# Annual Report 2017

THE LAND INSTITUTE

Two things characterized the natural ecosystems that built our soils and sustained our water and air, and two things will characterize any agriculture that can claim to regenerate them: perenniality and diversity. The unfolding story of Kernza® perennial grain in the field and the marketplace gives us proof of concept that such an agriculture can exist. Kernza, wheat, sorghum, silphium, legumes, rice — in each case this past year has brought stronger plants and stronger collaborations. Our research capacity has never been greater here in Kansas, yielding discoveries in sorghum cytogenetics and in Kernza-alfalfa nitrogen dynamics, or internationally, with a surging rice program in China and silphium research taking root in Argentina.

**About The Land Institute**

*The Land Institute, founded in 1976, is a nonprofit 501(c)(3) research and education organization funded by charitable contributions from individuals, families, organizations, and private foundations. Our scientists are developing perennial grain species to be grown in diverse mixtures that will require less fossil fuel, conserve soil and water, and weather the droughts and deluges that will become more frequent with climate change.*

We also believe two values are key to a healthy, just society in equilibrium with the earth of which it is a part: perenniality and diversity. The Land Institute was founded on the notion our sustainability stumbling blocks are as much philosophical and cultural as biological. Our Ecosphere Studies program is a continuation and elevation of this way of thinking, and over the last year has launched into the scholarship and education needed for a regenerative society.

My first visit to The Land Institute was in the summer of 2000. I still remember the feeling of stepping over the property line, knowing that this place was a central node for the science and philosophy that will make us ecologically whole again. In October 2016, I came back in a new capacity — but I still feel that same wonder every morning.

I am indebted to several key leaders here. One is Wes Jackson, co-founder and President Emeritus, my mentor and now my co-worker. Another is environmental historian Angus Wright, who led the leadership transition with a steady hand before stepping down after six years as board chair. I am now pleased to partner with his successor, rancher Pete Ferrell.

Our team is talented, our finances are strong, and we have a movement standing behind us: all of you who support this work with your friendship, your encouragement, your collaboration, and your donations. It is because of you that we have reached this point. It will be because of you that we can take the next steps on the journey to bring about an agriculture and a community life at once prosperous and enduring.

Perennially,

**Fred Iutzi**
PRESIDENT
The Land Institute

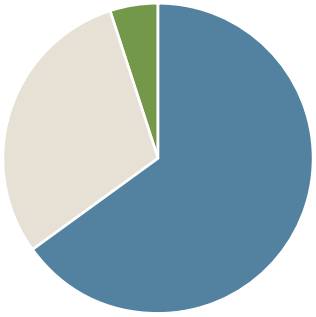
*Cover image: Interns Emily Ralston, Siwook Hwang, and Meg McDonald, hoeing Kernza® in the breeding nursery.*

## Summary Statement of Financial Position

YEAR ENDED JUNE 30, 2017

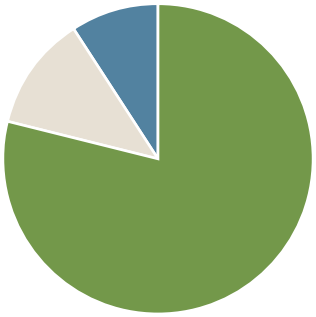
| | FY 2017 | FY 2016 |
|---|---|---|
| Assets | 18,253,076 | 17,612,949 |
| Liabilities | 150,492 | 116,197 |
| **Net Assets** | **18,102,584** | **17,496,752** |

### Revenue



| | |
|---|---|
| Foundations \| 65% | 2,705,228 |
| Individuals \| 30% | 1,259,334 |
| Other Revenue \| 5% | 215,262 |
| **TOTAL** | **4,179,824** |

### Expenses



| | |
|---|---|
| Programs \| 79% | 2,811,754 |
| Fundraising \| 12% | 427,355 |
| Management \| 9% | 334,883 |
| **TOTAL** | **3,573,992** |

### LEADERSHIP

AS OF 6/30/17

**Fred Iutzi** PRESIDENT

**Rachel Stroer** CHIEF OPERATING OFFICER

**Tim Crews** DIRECTOR OF RESEARCH

**Amy Cole** DIRECTOR OF DEVELOPMENT

### BOARD OF DIRECTORS

AS OF 6/30/17

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# Local & Global Growth Continues

## Kernza® Commercialization: Demand Continues to Grow

The October 2016 release of Patagonia Provisions' "Long Root Ale" (including Kernza® as an ingredient), opened the floodgates of interest. In November, a delegation from General Mills visited The Land Institute (TLI) to learn about our development of intermediate wheatgrass as a perennial grain crop. That visit led to a $500K commitment in March 2017 from General Mills to TLI and the University of Minnesota for research both into developing Kernza as a viable ingredient and to investigate the greenhouse gas consequences of growing it in different systems.

Both announcements caused a spike in attention. Plovgh, the agricultural coordinator we hired to orchestrate Kernza seed distribution and grain processing, reported they received 200 inquiries in the first three months after the Patagonia release, and as of fall 2016, 17 farms had added a total of 174 Kernza acres. Since the General Mills announcement, farmers and buyers from across the U.S. and overseas continue to call. By fall 2017, another 300 acres had been planted.

## Perennial Grains Story Project

Funded in part by the McKnight Foundation, TLI is leading a coordinated effort to create an integrated communication strategy for the commercialization of perennial crops grown in mixtures. With several Kernza® products on the market, players across the supply chain have reacted positively to the ecological benefits of perennial agriculture, but the context has been that of narrow or biased consumer and producer awareness.

This project brings together Kernza early adopters and innovators, researchers, farmers, and millers to develop a communications plan to guide the deeply rooted story of perennial agriculture in the marketplace. The goal is to integrate the market-facing communications with the broader agronomic and ecological vision established by TLI. Involved commercial partners include Patagonia Provisions, General Mills, Plovgh, Dumpling & Strand, Birchwood Café, The Perennial, and others.

## New Director of Development

Amy Cole joined TLI as Director of Development on June 28, 2017. She previously served as the director of development for the Kansas State University Polytechnic campus, where she oversaw a major campaign, and Saint Francis Community Services, where she helped to build the foundation infrastructure. Amy holds a green belt in Six Sigma and has many years of business development experience prior to joining the nonprofit world. She has strong ties to the ag community, grew up in Gypsum, Kansas, and now lives in Salina with her husband and two boys after moving back to the area to raise their children amongst family.

## Sorghum Diploid Genotype Discovery

Stan Cox and Pheonah Nabukalu, along with other researchers from The Land Institute and the University of Georgia, completed and published the first study demonstrating that large numbers of 20-chromosome sorghum plants were produced by crossing 20- and 40-chromosome plants. This could have big consequences for our perennial sorghum development, which to date has been restricted to 40-chromosome populations, which are much more difficult to deal with in breeding and genetics. So, for example, it will be much easier for colleagues in Africa to cross locally adapted annual sorghum with our perennial sorghum germplasm.

## Ecosphere Studies

How can humans create stable, decent, and just communities within the limits of the ecosphere—the creative, living globe that is our home? TLI's approach to a new agriculture emerges from a deeply ecological worldview. Ecosphere Studies nurtures the institute's perennial thinking through research and education for a sustainable society.

Ecosphere Studies drives knowledge out of its categories by bringing together scholars, activists, teachers, and students to pursue collaborative research and learn through experimental, experiential workshops. Informed by an understanding of the social-ecological effects of agriculture, we seek to transform human ways of thinking and making a living.

## Ground Broken for Second Greenhouse

Thanks to support from our dedicated partners, ground was broken for a second greenhouse in September 2017. It will contain several partitioned rooms, heated floors, and a flood floor/bench system allowing simultaneous uniform watering of all the plants in a region. Built-in insect nets and shields will help provide organic pest management inside. Funds allowed for inclusion of a head house – used for everything from washing pots and potting plants, to sterilizing soil and raising plants in specialized growth chambers. Our demand for space outpaces supply for several months annually. This new facility will resolve this bottleneck and provide critical space for new programs. The anticipated project completion date is May 2018.

## Perennial Grains Center Opened at Yunnan University in China

Since 2008, TLI has been helping fund the perennial rice research of colleague Fengyi Hu in China. He has planted more than 100 acres, and after six harvests over three years, found the plants matched the grain yields of annual rice.

In February and May 2017, Fengyi Hu, now a professor at Yunnan University, China, brought delegations of administrators from his school and city to TLI to further investigate our work. These visits led to Shuwen Wang and Tim Crews being invited to Kunming to sign a joint project agreement to open a Perennial Grains Center in China.

This non-binding agreement describes the intention of the partners to continue collaborating in breeding perennial grains and applying ecology in the design of cropping arrangements. Collaboration includes the possible exchange of researchers, students, use of facilities, pursuit of funding, and publishing.

# Progress continues toward a Natural Systems Agriculture

## *Kernza*® Perennial Grain

- Using the recently-developed genomic sequence, we initiated the first round of genomic selection in breeding Kernza®, an intermediate wheatgrass, domesticated as a grain crop. With data collected on thousands of plants grown for two years in the field, we developed a model that could predict the performance of plants by testing their DNA.
- We have begun to experiment with the possibility of speeding the domestication of intermediate wheatgrass by introducing a few important genes directly from wheat, which already has the needed traits. We use old-fashioned pollination for this approach, but the young seeds require some assistance to survive. We now have plants that have all the chromosomes of wheatgrass and some from wheat.

## Perennial Wheat

- We grew 1,200 plants in greenhouse and created 257 new hybrids with focuses on the hybridization of annual winter durum with perennial intermediate wheatgrass (IWG), a promising method for increasing the longevity of perennial wheat. A variation in wheat VRN1 gene could enhance longevity by 28%. Additionally, we successfully crossed a new wheatgrass species with seven winter durum cultivars.
- In field, we grew out 600 small plots and 6,000 head rows for the comparison of regrowth, grain size, grain yield, and free threshablility.
- We continued working on the molecular genetics of a research population involving durum wheat and IWG hybridization. Eventually, we could identify every wheat and wheatgrass chromosome with high confidence based on 34,000 sequence tags.

## Perennial Legumes

- In the first year of the TLI legume breeding program, we focused on identifying specific attributes considered necessary for an herbaceous perennial grain legume and/or perennial companion legumes. Specifically, we reviewed literature searching for candidate legume species that meet our criteria for ease of harvestability, ease of breeding, and highly nutritional seeds. Ultimately, we planted and evaluated thousands of alfalfa and lupin accessions and began selecting the most promising plants to be the founding parents of our perennial grain legume breeding populations. Additionally, we planted 150+ Kura clover accessions, and selected plants among them that we determined most closely resemble the perennial companion legume we envision.

## Perennial Sunflower (Silphium)

- We found that silphium can acquire water and nitrogen from a depth of at least two meters (6 feet) down in the soil. We are seeing mature plants in Patagonia (a region that receives less than 8 inches of precipitation per year), thriving without irrigation because they can access deeper groundwater resources. There are many parts of the world where irrigation is economically and/or environmentally costly. A crop like silphium that can be watered from 4-6 feet below the surface could be a game-changer. We need to find ways to make sure that as we increase seed yield, we do not lose the ability to produce deep, robust roots.

## Perennial Sorghum

- We made by far the largest number of annual x perennial pollinations we have ever made in a single summer and obtained the largest quantity of seed. In coming years, we will grow out populations descended from the hybrids thus produced and select improved perennial plants.
- We published research led by our student Shakirah Nakasagga in Uganda, showing that our material is strongly perennial in that tropical environment with two growing seasons per year. Shakirah is now a Ph.D. candidate at Texas A&M University, working on perennial sorghum; she started in January 2018.

## Agroecology

- Five years of Kernza®-alfalfa experimentation demonstrated a high degree of compatibility between these two. Our results indicate that alfalfa enriches the soil nitrogen through biological nitrogen fixation and that this enrichment significantly boosts productivity of the intercropped Kernza. However, this Kernza is generally not as productive as single-species stands fertilized with synthetic nitrogen. This could be because alfalfa provides most, but not all the Kernza's nitrogen demands, or it could be due to competition for another resource, like water. One experiemental approach involves planting a solid stand of alfalfa to "front load" organicaly-bound nitrogen into soil and then establish Kernza into the stand after several years.

## Ecosphere Studies

- We held a June conference at TLI to refine the concepts that inform Ecosphere Studies and develop our methods for disseminating new knowledge and practices. Two dozen educators and scientists discussed the ideas of process and emergence, with help from philosopher John Cobb Jr. and ecologist Robert Ulanowicz. We began making plans to offer public workshops in selected communities around the country in the coming year.
- We participated in a variety of other events to help build our network of partners and collaborators, along with our intergenerational leadership team. The first Ecosphere Studies postdoctoral fellow began her work in summer 2017 with a research program that includes designing, testing, and coordinating curriculum efforts.

## Recent Publications

**Realizing resilient food systems** | M.E. Schipanski, G.K. MacDonald, S. Rosenzweig, M.J. Chappell, E.M. Bennett, R. Bezner Kerr, J. Blesh, T. Crews, L. Drinkwater, J.G. Lundgren, C. Schnarr | 2016 | *BioScience* 66(7):600-610.

**What Agriculture Can Learn from Native Ecosystems in Building Soil Organic Matter: A Review** | T.E. Crews, B. E. Rumsey | 2017 | *Sustainability* 9:578-595.

**Can Modern Agriculture be Sustainable?** | B. Baker | 2017 | *BioScience* 67(4):325-331.

**Accelerating Silphium domestication: An opportunity to develop new crop ideotypes and breeding strategies informed by multiple disciplines** | D. Van Tassel, K.A. Albrecht, J.D. Bever, A.A. Boe, Y. Brandvain, T.E. Crews, M. Gerstberger, L. Gonzalez-Paleo, B.S. Hulke, N.C. Kane, P.J. Johnson, E.G. Pestsova, V.D. Picasso Risso, J.R. Prasifka, D.A. Ravetta, B. Schlautman, C.C. Sheaffer, K.P. Smith, P.R. Speranza, M. K. Turner, A.E. Vilela, P. von Gehren, C. Wever | 2017 | *Crop Science* 57:1-11.

**SOFIA: An R package for enhancing genetic visualization with Circos** | L. Diaz-Garcia, G. Covarrubias-Pazaran, B. Schlautman, J. E. Zalapa | 2017 | *Journal of Heredity* 108(4): 443-448.

**Development of the first consensus genetic map of intermediate wheatgrass (Thinopyrum intermedium) using genotyping-by-sequencing.** | T. Kantarski, S. Larson, X. Zhang, L.R. DeHaan, J. Borevitz, J. Anderson, J. Poland | 2017 | *Theoretical and Applied Genetics* 130(1):137-150.

**High proportion of diploid hybrids produced by interspecific diploid x tetraploid Sorghum hybridization** | Cox, S., P. Nabukalu, A.H. Paterson W. Kong, S. Auckland, L. Rainville, S. Cox and S. Wang | 2017 | *Genetic Resources and Crop Evolution* DOI 10.1007/s10722-017-0580-7.

## Selected Presentations

**NOVEMBER 2016**
**Association Mapping of Leaf Rust Resistance Loci in Diverse Wheat Germplasm** *Presented by Kathryn Turner* | Jiangsu Academy of Agricultural Sciences | NANJING, CHINA

**NOVEMBER 2016**
**Kernza Perennial Grain: Sustainable by Design** *Presented by Lee DeHaan* | Molecular Plant Sciences Seminar | PULLMAN, WA

**DECEMBER 2016**
**New Advances in the Breeding and Genetics of Perennial Wheat** *Presented by Shuwen Wang* | Jiangsu Academy of Agricultural Sciences | NANJING, CHINA

**FEBRUARY 2017**
**Can a Sustainable Food System be Health-Promoting and Economically Viable and Equitable and Ecologically Sound?** *Presented by Tim Crews* | University of Michigan Food Literacy Speaker Series | ANN ARBOR, MI

**JUNE 2017**
**The Potential for Newly Developed Perennial Polyculture to Deliver Ecosystem Services** *Presented by Tim Crews* | Roots for Sustainability Symposium, University of Copenhagen | COPENHAGEN, DENMARK

**APRIL 2017**
**The New Emergency: Ecosphere Studies and the Future University** *Presented by Wes Jackson, Bill Vitek, and Aubrey Streit Krug* | University of Kansas | LAWRENCE, KS

**JUNE 2017**
**Ecosphere Studies: Recovering Our Membership in "Earth Alive!"** *Panel discussion presented by Aubrey Streit Krug* | Association for the Study of Literature and Environment | DETROIT, MI

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