that will be adapted to Utah and neighboring states.