Perennial Impact 2024

For nearly 50 years, The Land Institute has pursued a bold vision: reconciling the human economy with Nature's economy, starting with food. What was once a radical idea—developing deep-rooted, perennial grain crops—is becoming a reality, thanks to decades of research in genetics, ecology, and agronomy. Our work is proving that high-yielding, resilient perennial grains can restore soil, conserve water, and transform food systems.

Last year, Kernza® perennial grain continued to gain traction, with genetic improvements increasing yields and carbon sequestration potential. New crops, like perennial Baki™ bean, are also emerging. Beyond the lab and the field, early commercial adoption, policy momentum, and growing research partnerships signal that the perennial grain movement is accelerating.

This transformation is only possible through sustained collaboration. Farmers, scientists, food companies, and policymakers around the world are co-developing a perennial grain future rooted in place and networked across the globe. Together with advocates and sustaining donors, The Land Institute is committed to fostering this movement, ensuring that innovation continues and that perennial grains become a viable, lasting part of agriculture. I invite you to read more about our impact over the last year and to join us on the journey.

Perennially,

Rachel A. Stroer
PRESIDENT
The Land Institute

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CENTRAL GREAT PLAINS

Kansas Initiative Shows Kernza®'s Potential in the US Central Great Plains

The first-ever "Kernza for Kansas" initiative was launched during Earth Month in April 2024 to demonstrate what perennial grains can bring to the table as a new staple food crop in the US Central Great Plains.

Sustain-A-Grain, a Kansas-based Kernza® perennial grain supply chain innovator, launched this initiative in partnership with The Land Institute and 20 local businesses in 13 cities across Kansas. Together, they showcased Kernza's unique flavor and uses in fan-favorite foods and beverages, from flatbreads to desserts to craft beers. This month-long initiative highlighted Kernza's versatility, connecting people with this exciting emerging food crop, sparking interest, and laying the groundwork for a more formalized market for Kernza farmers.

Knowledge of Kernza's potential as a commonplace and tasty addition to peoples' diets is limited. Initiatives like "Kernza for Kansas" invite people and organizations into the Kernza food movement, building new communities centered around perennial agriculture. Understanding how restaurants, breweries, and makers can practically use Kernza is a noteworthy step forward as these businesses invite their customers to experience its enticing flavor in foods and new products and learn more about the environmental benefits of growing the crop. The "Kernza for Kansas" initiative is a significant progression in expanding the movement in The Land Institute's home regional hub and research center in central Kansas.

Collaborative initiatives like "Kernza for Kansas" that help advance the everyday use of a new perennial grain are now possible after decades of breeding progress accomplished through meticulous data collection and numerous rounds of breeding for the Central Great Plains region by a growing community of researchers. Furthermore, newly developed marketing materials, ingredient and application guidelines, and economic tools will enable businesses to utilize Kernza better and understand how to market products to an

2024 Kernza® for Kansas Partners

Courtland
Irrigation Ales

Council Grove
Riverbank Brewing

El Dorado
Walnut River Brewing Co.

Emporia
Radius Brewing Co.

Hutchinson
Sandhills Brewery

Kechi
Elderslie Farm

Marquette
Smoky Valley Distillery

McPherson
Three Rings Brewery

Minneapolis
The Farm & the Odd Fellows

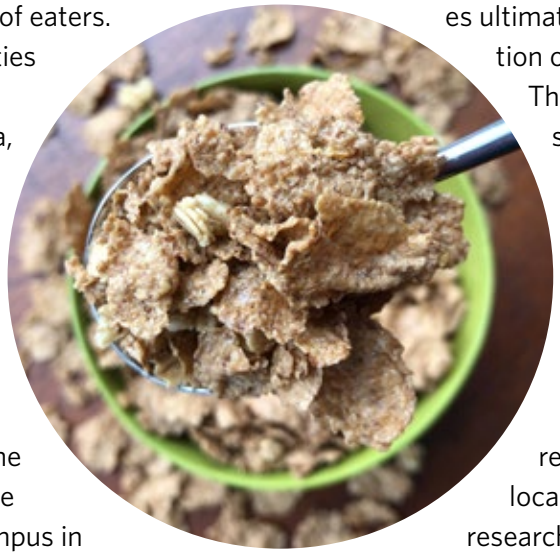
Salina
Ad Astra Books & Coffee
Blue Skye Brewery
Martnelli's Little Italy
Praireland Market
Barolo Grill

Sylvan Grove
Fly Boys Brewery & Eats

Wichita
NICHE
FioRito Ristorante
Public at the Brickyard
River City Brewing Co.

Wilson
Midland Railroad Hotel & Restaurant

ever-growing community of eaters. These foundational activities are crucial in driving early market success for Kernza, increasing adoption and business profitability, and enabling further research of this new sustainable ingredient.



With Kansas, a major wheat-growing state, at the heart of the initiative in the backyard of our home campus in Salina, The Land Institute's researchers, staff, and partners led and supported multiple events, including Kernza educational experiences, presentations, and community discussions. This initiative and others like it, along with the educational resources that support it, can serve as a model for further development of Kernza as a novel food in different regions of the US, with an increasing number of businesses ultimately driving crop production on more farmland acres. This initiative also raises some key challenges for Kernza adoption by businesses and farmers. These include the current high price of grain and the need to build and strengthen an intricate web of relationships between local farmers, policymakers, researchers, and businesses to ensure that research and development of perennial grains continue to support farmers, grow the supply chain infrastructure, and ensure initiatives like "Kernza for Kansas" can expand beyond Earth Month. Still, the initiative also shows that many dedicated changemakers are advancing agricultural sustainability and community resilience through perennial grain adoption. ▪

CENTRAL GREAT PLAINS

USDA NRCS Research Partnership Maps Kernza's Carbon Storage Potential

For the first time, researchers are illuminating the carbon storage potential of Kernza perennial grain on active working farms in Kansas.

The Land Institute's Soil Ecology Program team, in collaboration with the US Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS), is collecting soil data from Kansas farms to understand how carbon storage in soils under Kernza compares to soils under adjacent annual grains over time, in a project dubbed the "Kernza Carbon Network." The Land Institute researchers Madeline Dubois, Maya Allen, and Lead Scientist Laura van der Pol are leading the data collection effort alongside NRCS officials in Kansas.

Past scientific literature and research from The Land Institute have long shown that natural ecosystems dominated by perennial plants are highly productive at building healthy soils and promoting long-term carbon storage belowground. There is also **strong evidence** that converting fields from annuals to perennials effectively increases soil organic matter content at depth, a key consideration in climate change mitigation. The Soil Ecology Program will confirm these findings by maintaining a research plot of restored and natural prairies to serve as a baseline for comparing carbon data between Kernza fields on farms.

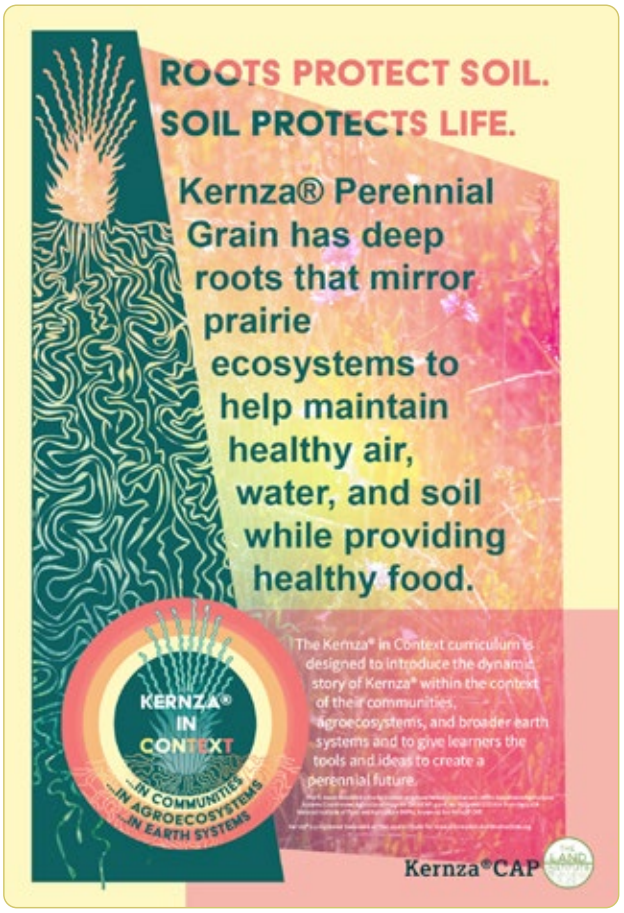
However, localized documentation on Kernza's role in carbon sequestration is sparse, especially data covering the crop's lifespan of three to five years or more. By pursuing research with Kernza on active working farms instead of research plots in controlled experiments, researchers can observe the variability farmers see in their operations and capture long-term carbon dynamics under more realistic conditions, providing data that will lend helpful insights to current and future perennial grain farmers. To collect valuable data on carbon content, soil moisture, and nitrogen content in these soils, the Soil Ecology team worked diligently to weigh, sieve, and pack soil subsamples from hundreds of individual soil cores.

The Kernza Carbon Network research will be instrumental in answering questions about how Kernza accumulates carbon belowground at depth in the Central Great Plains Region of the United States. The partnership aims to use this research to guide supply chain actors and food and beverage makers in making informed claims about Kernza and the soil and carbon impacts of their ingredients. It also seeks to provide farmers with clarity on their role in advancing regenerative, perennial agriculture to sequester carbon and mitigate climate change. Findings from this long-range study could also make valuable evidence available to policymakers, civil society groups, and philanthropic and other stakeholder groups to legitimize Kernza and other perennial grains. ▪

A dung beetle appears in a Kansas Kernza farmer's field, which could be an indication of a healthy farm ecosystem. ▼

Educating the Next Generation with "Kernza in Context" Curriculum

The open-access Kernza® in Context Educational Curriculum resource launched in the spring of 2024, introducing the dynamic story of Kernza® perennial grain to students and educators in the United States.



Developed and published by The Land Institute's Perennial Cultures Lab in partnership with several collaborators and funded in part by the USDA KernzaCAP grant, the accessible curriculum is designed for high school students but is appropriate for a wide demographic across a variety of settings.

Consisting of 10 modules and 29 lessons, Kernza® in Context familiarizes learners with the background and importance of grains in agriculture and human history, the benefits of perennial plants on landscapes, the development of new perennial grain crops, and the positive impacts Kernza can have on soil, water, and food. The educational tool emphasizes hands-on activities and a flexible format. Educators can determine how lessons best fit their classroom goals while aligning with national and state high school curricular standards. Developed through consultation and interviews with key stakeholders, beta testing, and educator feedback, Kernza® in Context was the culmination of a multi-year collaboration with educators, agricultural education experts, and university partners. It features newly conceptualized visual designs by Educational Design Technician Lydia Nicholson and uses a design approach that emphasizes specific learning outcomes across multiple subject areas, including the arts, humanities, and sciences, to enhance the student learning experience.

This first-of-its-kind curriculum will lead the way for future educational material development, using perennial grains as a case study to teach the next generation about emerging and persistent social and environmental challenges. As new audiences become familiar with perennial grains and their benefits to people and the planet, they can also better advocate for perennial agriculture. In turn, these informed advocates may become the next generation of perennial grain growers, researchers, eaters, and enthusiasts.

The curriculum has also proven valuable outside of the education realm as a bridge to The Land Institute's broader research and mission, helping wider audiences understand the reach of social, economic, and ecological possibilities for perennial grain agriculture. Kernza® in Context inspired new ways for The Land Institute to undertake community engagements with campus tours, school class visits, and local events, providing various teams with comprehensive and contextualized information for local communities. Developers of the curriculum have also created introductory materials covering topics that underscore The Land Institute's foundational work, including an introduction to grains, perennial plants, and the process of domestication. These resources will be helpful for the organization and its external partners who are furthering the reach of the work beyond its Central Great Plains home hub.

Looking forward, the Perennial Cultures Lab is beginning to explore how a similar educational design process might apply to other perennial grain crops, like perennial sorghum and the perennial oilseed candidate silflower, to continue educating future generations about additional plants and crop development efforts that support a perennial future. ▪

"Kernza® in Context" is made possible by the Agriculture and Food Research Initiative's (AFRI) Sustainable Agricultural Systems Coordinated Agricultural Program (SAS-CAP) grant no. 2020-68012-31934 from the USDA National Institute of Food and Agriculture (NIFA), known as the Kernza®CAP.

Kernza® Lager Program Inspires Beer Drinkers with Taste and Environmental Impact

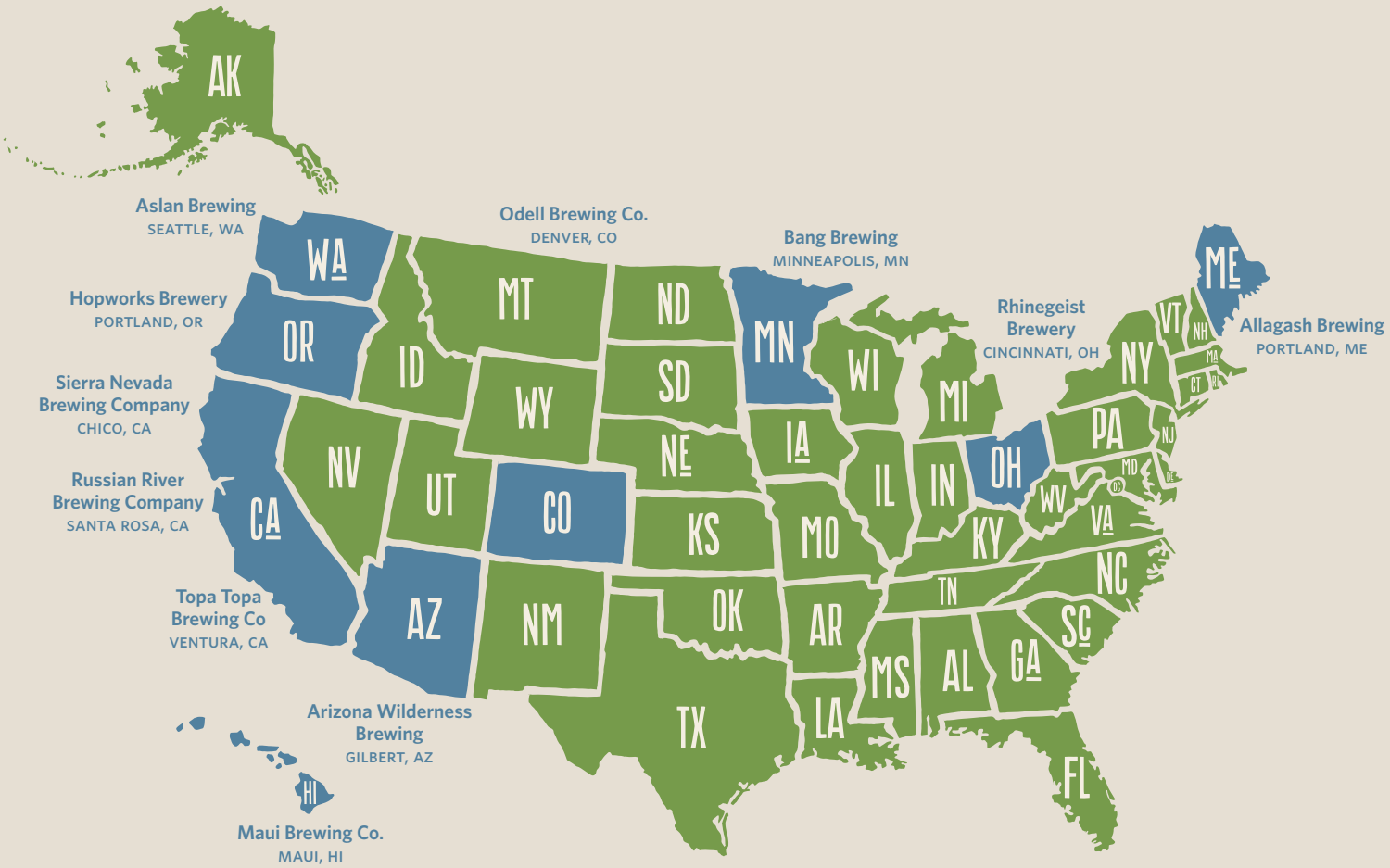
The regenerative food company and long-time The Land Institute supporter Patagonia Provisions mobilized a coalition of notable craft breweries to elevate Kernza® perennial grain with an innovative program to showcase the grain's potential in new lager-style craft beers.

Available in taprooms across the US, the Kernza Lager initiative helped educate consumers and advance the emerging perennial grain market.

Beer is an incredibly popular agricultural product that requires large quantities of grain, water, and energy to produce at scale. This first cohort of breweries in Patagonia Provisions' Kernza Lager program set out to create new craft beers that offer beer drinkers delicious new products that also support healthy soil, clean water, and carbon storage, marking a shift in the status quo for the brewing industry. Craft brewers are already at the forefront of natural resource conservation efforts and sustainable product innovation, making Kernza perennial grain an ideal fit for breweries looking to add cutting-edge ingredients to their beers while matching increasing consumer interest in regenerative products.

PHOTO CREDIT: BANG BREWING ON INSTAGRAM

The use of Kernza as a new and exciting ingredient in beer can be traced back to 2016 with the launch of the first Kernza beer, Long Root Ale, from Patagonia Provisions and Oregon-based Hopworks Brewery. This early innovation eventually led to increased experimentation by craft brewers in Kernza farming and research hubs like Minnesota, Wisconsin, and Kansas, followed by broader experimentation by brewers in Arkansas, Delaware, Colorado, Oregon, Washington, California, and many more.



2024 Kernza® Lager Pilot Program

These early adopters notably contributed to the brewing community's growing understanding of Kernza's qualities and performance in craft beer. Sustained plant breeding improvements, ecological research, and crop stewardship efforts at The Land Institute, along with efforts by university, NGO, government, and business collaborators, paved the way for the Kernza Lager program. Partnerships with groups like the Agricultural Utilization Research Institute (AURI) were equally valuable in developing and sharing knowledge about Kernza's use in food and beverage products and consumer insights for marketing sustainable products.

While brewer interest in Kernza continues to grow, investments in supply chain development for the novel grain are needed to ensure that brewers, food manufacturers, and other food and beverage businesses can utilize the grain consistently and affordably. Currently, perennial grain processing is limited to one Midwest location, creating a bottleneck in the market that circulates impacts from farmers to brewers to consumers. Nevertheless, by championing Kernza perennial grain in these standout beers, Patagonia Provisions and values-driven craft breweries are helping drive Kernza adoption with accessible, consumer-friendly beers, paving the way for future collaborations on a national scale. ▪

Perennial Baki™ Bean Nutrition Research Unlocks Potential for New Food Crop

The development of the Perennial Baki™ bean, a potential new edible pulse for human consumption, made significant strides toward becoming a new food crop in the US.

Researchers at The Land Institute, with collaborators in Türkiye, performed four first-of-their-kind food science studies highlighting positive food safety findings and noteworthy nutritional profiles for perennial Baki™ bean.

Long-term breeding efforts from the Perennial Legumes Program led to the identification of sainfoin as a potential edible pulse. The lentil-like pulse derived from the sainfoin plant was named "perennial Baki™ bean" (baki means eternal in Turkish) in honor of the plant's bioregional origin and the work of collaborators from Türkiye. Once identified as a candidate for becoming a food crop, nutritional and toxicity research followed, supplying critical and mandatory data to verify with government regulators that the new bean was safe to eat.

The Crop Stewardship and Perennial Legumes Programs formally began pursuing "Generally Recognized as Safe" (GRAS) status with the Food and Drug Administration (FDA) in 2022, which also laid the groundwork for nutritional and food safety research at The Land Institute. The first study determined that sainfoin seeds contained levels of crude protein and fat on par with soybean and chickpea, respectively, and quantified other important macronutrients like fiber and micronutrients like iron and zinc. The supporting paper, **"Nutritional quality of Onobrychis viciifolia (Scop.) seeds: A potentially novel perennial pulse crop for human use,"** was published in late 2023.

By demonstrating favorable fatty acid and amino acid profiles to human health, these results contribute to a growing body of evidence supporting the potential benefits of perennial Baki™ bean. CRAINE ET AL. 2024

The Land Institute team of authors Evan Craine, Spencer Barriball, Tessa Peters, and Brandon Schlautman partnered with Turkish collaborator Muhammet Şakiroğlu to advance food safety findings and publish two additional papers in early 2024. **"Perennial Baki™ Bean Safety for Human Consumption: Evidence from an Analysis of Heavy Metals, Folate, Canavanine, Mycotoxins, Microorganisms and Pesticides"** showed that heavy metals, mycotoxins, and microorganisms are absent or inconsequential in the bean and that seeds had no detectable amounts of the toxic compound l-canavanine sometimes found in legume seeds. **"Amino acid and fatty acid profiles of perennial Baki™ bean"** delivered key information on Baki bean's striking nutritional benefits that could enrich human diets and meet adult daily requirements to serve as a complete plant protein.

Finally, working with an even broader group of researchers in Türkiye, the team studied Baki bean in the diets of rats, a key step in assessing the potential effects of human consumption. They documented their findings in the paper **"Effect of sainfoin (Onobrychis viciifolia Scop.) seed-based diet on rats: A comprehensive evaluation of hemogram, biochemistry, and histopathology"**. The results indicated no adverse effects in rats and even suggested that Baki bean may have potential benefits for cardiovascular health, although further research will be required to verify these initial yet promising findings.

While the data is promising, researchers must confirm Baki bean's protein quality and digestibility and reach compulsory FDA GRAS status before entering the consumer marketplace as a new perennial grain food ingredient. Along with efforts to make perennial Baki bean breedable, growable, and scalable, this growing body of knowledge will help build legitimacy with government regulators and advance research to identify future food uses for Baki bean. Ultimately, these activities will facilitate Baki bean's transition from research onto fields and into the marketplace, encouraging farmers to grow this perennial grain crop and food makers to incorporate this gluten-free, protein-rich ingredient into new products. ▪

NATIONAL NETWORK

New Marketplace Connects Kernza® Ecological Benefits to Food and Beverage Businesses

A multi-sector collaboration created a new marketplace purchasing dashboard for Kernza® perennial grain with embedded data on its environmental benefits, a model for regenerative agricultural ingredient sourcing.

Created by Merge Impact and supported by Kernza grain supplier Sustain-A-Grain and The Land Institute's Crop Stewardship Program, the new Kernza marketplace dashboard allows farmers and distributors to list available Kernza perennial grain sources, quantities, and prices, linking the value of the grain to the critical and beneficial ecosystem services provided by the crop, such as carbon storage, water quality improvements, and biodiversity enhancements.

"One of the biggest complaints we've heard from buyers is confusion about how much grain is available and what nutritional and environmental impact the grain provides. The Merge Marketplace provides a seamless solution, providing transparency and integrity with every Kernza purchase."

TESSA PETERS
Crop Stewardship Director

The new dashboard helps solve a significant issue encountered by Kernza perennial grain buyers: a lack of clarity around how much grain is available at any given time and what measurable nutritional and environmental impacts are associated with the perennial grain. This exchange of information and services can accelerate Kernza's growth as an emerging regenerative crop by linking grain from specific locations to marketable and economically enticing sustainability benefits.

Merge Impact launched the platform with Kernza perennial grain as a model crop, bringing transparency, accessibility, and efficiency to regenerative and organic agricultural product markets. The new Merge Impact Marketplace provides agricultural product data for individual farmers and suppliers, along with aggregated data from all producers within a particular crop's supply chain. Producers benefit from a platform that enables them to list their sustainable products and capitalize on

the monetary value of verified environmental benefits. Meanwhile, buyers can see the sustainability claims of products to help inform their values-driven purchasing decisions. The platform also contains traceable product histories, empowering producers and buyers to make decisions based on sustainability and environmental impact measures, which are largely missing from traditional marketplaces.

The need for this platform emerged from years of research by The Land Institute and numerous collaborators on the ecosystem services value delivered by perennial crops and diverse perennial grain cropping systems, including benefits to soil health and water quality improvements. A 2022 paper written by The Land Institute's David Van Tassel and Lee DeHaan underscored the ability of perennial grain agroecosystems to improve carbon and nitrogen cycling in soils and provide ecosystem services similar to natural grasslands. Additionally, research from partners at the University of Minnesota clearly demonstrated that Kernza can successfully reduce the amount of nitrate leaching, or nitrates from fertilizer that escape fields and enter natural and human water sources, by over 100 times more compared to corn. These crucial findings indicate that Kernza provides tangible benefits to ecosystems and could be measured monetarily in coordination with recent industry pushes to value environmental benefits in the marketplace.

This core ecosystem service research, coupled with emerging environmental services markets that value carbon storage, clean water, biodiversity, pollinator services, and the involvement of farmers, distributors, and product-makers, highlighted the need to embed this value into ingredient purchases. Together, these factors signaled the right time for the launch of this new marketplace. Through additional work by The Land Institute's agricultural economist Hana Fancher, in collaboration with Kansas State University and the USDA's Natural Resources Conservation Service (NRCS), to quantify the market and non-market value of Kernza, these vital environmental benefits offered by perennial agriculture can begin to be translated into tangible economic value, benefiting producers, buyers, communities, and landscapes. •

Perennial Atlas Project Launches with Expansive Nationwide Participatory Research Cohort

The Civic Science Program at The Land Institute launched its most expansive civic scientist cohort with the new Perennial Atlas project, which aims to develop knowledge about how perennial grain crops survive and perform in different climates and environmental conditions compared to their annual counterparts.

The three-year study includes testing three perennial grains — silflower, sainfoin, and perennial flax — next to their annual grain relatives — sunflower, lentil, and annual flax. The Perennial Atlas project launched as the organization's largest and most geographically diverse participatory research project yet, beginning with 194 civic scientists in 43 US states.

Building on past civic science learnings, including the perennial wheat project, the Civic Science team identified the establishment season (setting up a test plot, planting, and getting seedlings to emerge) as the project's most challenging aspect. To better support the establishment phase, Civic Science Technician Reece Knapic and the team created educational resources and research protocols, fostered a community of knowledge sharing, and collaborated with partners to improve the data collection platform's accessibility. These efforts ensured civic scientists could initiate their plantings and maintain plants effectively.

Through testing civic science as a participatory research method, researchers can learn how to support community partners across the nation. Civic scientists share their time and feedback, which helps improve the approach to this research practice and understand its local impacts. Civic scientists

also share their inspirations and motivations to create better food futures. Building on these insights, the national movement will continue to grow understanding of the practical tools and hands-on opportunities communities of all kinds need to bring perennial agriculture to life in their places — including collecting research data and analyzing results, telling their stories about perennials to their neighbors and local decision-makers, growing and eating perennial grains, and building enduring perennial food cultures.

Researchers will use Perennial Atlas data to create digital data sets and maps to help researchers at The Land Institute and a global network of collaborators understand how perennial grains compare to their annual counterparts in terms of plant development, seed quality, diseases, pathogens, pollinator interactions, soil moisture and type, and more. These maps will provide insights into the adaptability of future perennial grain crops across different environments and build evidence to inform domestication research for agriculturally significant traits like yield and disease resistance. Maps and civic science data from this project can also help inform best management practices for perennial grain farmers to control pests and diseases. Because it can support the successful future expansion of perennial crops into broader geographies, the crowdsourced data in the Perennial Atlas can be a valuable multi-stakeholder resource. ▪

What is Civic Science?

Civic science is a way for people who aren't professional scientists to participate in and advance research. Civic scientists in a range of locations learn together as they each grow, tend, and observe test plots of future perennial grain crops. This broader, more diverse network of people studying and caring for perennials can help build more data, knowledge, and relationships.

NATIONAL NETWORK

Colorado Project Studies Drought Tolerance of Perennial Grains Crops

Timely research from The Land Institute and collaborators at Colorado State University, The Nature Conservancy, American Rivers, and Trout Unlimited is exploring the drought tolerance and water usage of three different perennial grains: sainfoin, silflower, and Kernza®. The research findings could suggest a perennial solution to addressing drought resilience in farming and ranching in water-insecure areas along the Colorado River in the arid western US.

The United States Geological Survey (USGS) determined that based on 100 years of recorded data, **the Colorado River Basin is experiencing its lowest 16-year period of water inflow**, with reservoir storage in the basin declining from almost full to halfway full in recent decades. Furthermore, local and state governments that depend on this river's water for agriculture and daily use have recently instructed farmers to drastically reduce the water they use to produce food in the coming years to adapt to current conditions. Agricultural activity accounts for **approximately 80% of all water usage** in this already drought-prone river corridor, with much of this water use directed toward producing the water-hungry yet highly productive alfalfa.

To address the agricultural production issues amidst ongoing drought, a multi-year project funded by the Colorado Water Plan studying these three perennial grains under different limited irrigation regimes is underway in partnership with American Rivers, Trout Unlimited, The Nature Conservancy, and Colorado State University. Although deep-rooted perennials have demonstrated early potential for using less water and performing well on water-stressed farmlands, this project will help provide tangible data on exactly how much water they can conserve to prove their potential as a financially viable alternative to current forage crops produced in the region to feed animals.

Perennial crops have shown promise for their ability to efficiently draw and utilize water from soils due to their characteristically deep root systems. **Research** from The Land Institute's scientists Lee DeHaan and Tim Crews and partners from the University of Kansas (KU) and the Swedish University of Agricultural Sciences (SLU) in 2020 indicates that Kernza maintains high water-use efficiency throughout the growing season to reduce water stress. **Research partners in Argentina** are also exploring methods for breeding varieties of the perennial oilseed silflower with drought tolerance in mind. These crucial studies around the potential drought-resilience of perennial grains create the foundations for investigating how perennial grains perform on fields in water-stressed areas of the country and the need to continue developing perennial grain crops with this vital trait in mind to adapt to a hotter, drier climate of the future. The next phase of this project will predict evapotranspiration (the release of water to the atmosphere from soils and plants) based on data from USDA satellites. Dr. Omar Tesdell, research partner at Birzeit University, built a model allowing researchers to access USDA data and understand how these crops could save water in arid and drought-prone regions.

By formalizing research on perennial grain water usage and drought resilience, Colorado River Basin farmers and ranchers could gain confidence in switching to water-saving alternatives like Kernza, silflower, and sainfoin. Ultimately, the project may show the potential scale at which these crops will be viable and what incentives and enabling conditions, like financial support and access to equipment and new markets, might influence farmers' adoption of these perennial grains, paving a pathway for a research and grower network in the Colorado River Basin and other western waterways to support establishing perennial grain crops on these landscapes. ▪

The Land Institute Joins the National Sustainable Agriculture Coalition

A group of more than 100 organizations that collectively support and advocate for federal policy reform for the sustainability of food systems, natural resources, and rural communities, the National Sustainable Agriculture Coalition (NSAC) brings a grassroots perspective to the critical federal policy arena.

By joining NSAC, The Land Institute gains access to a broader network of advocates and experts in sustainable agriculture policy to advance the perennial agriculture movement. Through partnership with NSAC and their member organization, The Land Institute hopes to achieve a sustained increase in research funding and infrastructure, large-scale adoption of perennial practices supported by policies that de-risk Kernza plantings by farmers, policy and financial incentives for growers, and marketplace support. For example, enacting policies that provide conservation payments to perennial grain growers, similar to those offered by the Natural Resources Conservation Service's Perennial Grain Enhancement program, can help incentivize perennial grain production.

NSAC also offers The Land Institute a space to share its expertise on perennial agriculture to support other organizations and policy experts working to bring more sustainable farming practices to a growing number of farmers and acres of farmland through research programs, education, and advocacy efforts. This new partnership will provide The Land Institute with enhanced opportunities for collaboration, policy impact, and resource sharing, amplifying its impact to advance sustainable agricultural practices and expand its reach in the federal policy space.

The addition of Kelsey Whiting, Policy and Governmental Affairs Postdoctoral Researcher, to the organization's Crop Stewardship team helped initiate The Land Institute's new

endeavor into the policy space, providing capacity to cultivate meaningful relationships with local, regional, and national stakeholders to begin formalizing a perennial agriculture coalition dedicated to applying perennial agriculture solutions into action. This added scope in policy and coalition-building expertise paved the way for The Land Institute to join NSAC. It will also strengthen the capacity of the perennial agriculture network to move toward policy solutions that address pressing social and environmental challenges through perennial crops and cropping solutions.

Furthermore, NSAC offers The Land Institute a space to share its expertise on perennial agriculture to support other organizations and policy experts working to bring more sustainable farming practices to a growing number of farmers and acres of farmland through research programs, education, and advocacy efforts. •

"From securing research funding to addressing market-based challenges, the range of policy support needed to scale perennial grains and realize their ecosystem benefits in our food system is complex. We're actively working to address these challenges through targeted advocacy efforts and by building strong relationships with coalitions like NSAC."

KELSEY WHITING
Policy and Governmental Affairs Postdoctoral Researcher

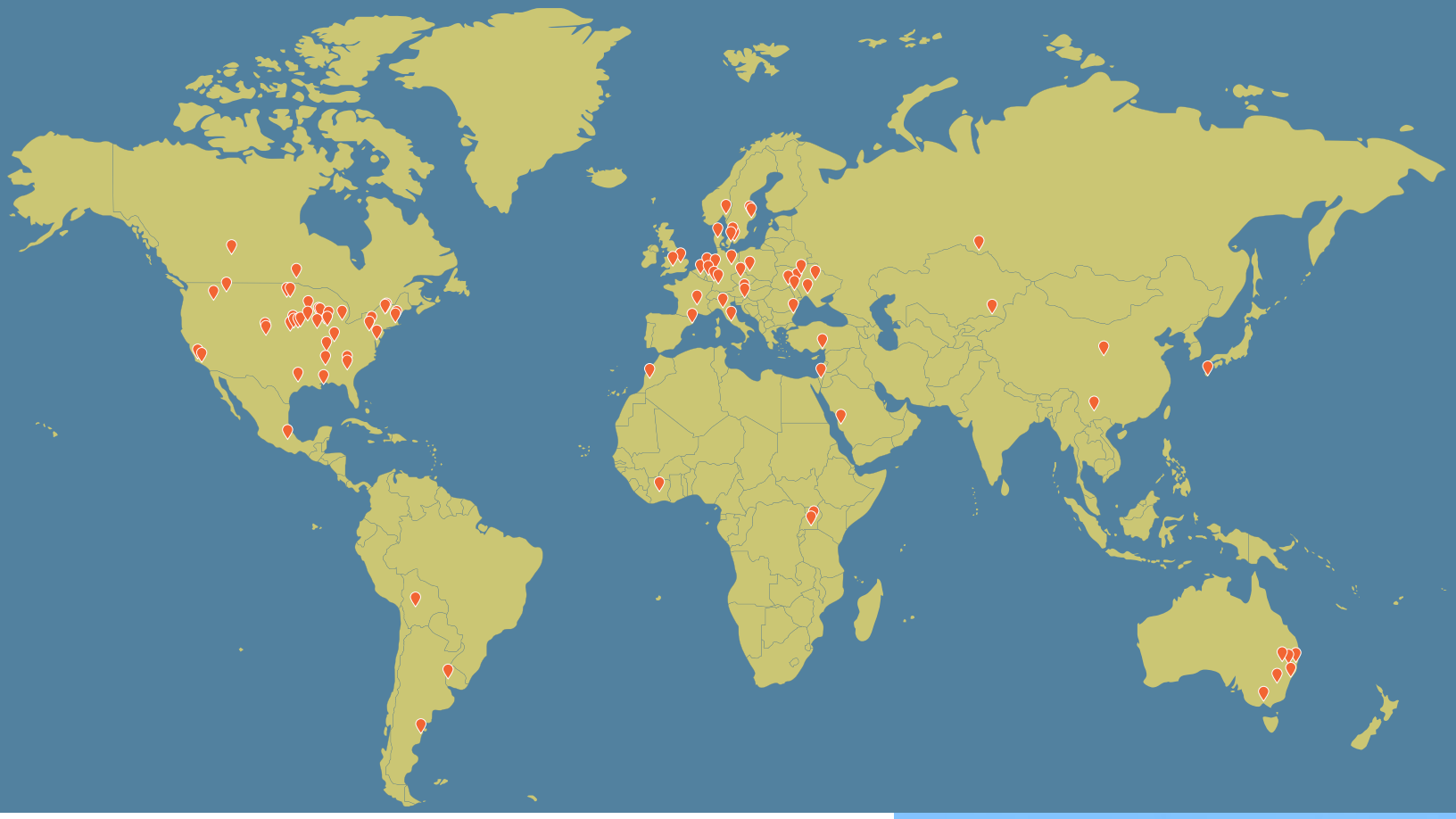
Global Perennial Grain Research Network Formalized

Since 2020, The Land Institute has led efforts to formalize and expand a growing global researcher and practitioner network dedicated to scaling perennial grains through concerted outreach and knowledge sharing to scientists in diverse geographies and cultural contexts.

The international agricultural research and policy communities envision a "regenerative agriculture" food future but struggle to find and implement transformative solutions. The Land Institute's goal is to rapidly expand its research network and deepen its impacts by 2030 to set the stage for successfully realizing perennial grains globally by 2050 and shape the future of food and farming.

A future where diverse perennial grain agroecosystems provide food for people globally is possible, as iterated in the 2023 paper "Prioritize perennial grain development for sustainable food production and environmental benefits," authored by The Land Institute researchers and dozens of partners across eight countries. Significant progress has been made toward breeding perennial grain cereal, oilseed, and legume crops in different regions of the world, with a growing network of over 200 researchers in various fields.

Building on more than a decade of successful international convenings that strengthened and advanced critical collaborations in perennial grain research, including Rome, Italy (2013), Estes Park, Colorado (2014), and Lund, Sweden (2019), The Land Institute is building scientific and institutional legitimacy based on the promise of a worldwide perennial agriculture transformation. New and emerging partnerships with groups like the International Center for Tropical Agriculture (CIAT), the Center for International Maize and Wheat Improvement (CIMMYT), and many



universities around the globe will help expand perennial grain research capacity and infrastructure. The goal is to leverage the sharing of knowledge, findings, and insights; increase the sheer number of researchers, partner institutions, policymakers, and funders; and establish locally-led, transdisciplinary perennial grain research hubs worldwide.

The Land Institute supports global partners in initiating and expanding perennial grain research in new environments and geographies. For example, these efforts include supporting perennial quinoa development by researchers in Bolivia using the same hybrid breeding techniques used to breed perennial sorghum in the US and Uganda and high-yielding perennial rice by partners in Yunnan, China. The Land Institute works to connect these research efforts and equip them with the resources and expertise they need to thrive.

A **global research map** on The Land Institute website showcases collaborating institutions, scientists, and research interests and goals. Website visitors can filter the map by perennial grain crop (like Kernza®, silphium, or perennial rice) or by research area (like plant breeding, soil ecology, or social science). The map webpage hosts an application form and contact information so prospective institutions and researchers can join the network. The map is continually updated, reflecting the growing international perennial grain network that is working to transform agriculture globally. ▪

Research partner Vasyl Bugajov examining a Kernza field in Ukraine.
PHOTO CREDIT: ЮРІЙ ДМИТРУК

INTERNATIONAL NETWORK

Advocating for Perennial Grains on the Global Climate Stage

The Land Institute amplified perennial grain agriculture's benefits as a nature-based solution in food, agriculture, and climate spaces nationally and globally through engagement at Climate Week NYC and the United Nations' 28th annual Conference of the Parties (COP28).

These movement-building engagements clarified where we might best advance perennial grain science and research networks, foster new collaborations, develop thought leadership opportunities to widely share expertise, and deploy our holistic perennial grain solutions with climate-conscious farmers, food and beverage makers, and communities of eaters who can help advance this work for years to come.

To explore the potential for perennial agriculture to break through as a viable climate solution worth funding and implementing, The Land Institute leadership engaged in Climate Week NYC, a global climate conference held concurrently with the annual United Nations General Assembly in New York City. President Rachel Stroer presented at the New York Times Changemakers Lunch as part of their Climate Forward Event alongside prominent climate leaders and activists from several sectors. Chief Communications Officer Tammy Kimbler also advocated in partnership with the US Nature for Climate coalition at the event's Nature Hub.

In December 2023, The Land Institute Chief Scientist Tim Crews and Tammy Kimbler attended the United Nations' 28th annual Conference of the Parties (COP28) in Dubai, UAE, as Official UN Observers. Agriculture and food systems are typically underrepresented, but COP28, coined "Food COP,"

provided an opportunity to open actionable dialogue around investments in changing food and agriculture systems, combining food production with climate mitigation and adaptation. This event provided the team with access to key stakeholders, NGOs, funders, government policymakers, and activists, helping to build relationships that could lead to the inclusion of perennial grains in food, agriculture, research, and climate policies. The Land Institute also joined nearly 50 organizations in signing an **open letter** to the United Nations expressing the need to include food systems in the final decision text for COP28's **Global Stocktake**, a collective process measuring current progress and future needs regarding global climate commitments and emissions reduction strategies.

For perennial agriculture to succeed, The Land Institute and its broader network must contribute to and strengthen a growing global community dedicated to transforming agriculture and food system policies worldwide to address the accelerating impacts of climate change on food systems and the greenhouse gas emissions from the food and agriculture sectors.

New Land Institute Logo Provides Legibility for a Global Audience

The Land Institute is excited to announce the launch of its new logo. The visual evolution honors the organization's rich, nearly 50-year history while positioning it as a leader in the global movement to realize perennial agriculture.

The new logo features stylized roots, symbolizing perennial grain crops such as long-rooted Kernza® and Baki™ bean, which build healthy soil, retain water, and foster a web of life below and above ground. An elaboration on the previous logo inspired by Wes Jackson's seminal book "New Roots for Agriculture," the new logo builds upon the legacy of The Land Institute's founding on the diverse Kansas prairie ecosystem. The logo continuity also reflects The Land Institute's longstanding reputation for scientific rigor and innovation while signaling its ambitious long-range vision for the future to transform agriculture to meet challenges like soil loss, extreme weather, and food security.

The logo and forthcoming new branding will help strengthen the organization's influence, galvanizing the global network of researchers and advocates by facilitating new strategic partnerships with land-grant universities, farmer groups, NGOs, and foundations. The new branding will also enhance communication efforts, enabling The Land Institute to tell accessible stories of collective impact with a broader audience to build a more substantial base of support — from its home hub in the Central Great Plains to emerging perennial agriculture hubs worldwide. This increased visibility will translate to greater awareness of the critical need to transition to perennial agriculture.

Supporters of The Land Institute can expect to start seeing this new logo in summer 2025.

The evolution of The Land Institute logo over 40 years.

Research Publications (JUNE 30, 2023 - JUNE 30, 2024)

David Pimentel consistently promoted perennial grains as the future of agriculture. Crews, T. E., & Polk, S. (2023). *Environment, Development and Sustainability*, 1-13. https://doi.org/10.1007/s10668-023-03654-7

Photosynthetic capacity, canopy size and rooting depth mediate response to heat and water stress of annual and perennial grain crops. Vico, G., Tang, F. H. M., Brunsell, N. A., **Crews, T. E.**, & Katul, G. G. (2023). *Agricultural and Forest Meteorology* 341 (2023). https://doi.org/10.1016/j.agrformet.2023.109666

Towards a practical theory for commercializing novel continuous living cover crops: a conceptual review through the lens of Kernza perennial grain, 2019–2022. Cureton, C., Peters, T.E., Skelly, S., Carlson, C., Conway, T., Tautges, N., Reser, A. and Jordan, N.R. (2023). *Frontiers in Sustainable Food Systems,* 7, 1014934. https://doi.org/10.3389/fsufs.2023.1014934

Perennial intermediate wheatgrass accumulates more soil organic carbon than annual winter wheat — a model assessment. Tang, F. H., **Crews, T. E.,** Brunsell, N. A., & Vico, G. (2024). *Plant and Soil,* 494(1), 509-528. https://doi.org/10.1007/s11104-023-06298-8

Assessing effective mechanical and chemical strategies for managing *Eucosma giganteana* (Lepidoptera: Tortricidae) in the perennial oilseed crop, *Silphium integrifolium* (Asteraceae: Heliantheae). Murrell, E. G., Zio, K. R., **Chérémond, N. E.,** & **Van Tassel, D. L.** (2023). *Journal of Insect Science*, 23(6), 4. https://doi.org/10.1093/jisesa/iead102

Discussion: Prioritize perennial grain development for sustainable food production and environmental benefits. DeHaan, Lee R., James A. Anderson, **Prabin Bajgain,** Andrea Basche, Douglas J. Cattani, Jared Crain, **Timothy E. Crews** et al. *Science of the Total Environment* 895 (2023): 164975. https://doi.org/10.1016/j.scitotenv.2023.164975

Amino acid and fatty acid profiles of perennial Baki™ bean. Craine, E. B., Barriball, S., Şakiroğlu, M., **Peters, T.,** & **Schlautman, B.** (2024). *Frontiers in Nutrition*, 10, 1292628. https://doi.org/10.3389/fnut.2023.1292628

Identification and Molecular Characterization of Dahlia Common Mosaic Virus from *Silphium* spp., a New Natural Host of the Virus. Zhai, Y., Gnanasekaran, P., Iftikhar, R., **Turner, K.,** Van Tassel, D., **Cassetta, E.,** Lubin, T. and Pappu, H.R. (2024). *PhytoFrontiers™,* PHYTOFR-12. https://doi.org/10.1094/PHYTOFR-12-23-0156-SC

Distinguishing Abiotic from Biotic Stressors in Perennial Grain Crops: Nutrient Deficiency Symptoms in *Silphium integrifolium* and *Thinopyrum intermedium*. Brekalo, A., Ravetta, D., Thompson, Y., & Turner, M. K. (2024). *Agronomy,* 14(4), 647. https://doi.org/10.3390/agronomy14040647

Origin of current intermediate wheatgrass germplasm being developed for Kernza grain production. Crain, J., Wagoner, P., Larson, S., & **DeHaan, L.** (2024). *Genetic Resources and Crop Evolution,* 1-16. https://doi.org/10.1007/s10722-024-01952-1

Perennial Baki™ Bean Safety for Human Consumption: Evidence from an Analysis of Heavy Metals, Folate, Canavanine, Mycotoxins, Microorganisms and Pesticides. Craine, E. B., Şakiroğlu, M., Barriball, S., Peters, T. E., & Schlautman, B. (2024). *Molecules,* 29(8), 1777. https://doi.org/10.3390/molecules29081777

Nutritional Quality of Early-Generation Kernza Perennial Grain. Craine, E. B., & DeHaan, L. R. (2024). *Agriculture,* 14(6), 919. https://doi.org/10.3390/agriculture14060919

Effect of sainfoin (*Onobrychis viciifolia* Scop.) seed-based diet on rats: A comprehensive evaluation of hemogram, biochemistry, and histopathology. Craine, E.B., Makav, M., Dağ, S., Yıldız, A., Eroğlu, H.A., Kuru, B.B., Bektaşoğlu, F., **Barriball, S., Schlautman, B.** and **Şakiroğlu, M.** (2024). https://doi.org/10.1002/fsn3.4117

Lignin, extractives and structural carbohydrate characteristics of *Thinopyrum intermedium* biomass reveal additional valorization opportunities for dual-crop utilization. Dräger, H., Mobley, J., Kamali, P., Dorrani, M., Lynn, B., **DeHaan, L.,** & Schendel, R. R. (2024). *Journal of the Science of Food and Agriculture,* 104(15), 9451-9461. https://doi.org/10.1002/jsfa.13768

Disease resistance gene count increases with rainfall in *Silphium integrifolium*. Keepers, K., **Peterson, K.,** Raduski, A., **Turner, K.M., Van Tassel, D.,** Smith, K., Harkess, A., Bever, J.D. and Brandvain, Y. (2024). *Ecology and Evolution,* 14(9), p.e11143. https://doi.org/10.1002/ece3.11143

What is the prospect of a perennial grain revolution of agriculture?. Olsson, L., Andersson, E., Ardö, J., **Crews, T.,** David, C., **DeHaan, L.,** Hilling, A., **Krug, A.S.,** Palmgren, M., Rey, S., Tagesson, T., Westerbergh, A., Vestin, P. (2024). *Global Sustainability,* 7, p.e35. https://doi.org/10.1017/sus.2024.27

Selection for agronomic traits in intermediate wheatgrass increases responsiveness to arbuscular mycorrhizal fungi. McKenna, T. P., Koziol, L., Crain, J., **Crews, T. E.,** Sikes, B. A., **DeHaan, L. R.,** & Bever, J. D. (2024). *Plants, People, Planet.* https://doi.org/10.1002/ppp3.10600

Review all research publications at our website.

Selected Presentations (JUNE 30, 2023 - JUNE 30, 2024)

SEPTEMBER 2023

Breeding Perennial Crops presented by Lee DeHaan | The National Academies' Committee on Exploring the Linkages Between Soil Health and Human Health | VIRTUAL

Poets in Praise of Prairie presented by Aubrey Streit Krug | Kansas Book Festival | TOPEKA, KANSAS

OCTOBER 2023

Perennial grains without borders presented by Tim Crews | International Perennial Grains Megaposium, Agronomy Society of America annual meeting | ST. LOUIS, MISSOURI

NOVEMBER 2023

Umóⁿhoⁿ (Omaha) Ethnobotany Project presented by Kelly Kindscher with Vida Stabler, Taylor Keen, and Aubrey Streit Krug | Nebraska Native Plant Society, Lauritzen Gardens | OMAHA, NEBRASKA

JANUARY 2024

Perennial Grains to Change Agriculture presented by Tessa Peters | Western Colorado Soil Health, Food, and Farm Forum | MONTROSE, COLORADO

FEBRUARY 2024

Perennial Systems presented by Brandon Schalutman | Innovative Farmers of Ontario Conference | ONTARIO, CANADA

Wild Words: Poetry & Prairie Plants presented by Aubrey Streit Krug | Poetry reading and presentation at Bethel College Life Enrichment Series | NORTH NEWTON, KANSAS

MARCH 2024

Rapid domestication of a perennial grain for diverse environments presented by Lee DeHaan | Washington State University Plant Science Symposium | PULLMAN, WASHINGTON

APRIL 2024

Intermediate wheatgrass genomics and breeding: A global update presented by Lee DeHaan | Forever Green Lab Meeting | ST. PAUL, MINNESOTA, AND ONLINE

When We Listen, What Can We Hear? Foregrounding Listening Methods in Ethnobotany roundtable presented by Kelly Kindscher, Marcela Paiva Veliz, Taylor Keen, Omar Tesdell, Tala Khouri, and Aubrey Streit Krug | Society of Ethnobiology Conference | ST. LOUIS, MISSOURI

Valuing Care Work in the Movement Toward Perennial Agricultures presented by Amy June Breesman and Aubrey Streit Krug | Bethel College Symposium | NORTH NEWTON, KANSAS

Hacia una agricultura perenne presented by Tim Crews | PROINPA (Bolivia) guest seminar, Centro de Innovación Agrícola Mario Antonio Gandarillas Antezana | COCHABAMBA, BOLIVIA

JUNE 2024

Regenerative and Locally-Adapted Grains in Wyoming and Beyond presented by Hana Fancher and Tessa Peters | Wyoming Food Coalition Speaker Series | VIRTUAL

Public Participation and Community Engagement in Perennial Grain Agriculture Research presented by Aubrey Streit Krug | Yunnan University | YUNNAN, CHINA

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