



About The Land Institute

Since 1976, The Land Institute has worked to transform grain agriculture globally from a system of extractive domination to one of generative care. Nature is our measure and from nature we are given two values that are key to a truly regenerative agriculture and to a healthy, just society in equilibrium with the earth of which it is a part: perenniality and diversity.

Our team of plant breeders and ecologists, together with collaborators on six continents, are working to develop perennial grains, pulses, and oilseed bearing plants to be grown in ecologically intensified, diverse crop mixtures. When realized, this new agricultural system promises to hold and restore soil, produce ample food, require less fossil fuels, conserve water, and mitigate and endure the impacts of climate change. In tandem, we are working to extend the insights of this new agricultural system to aid human communities to live in just relationships within an ecospheric standard.

The Land Institute is a nonprofit 501(c)(3) research and education organization funded by charitable contributions from individuals, organizations, and private foundations.

Cover: Megan Gladbach, a perennial sorghum technician at The Land Institute, battles weeds with a hoe in a field of sorghum. The Institute is breeding sorghum to be a perennial food crop. **Above:** Crystal Ma, left, and Sienna Polk (interns) carry bags of harvested perennial wheat to the edge of a breeding plot for pickup. The wheat will later be threshed and analyzed in the lab. Looking on is Piyush Labhsetwar, a perennial wheat research technician.

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Sometimes the need for change is palpable. Can we replace an extractive agriculture (based on short-lived, short-rooted annuals) and culture (based on dominating the planet and each other) with something more perennial and diverse? At The Land Institute we are dedicated to proving the necessity and possibility of this transformation – and the pages that follow illuminate the strides made just in the last year. But as I write these words on September 20, 2019, the first day of the Global Climate Strike, I am conscious that for people, land, and community alike, the stakes are high and time is short. And so we pursue this cultural and agricultural transformation with renewed urgency.

For us, 2019 was a year of fully living in to who we are called to be for the current moment. The world's first variety releases to farmers happened for both Kernza® and perennial rice, a key milestone in more than ten years of work on each, while our plant breeding and ecology programs made progress readying other perennial crops. We made a key hire that will help us advocate with our farmer and food sector partners for pathways to market for our perennial grains which are simultaneously successful and an embodiment of our values. Our Ecosphere Studies program hit its stride offering workshops and short courses, this year emphasizing intergenerational learning. And our development and administrative teams have upgraded their processes to ensure that our finances are even better aligned with the needs of our mission and the expectations of our supporters.

For us, 2019 was a year of visioning for the arrangements we will need for the future. Preparing the way for future perennial polyculture grain farming, we are making our first modest commercial polyculture pilot: intercrops of Kernza perennial grain and alfalfa for hay on several working farms. A successful and inspiring international gathering of perennial grain crop researchers in Sweden sparked discussions on forming an international support network to bring a larger international constellation of plant breeders and ecologists into this work — simultaneously elevating perennial agriculture research to the funding and staffing levels it deserves while grounding it in a diversity of people and experiences. And a new civic science community was launched for silphium research, integrating both our Ecosphere Studies and Natural Systems Agriculture programs, along with international collaborators.

Land Institute honorary board member Wendell Berry recently wrote, "Out of all our means of preparing for the future, I respect only provision. Provision is the sum of our ways of securing from the earth our food, clothing, and shelter — and taking proper care of the sources of these things in nature and human culture." Time is short, but better ways of provisioning human life on this planet beckon. As we prepare for operations in a warmer world, we are thankful for the generosity and fidelity of all of you who provision our work.

Perennially,

Fred lutzi
PRESIDENT

The Land Institute

ORGANIZATIONAL HIGHLIGHTS

Silphium Civic Science Project Invites Public Participation in Research

The Land Institute's programs in Perennial Oilseeds and Ecosphere Studies are collaborating to develop an innovative Civic Science community for *Silphium integrifolium*, the native perennial prairie plant being domesticated for oilseeds production at The Land Institute. Participants agree to plant silphium; they are collecting data from multiple growing environments and engaging in a shared learning process. This summer, we launched the small pilot cohort by sending seedlings and informational start-up kits to 45 generous growers. We are now receiving photos and news of silphium in the ground at locations across the U.S., including Kansas, New York, Pennsylvania, Arkansas, Texas, Washington, California, Arizona, and Florida. What we learn together in this initial season will shape our development of the next phase of research. The team plans to announce additional opportunities to participate in the future.

Through long-term research, we hope to find that this diverse and equitable network of people caring for silphium will accelerate its adaptation to a broad range of soils, climates, and pests; generate new strategies about building civic attachments to perennial crops; and increase the probability of silphium being adopted as a crop when it is ready to be commercially released.

Kernza[®] Commercialization Takes Root with New Hire

Tessa Peters, PhD, was hired in January 2019 as the first commercialization manager at The Land Institute. Prior to joining The Land Institute, she was employed by the Organic Seed Alliance, which gave her experience working directly with growers to troubleshoot production and economic issues. Tessa's expertise positions her to design perennial seed distribution systems and cultivate a new perennial grain supply chain. She is based in Montana.

The Land Institute's commercialization program provides leadership to an international consortium of industry and supply chain partners including Kernza® growers. Work to-date has focused on streamlining the licensing program and seed supply chain as well as implementing infrastructure for data gathering and sharing that will ensure on-farm innovation is harnessed and research results are disseminated across the network.



Limited Edition Kernza[®] Cereal Released by Cascadian Farm as Fundraiser



In mid-April, Cascadian Farm released 6,000 boxes of Honey Toasted Kernza® Cereal to introduce consumers to the grain and encourage them to join its mission to help advance climate-beneficial foods through its Deeply Rooted for Good fundraiser. Participants who donate \$25 or more through the online campaign receive a box of the cereal. All proceeds from the

campaign, which closed at the end of June, went to The Land Institute to advance our work to transform agriculture, perennially.

Land Institute Staff in Salina Grows

Chase Stratton, PhD, joined the Crop Protection Ecology team as a post doc. He is currently conducting greenhouse studies to compare the defense capabilities of corn, annual sorghum, and perennial sorghum against aboveground and belowground pests. He also has expertise in plant volatiles — chemical signals naturally emitted by plants that can attract or repel insects — and plans to investigate how these chemicals might be used to naturally protect our crops from pests.

Two Salina locals joined us on staff this last year. Valerie Linenberger, CPA, joins us an accountant after many years in financial roles including controller, auditor, and tax accountant. Scott Hamilton brought more than 20 years of construction experience and eight years of landscaping to his position as Facilities and Grounds Technician.

We also gained two new research technicians: Sydney Schiffner, came from the University of Minnesota to work for the Perennial Oilseeds program and Megan Gladbach, former intern, has joined the Perennial Sorghum team.

New Research Resident Program Allows for More In-Depth Educational Experience



The Land Institute recently launched a research residency program. Residents work with TLI lead researchers to conduct new projects that foster residents' intellectual growth and contribute to our program goals. The residency is long-term, usually 12-18 months or two growing seasons, to allow data collection and analysis and to ensure in-depth immersion here on our campus. Our first class of

residents are: Eric Cassetta, Alexandra Griffin, Abigail Han (former interns from summer 2018) and artist Rena Detrixhe.

The residents receive practical scientific training alongside training in trans-disciplinary knowledge and collaborative skills, as well as supported practice in reflective inquiry into values and ethics. Residents are guided to advance in their career and vocational paths through both self-discovery and engagement with TLI mentors and our research network.

Perennial Rice Officially Released to Farmers in Yunnan Province, China

The perennial rice program sponsored by The Land Institute and overseen by Dr. Fengyi Hu at Yunnan University in Kunming, China, has announced that their hybrid PR23 has been released as an official variety that is available for farmers to plant in the Yunnan Province. A cross between the annual rice Oryza japonica and a closely related perennial, Oryza longistaminata, PR23 has kept pace with annual rice yields over three years, with two harvests per year. This variety and others are being trialed in Laos, Cambodia, and Myanmar. Dr. Hu's group continues work on developing an upland perennial rice that would help to combat soil erosion throughout Southeast Asia. Perennial rice was served at the international Perennial Grains meeting in Lund, Sweden and also featured in food truck meals at this year's Prairie Festival.

Is the Future of Agriculture Perennial? International Research Conference Held in Europe

The Land Institute partnered with Lund University in Sweden to host the largest meeting to date of perennial grain researchers: *Is the Future of Agriculture Perennial?* The Land Institute, together with several partners and key donors in Sweden and the U.S., helped underwrite this conference which gathered 92 plant breeders, agroecologists, and social scientists from six continents to share their research and develop new collaborations. The researchers, many of whom are directly funded by the Perennial Agriculture Project, are part of a global movement to shape agriculture into an enterprise that can be sustained.



Swedish Professor and Kansas Attorney are New Board Members



TLI welcomed two new members to our Board of Directors. Lennart Olsson, professor of Geography at Lund University in Sweden, is TLI's first board member to reside outside of the U.S. during his tenure. His current research focuses on the politics of climate change in the context of poverty, food insecurity, and ill-health in sub-Saharan Africa and beyond. He was chapter lead author on Livelihoods and Poverty in Intergovernmental Panel on Climate Change's (IPCC) 5th Assessment Report 2011-14 and for the chapter on Land Degradation in the IPCC report on Climate Change and Land, 2017-19.

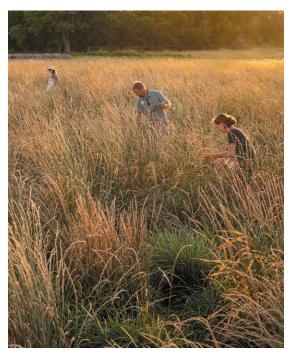


Ruth Anne French-Hodson, an attorney at Shook, Hardy & Bacon L.L.P., has worked on both individual and multidistrict matters in courts across the country for a broad range of industries including pharmaceuticals, energy infrastructure and extraction, and product manufacturers. In addition to industry, she has also been active in working with family court, inmates, and social justice issues. Before attending law school, Ruth was awarded a Rhodes Scholarship to the University of Oxford where she received a MPhil degree in Comparative Government and a DPhil in Politics.

We are grateful for the service of Angus Wright, Eric Gimon, and Jim Haines who rotated off the Board after the spring meeting.

PROGRAM UPDATES

Perennial Crops



Kernza[®]

- Over the past year we have used genomic selection to advance our intermediate wheatgrass breeding program another generation. Every cycle of planting, genetic evaluation, selection, and intermating moves us closer to our goal of a large-seeded, high-yielding, easily-managed perennial grain crop. Results obtained show that yield is steadily increasing. We also crossed thousands of heads to advance the project of introducing a few genes from wheat into intermediate wheatgrass. We obtained thousands of seeds which will be used to grow plants for evaluation in the field next summer.
- Intermediate wheatgrass continues to be grown and marketed as Kernza® perennial grain. As farmers begin to grow this new crop, the need for effective growing techniques and improved varieties becomes pressing. We have supported the initiation of breeding programs to develop regionally appropriate varieties in the West, Midwest, Central Canada, and Sweden. The first variety developed from breeding material distributed by The Land Institute has now been released by the University of Minnesota. We anticipate naming varieties adapted to other regions within a few years.



Perennial Wheat

- Winter durum derivatives, a new type of perennial wheat, performed well in field testing. They are superior to any existing cultivars/lines in terms of perenniality and yield potential. Minor morphological differences were observed within three advanced lines which comprised thousands of plants each. All the plants were more perennial with high seed set and large seed size. In 2020, we will have hundreds of kilograms of seeds to initiate a new round of international genotype by environment trials.
- Seven perennial wheat lines (having about 42 wheat and 14 wheatgrass chromosomes) are ready for "genetic stock" registration. They were selected by our program from 2009 to 2016, representing our achievements in the development of perennial wheat by crossing bread wheat with wheatgrass. A replicated experiment has been carried out for the comparison with annual wheat and some elite perennial wheat lines developed by other institutions.



Perennial Oilseeds (Silphium)

- Our research to analyze wild Silphium germplasm from diverse geographies revealed that some seedlings from other areas grow faster than Kansas native plants. Faster seedling growth could help farmers get perennials up and ahead of weeds in the year crops are established. We are now determining how this fast growth pattern impacts the mature plants' resilience and resistance to disease and pests.
- Disease and pest pressure persist, but we have found a small group of plants that are resilient. We are now incorporating these plants into the



larger breeding population. Silphium growing far from its native pests and diseases continues to thrive and attract interest. Work in dry western Kansas suggests that breeding could improve drought tolerance. In Argentina, our collaborators found that two plants with equivalent yield and growth may have different photosynthetic strategies. In both cases, we see that there are important genetic differences that can now be incorporated in our breeding program.

 Our new Civic Science project is helping us understand how broadly adapted our silphium breeding lines are across the country when exposed to a wide range of climates, soils, and management approaches.



Perennial Sorghum

Forty-chromosome sorghum plants (called tetraploids) are much more difficult to work with in a breeding program than are 20-chromosome plants (diploids). Until recently, all the plants in the perennial sorghum breeding program were tetraploid. Last summer, exploiting a couple of flukes we found in sorghum's reproductive cycle, we produced 250 diploid populations. They are much more like grain sorghum, with large, good quality seed, higher seed production, and other more crop-like traits. Most of the diploid populations show no perennial potential, but some do. Additionally, two 20-chromosome populations, derived via rare 30-chromosome ("triploid") hybrids, show strong rhizome development. This promises a breakthrough: the first diploid sorghum plants ever with a capacity to produce rhizomes that are derived from the wild tetraploid *S. halepense*. These plants can be crossed with any other grain sorghum and used much more easily in breeding perennial sorghum.



Perennial Legumes

- We have narrowed the list of perennial grain legumes to one long-term candidate: sainfoin (*Onobrychis viciifolia*), which appears to be promising for Kansas and the western U.S. We are conducting agronomic experiments to determine best management strategies for sainfoin seed production. A visiting scientist from Palestine, Mary Deeik, conducted a breeding trial and made selections at TLI this fall.
- Legume research resident, Abigail Han, started work in January with the legume team. She has been conducting breeding, genetic, and plant pathology (i.e. developing the first linkage map, screening for Alfalfa Mosaic Virus infection) with the goal of developing kura clover as a perennial companion legume.
- Legume technician and master's student, Spencer Barriball, is continuing
 a multistate trial studying intermediate wheatgrass (Kernza®) within
 intercropping systems (i.e. row spacing, harvest timing, nitrogen balance).
 That work combined in collaboration with Tim Crews and others has
 helped facilitate planting over 150 acres of intermediate wheatgrass +
 alfalfa intercropping fields in Kansas.

PROGRAM UPDATES

Agroecology



Crop Protection Genetics

- We doubled the size of the irrigated disease nursery this year to include perennial wheat and silphium in addition to expanding the Kernza® plantings. This nursery enables us to select for resistance to diseases in a uniform environment with high disease pressure, even when yearly weather patterns are not conducive for infection.
- We moved into the Crop Protection wing of the new greenhouse where we are working with pathogens in isolation from the plants in the breeding programs. In this new facility we are studying the life cycle of *P. silphii*, the rust disease affecting silphium, and observed clusters of infective teliospores dropping onto the floor of the growth chamber. This is an unusual phenomenon and may have an important role in the spread of disease for the next growing season.



Crop Protection Ecology

- Technician Edy Chérémond has successfully reared adults of Eucosma giganteana, our major silphium pest, in the lab. He is now working to increase caterpillar survivorship so that we can establish a breeding population to test pest management strategies.
- We found that perennial sorghum seems to have greater tolerance to chinch bugs, and that annual sorghum intercropped with perennial was attracting and increasing their populations throughout the field. In 2019, we used habitat management to reduce the likelihood of chinch bug damage.
- Ebony Murrell received funding for two shared grants: a NIFA
 Foundational Grant (USDA) investigating the effects of nutrient availability and arbuscular mycorrhizal colonization (a beneficial fungus in plant roots) on plant defenses against insect pests and a USDA NRCS
 Conservation Innovation Grant, to investigate ecosystem and agronomic services provided by our perennial grain species and perennial grain candidates, compared to prairie plantings.
- Research Resident Alex Griffin is investigating the ability of different silphium genotypes to take up beneficial fungi and resist root pathogens in the CPE lab.
- Kelsey Peterson, a Ph.D. student at UMN, conducted silphium research in our laboratory. Preliminary data suggests that different silphium genotypes and different species in the Silphium genus may differ in their toxicity to caterpillars. We hope to use these data to identify naturally resistant plants for silphium breeding.





Soil Ecology

- Numerous soil ecology graduate students and post docs came to The Land Institute in 2019 to work in our experimental plots. These young researchers from University of Kansas, University of Oklahoma, and Colorado State University are working to understand how the soil microbial community functions in soils protected and fed by roots from perennial grains compared to microbial communities growing in disturbed soils planted to annual grains.
- Work on Kernza®-legume intercrops continues on two fronts. We are evaluating whether deep-rooted alfalfa delivers not only nitrogen to Kernza plants growing close by, but also water. Ecologists have found that certain deep-rooted plants can facilitate the movement of water through their roots at night, which can benefit more shallow-rooted plants during times of drought. We have installed moisture sensors to measure whether this function, called hydraulic redistribution, is happening in Kernza-alfalfa intercrops.
- As part of a multi-institutional project partially funded by the USDA's
 Sustainable Agriculture, Research, and Education program, we are joining
 with researchers at the University of Minnesota and the University of
 Wisconsin to facilitate the planting of Kernza-alfalfa and Kernza-sainfoin
 intercrops on two local farms in each of the three states. Researchers will
 work with the farmers to evaluate and troubleshoot how to grow the new
 perennial biculture at a farm scale.



Ecosphere Studies

- Our July 2018 conference investigated diverse disciplinary and cultural
 perspectives of the history and future of agriculture in the ecosphere, with
 presentations that explored what knowledge human communities need to
 remember and shelter, what limits we need to accept, and what we need
 to learn for the first time in this era of ecological crisis.
- We designed and facilitated seven workshops, short courses, and symposia in Kansas, Nebraska, and lowa to test experiential learning approaches and build community. Most of these events were collaborations; our partners were college faculty and professionals in the creative and healing arts, including our new Ecosphere Studies research resident, artist Rena Detrixhe.
- With TLI scientists, we began to initiate new sociocultural research integrated with their development of perennial polycultures. Recognizing that crop domestication involves changes to both plants and people, we aim to generate transdisciplinary domestication strategies and build a broader constituency for future perennial crops and agroecosystems.

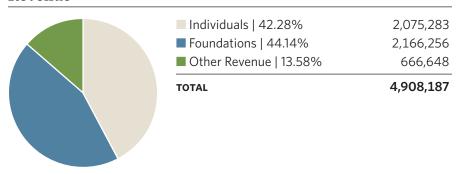


Summary Statement of Financial Position

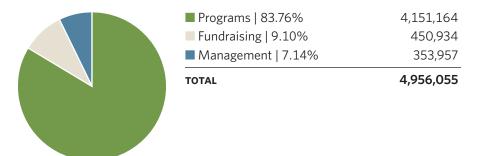
YEAR ENDED JUNE 30, 2019

	FY 2018	FY 2019
Assets	17,389,765	17,213,465
Liabilities	1,356,844	1,228,413
Net Assets	16,032,921	15,985,052

Revenue



Expenses



LEADERSHIP

AS OF 6/30/19

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Tim Crews DIRECTOR OF RESEARCH

Chris Pembleton DIRECTOR OF ADMINISTRATION

Aubrey Streit Krug DIRECTOR OF ECOSPHERE STUDIES

Rachel Stroer CHIEF STRATEGY OFFICER

Wes Jackson PRESIDENT EMERITUS

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AS OF 6/30/19

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The Land Institute is a 501(c)(3) nonprofit. We work to raise our operating budget every year. We believe The Land Institute offers hope that is rooted in science, and we rely on your advocacy, education, and donations to move our work forward.

All donations are tax-deductible and allow us to continue transforming agriculture, perennially. Please consider donating today via a monthly gift, a one-time gift, or speaking with someone on our development team about additional options. Our team is small, yet our work is mighty and the vision is transformational.

Join us on this journey.

Selected Publications and Presentations

Publications

Characterization of Genetic Resistance to Fusarium Head Blight and Bacterial Leaf Streak in Intermediate Wheatgrass (*Thinopyrum intermedium*) | P. Bajgain, X. Zhang, M.K. Turner, R.D. Curland, B. Heim, R. Dill-Macky, C.A. Ishimaru, J.A. Anderson | 2019 | *Agronomy*, 9(8), 429

Building a Botanical Foundation For Perennial Agriculture: Global Inventory of Wild, Perennial Herbaceous Fabaceae Species | C. Ciotir, W. Applequist, T.E. Crews, N. Cristea, L.R. DeHaan, E. Frawley, S.A. Herron, R. Magill, J.S. Miller, Y. Roskov, B. Schlautman, J.C. Solomon, A. Townesmith, D. Van Tassel, J.L. Zarucchi, A. Miller | 2019 | Preprint: https://www.biorxiv.org/content/10.1101/515189v1

Is the Future of Agriculture Perennial? Imperatives and Opportunities to Reinvent Agriculture by Shifting from Annual Monocultures to Perennial Polycultures | T.E. Crews, W. Carton, L. Olsson | 2018 | *Global Sustainability*, 1, e11, 1-18

Integrating Multipurpose Perennial Grains Crops in Western European Farming Systems | O. Duchene, F. Celette, M.R. Ryan, L.R. DeHaan, T.E. Crews, C. David | 2019 | Agriculture, Ecosystems & Environment, 284. DOI: 10.1016/j. agee.2019.106591

Growing a Green New Deal: Agriculture's Role in Economic Justice and Ecological Sustainability | F. lutzi, R. Jensen | 2019 | Resilience.org, https://www.resilience.org/stories/2019-02-13/growing-a-green-new-deal-agricultures-role-in-economic-justice-and-ecological-sustainability/

Let's Get 'Creaturely': A New Worldview Can Help Us Face Ecological Crises | W. Jackson, R. Jensen | 2019 | Resilience.org, https://www.resilience.org/stories/2019-04-03/lets-get-creaturely-a-new-worldview-can-help-us-face-ecological-crises/

Reduced Nitrate Leaching in a Perennial Grain Crop Compared to Maize in the Upper Midwest, USA | J.M. Jungers, L.R. DeHaan, D.J. Mulla, C.C. Sheaffer, D.L. Wyse | 2019 | Agriculture, Ecosystems, and Environment, 272:63-73

Assessment of the Biogeographical Variation of Seed Size and Seed Oil Traits in Wild Silphium Integrifolium Michx.

Genotypes | S. Reinert., D. Van Tassel, B. Schlautman, N.C.

Kane, B.S. Hulke | 2019 | Plant Genetic Resources (accepted for publication)

Populus deltoides: Cottonwood. | A. Streit Krug | 2019 | becoming-Botanical: A Post-Modern Liber Herbalis, Objet-a Creative Studio, pp. 89-92

Presentations

OCTOBER 2018

Entomology Seminar Series Presented by Ebony Murrell | Kansas State University | MANHATTAN, KS

DECEMBER 2018

Nourishing Change in Ag and Culture Presented by Fred Iutzi, Peter Buffett, Jen Cirillo, Amani Olugbala, and Don Stevens | Roundtable discussion moderated by Aubrey Streit Krug, Middlebury College | MIDDLEBURY, VT

JANUARY 2019

Improving the Longevity of Perennial Wheat for Better Ecosystem Services Presented by Shuwen Wang | Plant and Animal Genome Conference 2019 | SAN DIEGO, CA

APRIL 2019

Breeding Common Plants for Uncommon Goals:
Perennializing Our Grains and Diversifying Our Cropping
Systems Presented by Brandon Schlautman | Synapsis Plant
Sciences Symposium, Cornell University | ITHACA, NY

MAY 2019

Natural Systems Agriculture and the Need for a Creaturely World View Presented by Wes Jackson | Keynote address at the "Is the Future of Agriculture Perennial?" conference, Pufendorf Institute of Advanced Studies at Lund University | LUND, SWEDEN

MAY 2019

Is the Future of Agriculture Perennial? How Functional Ecosystems Will Lead the Way to a Post Fossil Fuel Intensive Agriculture. Presented by Tim Crews | Pufendorf Institute, Lund University | LUND, SWEDEN

MAY 2019

Developing Kernza Perennial Grain *Presented by Lee DeHaan* | L'Institut National de la Recherche Agronomique (INRA) | CLERMONT, FRANCE

JUNE 2019

Diversity and Perenniality in Contemporary Agroecological Storytelling Presented by Aubrey Streit Krug, panel organizer and presenter | Association for the Study of Literature & Environment conference, University of California-Davis | DAVIS, CA

SEPTEMBER 2019

Perennial Grain Polyculture and Plant Pathogens Presented by Kathryn Turner | Plant Pathology Seminar Series | MANHATTAN, KS

