Land Report

Number 109, *Summer* 2014 · *The Land Institute*

About The Land Institute

MISSION STATEMENT

When people, land and community are as one, all three members prosper; when they relate not as members but as competing interests, all three are exploited. By consulting nature as the source and measure of that membership, The Land Institute seeks to develop an agriculture that will save soil from being lost or poisoned, while promoting a community life at once prosperous and enduring.

OUR WORK

Thousands of new perennial grain plants live year-round at The Land Institute, prototypes we developed in pursuit of a new agriculture that mimics natural ecosystems. Grown in polycultures, perennial crops require less fertilizer, herbicide and pesticide. Their root systems are massive. They manage water better, exchange nutrients more efficiently and hold soil against the erosion of water and wind. This strengthens the plants' resilience to weather extremes, and restores the soil's capacity to hold carbon. Our aim is to make conservation a consequence, not a casualty, of agricultural production.

LAND REPORT

Land Report is published three times a year. ISSN 1093-1171. The editor is Scott Bontz. To use material from the magazine, reach him at bontz@landinstitute.org, or the address or phone number below.

ELECTRONIC MEDIA

For e-mail news about The Land Institute, write to Carrie Carpenter at carpenter@landinstitute.org, or call. Web site: landinstitute.org.

SUPPORT

To help The Land Institute, see the contribution form on page 30, or go to landinstitute.org. Funders receive the Land Report.

TO REACH US

The Land Institute
2440 E. Water Well Road, Salina, KS 67401
phone 785-823-5376
fax 785-823-8728
info@landinstitute.org

Land Report

Number 109, Summer 2014 · The Land Institute

Cover

Nitrous oxide is a potent greenhouse gas that has increased in the atmosphere over the last century primarily because of crop fertilizers. The Land Institute's goal is perennial grains grown in mixtures including legumes – plants that, in consort with root bacteria, can fix atmospheric nitrogen and cut fertilizer use. Will this cut nitrous oxide emissions? Research director Tim Crews and his technician, Laura Kemp, are trying to find out, with plots of Kernza, a perennial grass being developed as a grain crop. Some plots receive synthesized urea, a type of fertilizer. Others are intercropped with alfalfa, a nitrogen fixer. In the picture, Kemp places a ring that will be capped to capture nitrous oxide coming from the soil. For other ways that perennials may curb climate change, see page 10. Scott Bontz photo.

Mark Lostetter and Greg Cuomo, of the University of Minnesota's Rosemount Research and Outreach Center, in one of the fields growing Kernza for Patagonia Provisions and Ventura Spirits. Lee DeHaan photo.

Perennial grain in product R&D

Adventure purveyor Patagonia explores food uses of Land Institute's Kernza

For the first time, one of The Land Institute's perennial grains in development is being grown for possible commercial use. The Ventura, California, adventure clothing company Patagonia is expanding with food products under the name Patagonia Provisions, and hired planting of the institute's Kernza on 80 acres at the University of Minnesota. Patagonia Provisions Director Birgit Cameron said the company is in research and development of products using Kernza. Another 10 acres is being grown for Ventura Spirits, another southern California company, to make whiskey. (Ventura's hopes were covered in the spring 2013 Land Report.)

The two companies are planning to talk with a perennial grass seed growers group in Minnesota about expanding the acreage devoted to Kernza, said Lee DeHaan, the Land Institute scientist who is developing the crop.

Research Director Tim Crews said the Patagonia venture does not mean Kernza is a finished crop plant or that its seed is available, either from The Land Institute or the University of Minnesota. He often receives requests. The eager should realize that Patagonia and Ventura Spirits are essentially buying research. "It's almost a part of the experimentation – it just happens to be on the commercial end," Crews said. "It's not done, and it's not ready for show time. It's just an important step on the path."

Patagonia promotes its products by showing ecological concern. It introduced – or reintroduced, after the rise of pesticides – organic cotton clothes. Recently it has expanded its remediation to what founder Yvon Choinard called a food chain broken by industry. Patagonia Provisions sells smoked wild sockeye salmon from Alaska's Situk River, instead of from the sea, where most commercial fishing is done. Salmon species swim upriver to spawn at different times of the year. River catches allow fishermen to target a specific population. Sockeye is under less pressure than some other species. In the May issue of Men's Journal, Choinard talked of plans for bison jerky and a fruit bar with protein powder from sustainably farmed African baobab trees. He is also interested in a dried soup modeled after a meal he saw while climbing in Tibet. But he said, "I'm not out to make a line of backpacking foods. I want this stuff in every supermarket eventually. I'm out to change the world of food."

Free State Brewing Co. in Lawrence, Kansas, and Boulevard Brewing Co. in Kansas City, Missouri, have experimented with Kernza but are not sustaining commercial production.

The University of Minnesota is a longtime collaborator with The Land Institute, and enjoys a climate that can produce twice as much yield as Kernza in Kansas. The university's Department of Food Science and Nutrition is studying Kernza's food quality and potential. (See the spring 2013 Land Report, and the short on page 9 of this issue.)

Land Institute shorts

Scientist earns fellowship for plants trial in South America

For any crop plant being developed at The Land Institute to find itself not in Kansas anymore may be as odd as Dorothy found Oz. But in a still largely wild plant population there remains great genetic diversity, and some may thrive in new environs. We want to find out which of our crops have the potential to become global crops, grown in many regions and conditions. On a Fulbright fellowship, Land Institute scientist David Van Tassel will explore this in humid Uruguay. He will test populations of his improved perennial oilseed plants from the genus *Silphium*, and colleague Stan Cox's hybrid perennial sorghum plants. He will fly from near 39 degrees north latitude to 35 degrees south for two months during each of the next two Uruguayan summers. His plots of at least 1,000 plants will be on land of the University of the Republic, in the capital, Montevideo. Uruguay is developed and politically stable. Its agriculture is similar to that in Kansas: beef, maize, sorghum, sunflower, wheat. Precipitation is higher. Summers and winters both are milder.

Lack of cold might prove a challenge with *Silphium*, a genus evolved in North America. Some plants might not even flower in the south. To handle plants that do, Van Tassel will need a different selection strategy. His goal with a crop is for all plants to flower and set seed at once. This is a big challenge for developing perennial grains from wild populations with less synchrony. "It would be better to select plants that flower uniformly and predictably in almost any environment, rather than two separate mechanisms, one for places with cold winters and one for mild winters," Van Tassel said. It is better to resolve this now, rather than after the crop is perfected only for Kansas. Growing *Silphium* in Uruguay may allow discovery of genes that can be selected to make the crop most adaptabile. This applies to other traits desirable in a crop plant, such as yield and rooting habit, not just flowering synchrony.

Another North American native, sunflower, has thrived as a crop from Russia to Mozambique. Sorghum came from Africa, and likely will do better in Uruguay than in Kansas.

Van Tassel hopes to not just prove plants in a new place, but also encourage South Americans to pursue development of perennial grains. We have made a similar effort in China, with progress on perennial upland rice. By the second year of growth in Uruguay, Van Tassel hopes to begin making crosses of good, perennial plants, or at least gathering data for future attempts. If a good relationship builds with the Uruguayans, we might be allowed space for shuttling stock between the hemispheres, and fit two plant improvement generations each year.

Live, in New York: Bittman, Berry, and Jackson

In a New York City venue that was scene of historic speeches by Abraham Lincoln and Frederick Douglass, Land Institute President Wes Jackson and writer Wendell Berry talk-

ed with New York Times columnist Mark Bittman before an audience of more than 600. Institute Vice President Josh Svaty was there, and learned from conversation that New Yorkers who had known of the men and their ideas now got to connect in a way that moved them to want to help improve the state of how humans conserve their land and secure their food. "It took inspiration of the event," Svaty said. "This is the exact sort of thing you want to see happen."

Early in the April 4 conversation at The Cooper Union, Bittman asked if the situation for sustainability had grown better or worse.

Plants sprouted in The Land Institute greenhouse are moved outside to make room and to harden them off before transplanting to the field. Formerly, this exposed them to damage by wind, hail, birds, dogs, and rabbits. Movable shelter hoops helped, but made watering difficult and could overheat. All problems were solved this spring by construction of a 650-square-foot shelter of 13-foot-tall steel hoops and plastic sheet. Here Sheila Cox and Kris Boele move seedlings into the "high tunnel." Scott Bontz photo.

Berry said both. It's worse in the sense of a technology and market driven corn and soybean economy continuing to abuse and invade vulnerable land. But he said support and attention paid such public conversation as theirs on that rainy night in Manhattan wouldn't have been imaginable three decades earlier – not even one decade ago. He said that people now understand talk about local food economies and dependence on land. "There is a growing conversation," he said. A video of the interview is being prepared for The Land Institute web site.

Berry Center co-founder Brown joins Land's Board of Directors

Christina Lee Brown joined The Land Institute Board of Directors. She recently co-founded the Berry Center to foster culture that looks to nature as a standard, preserves ecosystems, and promotes human health. She lives in Louisville, Kentucky. Her family's business is wine and spirits manufacturer Brown-Forman Corp.

Recently retired from the board are Anne Simpson Byrne, a management consultant in Seattle, and Lloyd Schermer, a former newspaper executive who lives in Aspen, Colorado, and Tucson, Arizona. Byrne served on the board for seven years, Schermer for six.

165 more acres are donated near University of Kansas

Former electricity utility executive Jim Haines and his wife, Cindy Haines, who last year gave The Land Institute their 19th-century stone house and 65 acres of pasture and woodland, donated another 165 acres that might be used for research. One corner of the land meets a corner of the first spread. The new land is hillier, mostly woods, with some grass. The former Haines properties are near the Lecompton interchange of Interstate 70, just west of Lawrence, home of the University of Kansas. The Land Institute is developing a consortium with the university and Kansas State University to advance perennial-grain development and companion ecological study. A Lawrence group is working to develop a trail through the 165 acres.

John Schmidt, who raised money for 10 years, retires

John Schmidt grew up on a turkey farm in McPherson County, just south of The Land Institute. He's a lifelong hunter. When he learned of our goal of perennial grains grown in mixtures like prairie, he thought, "Why didn't somebody think of this 100 years ago?" He loved the idea because he saw that it would benefit both farm and game. It would reduce pesticides, boost biodiversity, and give year-round cover to both the ground and wildlife.

Schmidt is enthusiastic, and he is outgoing. "I like talking to people," he said. "I like finding out about them, and what makes them tick, and makes them excited." Ten years ago he joined the institute as development director – lead fundraiser. Because he saw many benefits in perennial polycultures, he could promote them to multiple interests. He traveled from Maine to California. There were no cold calls. The job was about going face-to-face, reading body language, and building relationships. He might meet a prospective donor many times before popping the question.

Schmidt loved the work, but he wants to return to Colorado, nearer two children and grandchildren, and where he spent decades in wildlife research and fund raising. He retired June 30. Asked what he'll miss about Land Institute work, Schmidt,

the outgoing man with a strong bass voice, briefly came to tears. "I'm sure I'll always be an ambassador," he said. "There will be a lot of opportunities to bring it up."

Wired magazine story on new crops includes Kernza

The July issue of Wired magazine features a story headlined "How We Can Tame Overlooked Wild Plants to Feed the World," and devotes a fair share of it to The Land Institute's development of intermediate wheatgrass, or Kernza.

Scientist, writer Cox covers wheat for Mother Earth News

Land Institute scientist Stan Cox wrote a two-part series about wheat for the magazine Mother Earth News. The February-March issue covered wheat history, varieties, and their comparative nutritional value. The April-May issue told how to grow, harvest, and process wheat in small plots. Since 2000, Cox has been developing perennial sorghum for The Land Institute, but before that he bred wheat.

Analysis of Kernza in breads wins at Minnesota science fairs

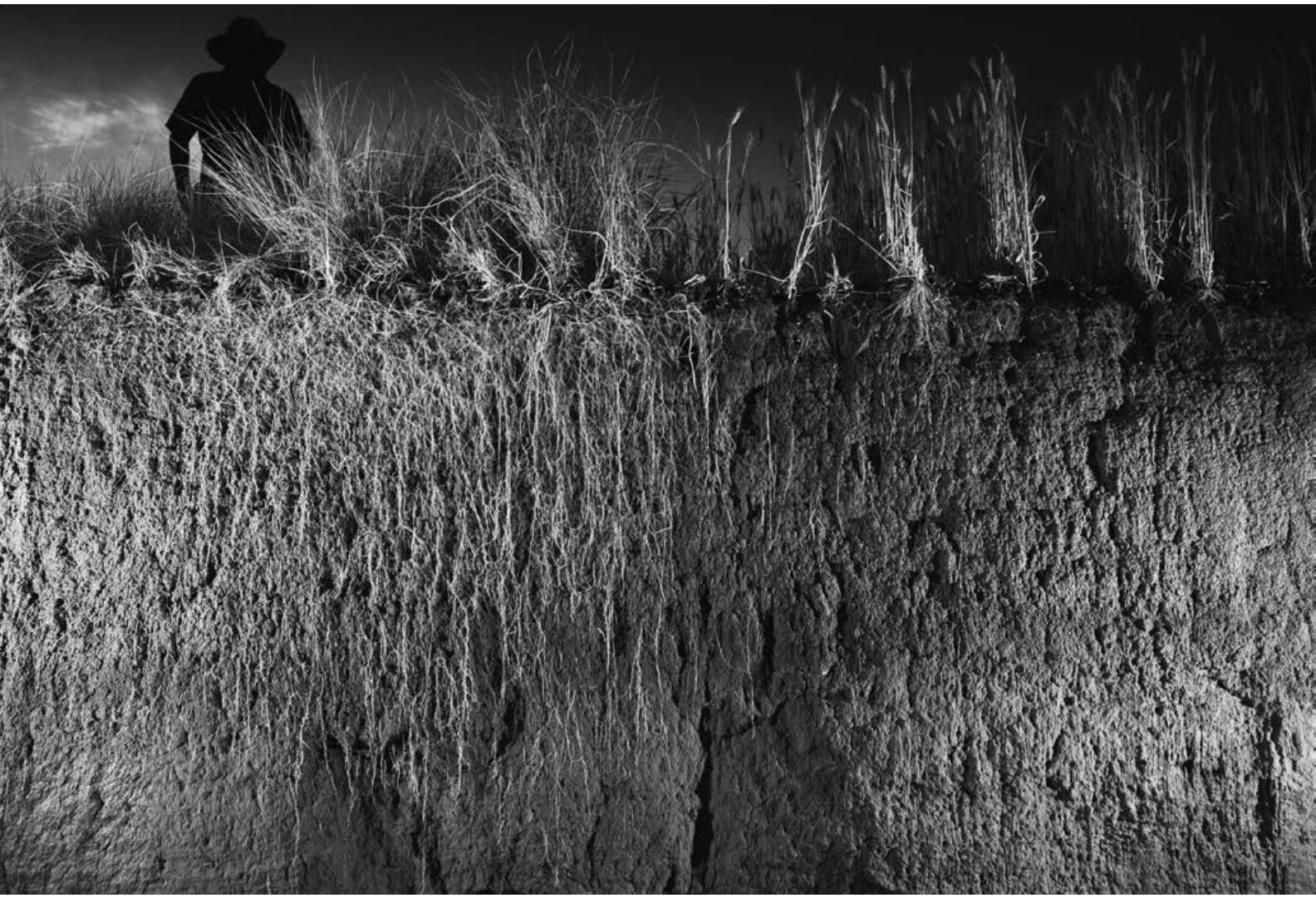
A Minnesota high school student won at the Minneapolis-St. Paul region science fair by testing one of The Land Institute's grain crops in development, Kernza, for making leavened bread, flatbread, and pasta. Heather Joy Stone was a senior at Mounds View High School in Arden Hills. Her adviser was Tonya Schoenfuss, a scientist at the University of Minnesota's Department of Food Science and Nutrition. (For a story about Schoenfuss's work with Kernza, see the spring 2013 Land Report.) Stone had won an internship in the department lab. She assisted a graduate student in analyzing Kernza's starch content, said she was enthralled by the perennial's prospects as a grain crop, and arranged her own experiments. She found that Kernza made pasta with better volume, but was harder to handle than wheat dough. Kernza had superior volume and moisture retention than traditional flour in flatbreads. Leavened Kernza rose more like banana bread than like airy wheat loaves, but Stone said that this is outweighed by the benefits. She hoped to see Kernza make its way into bread products around the world and help reduce malnutrition. She plans to attend the University of Minnesota, majoring in both Food Science and Nutrition, and community development.

UN organization's book about perennial crops is online

In August 2013, three Land Institute scientists and other researchers met in Rome to tell officials of the United Nation's Food and Agriculture Organization about developing perennial grains. The reports are available in a book online. It is titled "Perennial Crops for Food Security," and can be downloaded by going to fao.org, clicking on "Publications," and entering the title. There is also a printed book.

Land Institute staff will speak in Colorado and St. Louis

Land Institute staff members are scheduled to speak on August 6 in Crested Butte, Colorado, and November 14 in St. Louis. For more information, call 785-823-5376. In recent months staff members spoke in Iowa, New York, Georgia, California, Nebraska, and the Washington, DC, area.



The roots of Kernza, left, reach deeper and thicker than those of wheat. Wheat and the plow have given up soil carbon to the atmosphere as global-warming carbon dioxide. Perennials crops like The Land Institute's Kernza should be able to restore at least a couple of pounds of carbon per square meter of soil. Photo by Jim Richardson. See jimrichardsonphotography.com.

Perennial crops and climate change

Longer, livelier roots should restore carbon from atmosphere to soil

BRIAN RUMSEY

By nearly any measure, dealing with climate change appears to be one of the greatest challenges humanity will face in the coming decades. Many of Earth's species have lived through drastic climate fluctuations in the past, and while the coming changes will likely be traumatic, life on Earth will probably endure. Human societies, however, have developed in a tiny window of geologic time that has been remarkably stable climatically. We have no experience with climate fluctuations on the magnitude of what are expected based on increasing concentrations of atmospheric greenhouse gases. Our historical experiences with much smaller fluctuations suggest that we are going to have our hands full.

While it seems like most of the news about climate change is bad news, my intent here is not to add to that depressing litany. Granted, the political will to meaningfully address climate change often appears to be desperately lacking. The good news is that the steps needed to address the coming challenge are pretty clear. Which is worse, a problem with daunting but obvious solutions, or one that we cannot even understand how to solve? The history of science is full of problems with inconceivable solutions: how to control infectious disease prior to the germ theory, how to breed plants or animals for certain traits prior to Mendelian genetics, and how to explain changes in Earth's surface before the theory of plate tectonics, to name just a few. For climate change, plenty of research remains. But we have a good sense of the basic problem and what people can do about it. We can limit atmospheric greenhouse gas concentrations, and we can prepare for a world that is less stable climatically. Both types of preparation are imperative, and the work of The Land Institute can contribute to both. Here I will focus specifically on the ways that The Land Institute's goal of perennial grains grown in mixtures – as opposed to the conventional agricultural practice of annuals grown in monocultures – can help reduce concentrations of the gases that are driving climate change. These gases, including carbon dioxide, nitrous oxide, and methane, retain solar heat when present in the atmosphere. Their presence is necessary to maintain conditions needed for life on Earth, but human activity is driving the atmospheric concentrations of these gases to levels that threaten to upset the relative climatic balance of the past several thousand years.

Although there are reasons to think that perennial crops, and especially perennial polycultures, will be more resilient than annual monocultures in the face of climatic extremes, The Land Institute's study of

> "Virtually all of the added carbon dioxide entering the atmosphere was once carbon sequestered beneath Earth's surface."
>
> *Brian Rumsey*

this is just beginning. Better understood is how perennial crop species might help curb greenhouse gas emissions, especially carbon dioxide. Carbon dioxide is one of the most important greenhouse gases, and because of human activities, its atmospheric concentration has increased by almost 50 percent in the past three centuries, with about three quarters of that increase happening since 1950. Per molecule, nitrous oxide and methane are much more powerful greenhouse gases, but they are so much less concentrated in the atmosphere that their total effect is less than that of carbon dioxide

But why do we look toward agriculture for ways to rein in runaway greenhouse gases? Everybody knows that climate change is being driven by increased burning of fossil fuels, right? Well, yes, fossil fuel combustion is the leading source of greenhouse gases. In the 21st century, nothing else is even close. Farming contributes a modest, though not negligible, fraction of these combustion emissions. But there are other ways that greenhouse gases enter the atmosphere. Consider the sizes of various global carbon reservoirs. The atmosphere now holds over 800 gigatons of carbon as gaseous carbon dioxide. One gigaton is 1 billion metric tons. While this sounds like an enormous number, all of that carbon in the miles of atmosphere above our heads is barely more than a third as much as the 2,250 gigatons that can be found in the first few feet of soil below our feet. The world's oceans hold even more carbon, and like the atmosphere, they are a net sink of surplus carbon emissions, meaning that they absorb more than they emit. This does help blunt the climatic impact of elevated carbon emissions, but the oceans are not an ideal repository for surplus carbon. Increased carbon dioxide levels are driving their acidification, which harms marine ecosystems in a variety of ways, most notably by damaging calcium-rich organisms like coral and mollusks.

Soils are different. Virtually all of the added carbon dioxide entering the atmosphere was once carbon sequestered beneath Earth's surface. Much of this is in the form of fossil fuel deposits, many of them deeply buried. A significant amount, though, comes from that 2,250 gigaton reservoir in the top three feet of soils—and especially the organic part of that reservoir, which amounts to about 1,550 gigatons. The boundary between this reservoir and the atmosphere has always been a porous one. Prior to agriculture, soil carbon reservoirs were more or less at equilibrium with the atmosphere. Over the long term soils gained carbon from plant inputs and lost it to microbial decomposition at roughly equal rates.

Farming upset this balance. Soil tillage exposes previously protected carbon to decomposing organisms, warmer temperatures, and erosion. Bare, fallow fields are especially troublesome, but even fields under farm crops usually lose organic carbon. Annual monocultures often have lower overall levels of net primary productivity – the sum of plant growth minus plant respi-

ration, or the annual addition of biomass per area of land – than uncultivated prairie and forest. What all of this means is that farmland usually loses more carbon to the atmosphere as carbon dioxide than it retains in soil organic matter, leading to a net increase in the atmosphere's heat-trapping ability. On the bright side, it also means that agricultural soils have ready potential to serve as carbon sinks. What's more, unlike in the cases of oceans or the atmosphere, higher carbon levels in soils are desirable. Most soil carbon exists in the form of organic matter, which benefits a soil's fertility, water-holding capacity, and physical structure.

Carbon that is locked away, unavailable to enter the atmospheric pool, is called sequestered carbon. This sequestration can occur chemically, via molecular bonds, or with a physical barrier. In soils, both types of carbon sequestration are at work.

Agricultural soil carbon sequestration is not a panacea. Soils cannot sequester infinitely high levels of carbon. Each has a carbon equilibrium point determined by the plant growth it supports, its physical qualities, and climate. Though some studies have reported higher total sequestration potentials under certain cropping practices, it is wise to expect that soils cannot sustainably sequester higher levels of organic carbon than they did before they were farmed. In general, if carbon is added to soils by processes that require direct human intervention, that carbon can be expected to decompose and return to the atmosphere once management ceases – though some forms of carbon do have much longer soil residence times than others. Composts and manures can provide important agronomic benefits besides carbon enrichment, but for long-term carbon storage, their potential is limited. Biochar – essentially charcoal that is used as a soil amendment – has a longer soil residence time, but its agronomic benefits are less uniform than those of composts and manures. Irrigation and synthetic fertilizers also boost plant growth, in turn elevating soil carbon inputs, but raise concerns about aquifer depletion and nitrous oxide emissions, respectively. Each method for enhancing soil carbon sequestration presents its own questions and challenges. But, by mimicking natural ecosystems, perennial polycultures should prove to be less problematic than most.

Plants are the primary avenue for atmospheric carbon dioxide to enter soils as sequestered organic carbon. Via photosynthesis, plants convert carbon dioxide and water into sugar and oxygen. The sugar produced in photosynthesis is used by plants both for energy and for creating new plant material, which is rich in organic carbon. When aboveground plant material dies, some portion may find its way into the soil and thereby add carbon. A much greater proportion of soil organic carbon comes from plant roots. This happens both in life and in death. As they grow, roots exude carbon compounds at their growing tips. More importantly, when roots die, they remain in the soil, less accessible to decomposing organisms than aboveground plant matter. This happens when entire plants die, but individual roots also die, even on healthy plants. Thus, soil carbon sequestration does not depend on plant death.

Accurately measuring soil carbon can be difficult and expensive, and The Land Institute is just beginning to collect robust data from its plots. Knowing how perennial crops now under development will affect soil carbon sequestration will require measurements across a wide range of soil and climate conditions. In the meantime, data from a range of similar farm practices aids in producing some high-confidence estimates

of how much soil organic carbon perennial polycultures can potentially sequester.

Some of the best available analogs to the crops under development at The Land Institute can be found in perennial biofuel crops. Already the subject of intense, global research and development, these crops are poised to explode into large-scale cultivation. This is being driven by second-generation biofuel production technology that will use not just seeds, which generally are inefficient biofuel sources, but biomass from feedstocks including perennial grasses. One of the major selling points of second-generation biofuels is their enhanced potential to reduce greenhouse gases. There is a solid body of research into their soil carbon sequestration. A recent model suggests that cultivation of *Miscanthus*, a perennial grass and promising second-generation biofuel feedstock, could result in annual carbon sequestration rates of 16 to 82 grams – about half an ounce to nearly 3 ounces – of carbon per square meter in the United States, with the upper end of that range found in the humid East and the lower end found in the arid West. This projection takes into account both increased biomass production, above and below ground, and elimination of tillage.

More than any other agricultural practice, tillage has gutted soil of organic carbon. Globally, soils lose about 30 percent of their original carbon content after conversion to cultivation, and in some instances up to 70 percent. Each time the soil is tilled, formerly protected carbon is made accessible to organisms that decompose it. Tilled soil is also generally warmer than untilled soil, because it is darker than soil covered by plant residues, and darker colors absorb more heat, and higher temperatures speed up the decomposition of organic carbon.

One of the most studied farming techniques of recent decades is no-till. Although no-till's popularity is due mostly to other benefits, especially decreased erosion and reduced need for labor and fuel, it also sometimes helps keep more carbon in the soil. Popular reviews peg the annual benefit at 30 to 57 grams per square meter. Recent research has cast some uncertainty on this. Some – but not all – experiments have shown that soil carbon levels decline under no-till below the usual testing depth of 30 centimeters. This may happen because untilled soil is usually cooler, more resistant to penetration, and more dense – all of which decrease root growth. In recent years, techniques for measuring soil carbon have also improved, revealing some of the supposed carbon gains brought about by no-till to be illusory. Further, research shows that even infrequent tillage can cause major soil carbon losses. One study found that a single tillage event released an amount of carbon that would have taken eight years to accumulate under no-till, based on a annual sequestration rate of 30 grams per square meter. Fortunately, perennial polycultures have great potential to address no-till's shortcomings. Exactly how perennial grains will be tended is not yet known, but one can expect tillage to be vastly reduced. Perennials produce much more vigorous and extensive roots than annuals do, which should make deep root development less of a concern than it is for annual crops under no-till.

Another useful sequestration analog is grasslands. The prairie serves as an inspiration for what The Land Institute is trying to create: a productive, perennial polyculture. Fields of mixed perennial crops may never quite equal the biodiversity and net ecosystem productivity of uncultivated prairies, but they are expected to function more like prairies than do today's monoculture fields of crops like corn, wheat, and soybeans.

Undisturbed grasslands are typically at carbon equilibrium, and are most usefully thought of as long-term goals rather than as analogs for what can be accomplished quickly. Prairie restoration projects are especially helpful in thinking about perennial polycultures, because getting to each will be a similar process. A well-respected review of cropland that is being restored to prairie via the Conservation Reserve Program found an average sequestration rate of 33 grams of carbon per square meter per year.

To arrive at a useful estimate of how much soil carbon could be sequestered by perennial polycultures, one must answer two key questions: how much carbon can be sequestered per area, and how much land can be planted to perennial polycultures. As for the former, given review of no-till, prairie restoration, and perennial biofuel crops, an estimated sequestration rate of 30 grams per square meter per year is realistic and conservative. Some of the higher figures cited here must be taken with a grain of salt. With the new analyses of no-till, older claims as high as 57 grams per square meter or higher warrant caution. In the *Miscanthus* model, rates near the upper limit of 82 grams were only projected in isolated areas. As more data become available, especially data from The Land Institute's plots, perhaps the estimate will be revised upward. But the justification is not there yet.

For where perennial polycultures could take hold, one can think big, envisioning a world where all suitable annual crops have been replaced by perennials. These annuals include all cereals, pulses, and cotton, plus several oilseed crops. The total area taken by these crops in 2012 was about 2.5 billion acres. Looking at the soil organic carbon levels in the countries growing these crops, those 2.5 billion acres should eventually be able to sequester an average of 1,193 grams – 2.6 pounds – of carbon per square meter under perennial polycultures. With an average rate of sequestration near 30 grams per year, this suggests benefits would be seen for almost 40 years. Such projections are not an exact science, but this duration falls within the 25- to 50-year window of maximum benefits that have been calculated for some of the agricultural analogs discussed above.

In total, perennial polycultures should be able to sequester at least 12.6 gigatons of organic carbon in soils. This amounts to almost 6 percent of each year's net global carbon emissions from all sectors, at current emission levels. This may not sound like a lot, and it pales in comparison to the 100 percent offset that some writers have suggested agricultural soil carbon sequestration might achieve. But looking at the science, projections of soil carbon sequestration rates approaching 100 percent offsets rely upon radically different techniques or understandings that either fall apart at global scales, or are lacking in large-scale experimental results. While 6 percent might seem small, it represents a robust tool among many that will be needed to control atmospheric carbon dioxide. Further, this estimate is based on making careful assumptions whenever uncertain, and if some of the numbers used here turn out to be overly conservative, the figure could easily jump to 10 percent, or even more, of annual emissions offset.

Carbon certainly isn't the last word in climate change. It is harder to project how perennial polycultures might affect nitrous oxide emissions, which are less thoroughly understood even in analogous cropping systems. Since perennial polycultures will need less potent applications of synthetic fertilizer, because of nitrogen fixing by legumes, it makes sense that they would emit less nitrous oxide than conventional monocultures do. But The Land Institute does not

We don't see the carbon dioxide that we add to the atmosphere, which helps explain why we don't cut back. Here is a pinch of the tonna
2005 still used coal-fired steam locomotives. Each pound of carbon burned combines with oxygen to make 2 2/3 pounds of carbon dioxide

ge, one coal mine in Inner Mongolia, which in e. Photo by Scott Lothes. See scottlothes.com.

yet have experimental results of its own, and the scientific literature does not currently offer much consensus. It also seems likely that perennial polycultures can help reduce methane emissions, especially in rice. Perennial rice is expected to require less flooding for weed control, and flooding of rice cropland is a major methane source.

Suggestions for purging the atmosphere of excess carbon dioxide range from those that seem inspired by science fiction, like injecting the gas into deep geological cavities, to practices centuries if not millennia old, like incorporating charcoal into soil. We will need all available tools to confront ever-increasing greenhouse gas concentrations. Perennial crops and particularly perennial polycultures are an especially exciting line of research. Since the goal of perennial polycultures is to mimic rather than replace natural ecosystems, the carbon they sequester can be kept out of the atmosphere indefinitely, while improving soil quality, with minimal ongoing intervention required. Of course, a return to actual natural ecosystems would produce similar results with even less human intervention – but therein lies the catch. Nothing near Earth's current human population could survive on the productivity of natural ecosystems. A return to ecosystems unmodified by human action seems likely only in the face of a catastrophic failure by humanity to meet the challenges ahead. As we place perennial polycultures into our collective toolkit, we hope those challenges will become increasingly manageable.

The writer is a doctoral student in environmental history at the University of Kansas, with research interests in climate change and environmental risk. He spent the spring 2014 semester working with Land Institute scientist Tim Crews researching the climate mitigation potential of our work.

Leaf Skeleton, 22 x 30 inches, mixed media, by Mary Kay, who will show September 26-28 at the Prairie Festival.

Prairie Festival

"Christian monk, Biblical scholar, India critic, scientific rationalist, Whiteheadian philosopher, historian of Russia, wildlife conservationist – that's the lineup for Prairie Festival 2014," Wes Jackson said. "Their challenge: what does your passion or knowledge have to offer with the need to protect our ecosphere?"

The festival will be September 26-28 at The Land Institute, Salina, Kansas. In the following eight pages are stories by editor Scott Bontz about three festival speakers: scientist Ted Burk, theologian Ellen F. Davis, and philosopher Willam Vitek. Other scheduled talks: historian Ken Levy-Church on lessons from the radical agrarian politics in tsarist Russia; artist Priti Cox on modern India and its oppressed castes and classes; entrepreneur Kristine Tompkins, who has bought for preservation 2.2 million acres in South America; Benedictine monk David Steindl-Rast, a leader of the gratitude movement; and Land Institute President Wes Jackson. Artist Mary Kay will show. (See opposite page.) The festival features a barn dance Friday night. Singer-songwriter Chuck Pyle, known as the Zen Cowboy, will perform Saturday night. Singer Ann Zimmerman plays Sunday morning. Primitive camping is available. For more information, or to register, click the Visit tab at landinstitute.org or call 785-823-5376. Schedule and updates appear on the Land Institute web site calendar.

Three paths, one ethic

Practical, emotional, and obligational perspectives all can lead to care for nature

Ted Burk studies the behavior of animals, especially of insects, though his concerns reach further. He has watched how cockroaches navigate and move by chemical signals, and how fruit flies and crickets sing for sex. In science journals he has written articles like "Dominance hierarchies and the evolution of individual recognition." He also writes for lay readers, in essays such as "What good is a bug?" and "Fly-witness testimony," a description of forensic scientists measuring decay by maggots to help solve crimes. Looking past insects, he has the stories "Plagues are as certain as death and taxes," "Darwinism at a Jesuit university," and the wryly titled "Sexual selection, feminism, and the behavior of biologists." More broadly yet, he observes that humanists, who consider man as the measure of all things, get in bed with God-fearing fundamentalist Christians, both seeing the earth simply as

a commodity source, while other odd partners see it as a community, in which they are only a beholden part. Politics seems to matter less than the perception of relation to nature. What explains the difference? Is it acculturation, or narrow focus? Scientist Burk, who taught a course called "The Moral Animal," said, "I don't know." But at The Land Institute's Prairie Festival September 26-28, he will examine how believer and nonbeliever alike can arrive at the same ethic for how to behave toward the land.

Burk, a Kansas native and professor at Creighton University in Omaha, Nebraska, earned his doctorate at Oxford University under Richard Dawkins. Since then Dawkins has written books, including "The Selfish Gene" and "The God Delusion," that make him what Burk called the world's most famous atheist. Burk already had his empiricist views. (He described Dawkins as brilliant, narrowly focused, and not a very good doctoral adviser.) But the connection helped him to be invited as the scientific skeptic to a festival where other speakers are to bring to land ethic discussion their philosophical and theological perspectives.

Ted Burk

Creighton is a Jesuit school. Burk has written, and talked in an interview, about how the Catholic Church stumbled toward acceptance of evolution. For a century after Charles Darwin published "Origin of Species," there were camps of push and pull that made the church appear ambiguous. It didn't ban "Origins," but it did go after Darwin's "Descent of Man." By the 1950s evolutionary biology was considered a legitimate field, if not with ringing endorsement. By the 1970s acceptance was unambiguous. It became clearer yet in the 1990s, with Pope John Paul. Burk said the church, especially the Jesuits, have sought to bring faith and reason together. He faces no restriction. "I'm just supposed to teach biology, and leave theology to the Jesuits," he said.

Burk doesn't see a religious sense of stewardship toward land as invalid, but only as a different outlook leading to the same conclusion he reaches for need of work toward conservation and sustainability. He said that this idea of different paths to the same peak is not new. Southern Baptist-turned atheist scientist E. O. Wilson has sought a convergence in works such as his book "The Creation."

Burk said he will lay out at the Prairie Festival three kinds of reasons for developing a land ethic. One is the purely practical. For this, science has an easy role. It shows that we need healthy ecosystems to maintain our own health, for clean water, soil conservation, and the like.

Then there are emotional reasons. For this the believer can play an obvious part. But so can the nonbeliever. Again citing Wilson, for his idea of "biophilia," and Gordon H. Orians, for seeing our love of open spaces interspersed with trees harking back to our origin on savannah, Burk said that as part of our evolved nature, we have an emotional, psychological need for natural landscape. Just as do stewards citing Scripture, "We have the same sort of emotional commitment to the land. We want facts, but we're not devoid of passion."

Burk's last reason is the obligational. We owe something to the next generation. "Unless you believe the second coming is tomorrow," he said.

A sense of obligation will take better appreciation of unanticipated consequences. Burk is a member of the Xerces Society for

Invertebrate Conservation, named for a vanished butterfly. He said that in 20 years the population of monarch butterflies east of the Rockies has plummeted 97 percent. It is not exaggeration to claim monarchs as the passenger pigeon of our day, he said. Habitat destruction and hunting took the passenger pigeon from a population of billions, moving in flocks that could darken the sky for hours, to extinction in September 1914, 100 years to the month before this year's Prairie Festival. Why has the monarch fallen? Partly because of habitat loss in the Mexican winter grounds. But Burk largely blamed glyphosate herbicide and the loss of 85 percent of milkweed, the butterfly larvae's only food, in and around United States corn fields. "A world without monarchs probably isn't going to have any economic effect on us at all," Burk said. But he said it would be a "great crime." "Wonderful" and "incredible" is how he described the animal's annual passage through four generations in 2,000 miles of migration between American farmland and a mountain in Mexico. "If that can't inspire you …". He made an appeal both emotional and obligational. "It would be a sad, sad world … if my grandkids grew up in a world without monarch butterflies." In the short term we can't expect farmers to quit glyphosate, he said. "But in the meantime, we need everyone to plant all the milkweed we can."

Two years ago monarch butterflies still fed from sunflower in development as a perennial crop at The Land Institute. But their population has plunged while glyphosate herbicide kills their larvae's only food, milkweed. For Ted Burk, such unintended consequences are among many reasons for a land ethic. Scott Bontz photo.

The Land Testament

The Bible is old agrarian literature with fresh perspective for our problems

At Yale University, Ellen F. Davis was teaching a yearlong course on the Old Testament. A graduate student who was helping her prepare an exam said, "You need to ask a question about land." She wondered why. "You mention it in every single lecture," he said. Davis began paying attention to something she hadn't been taught in graduate school, though the Bible is thick with it. "You can't go more than a page or two in the Old Testament without coming across mention of the land, or food, or water, or farm animals," she said.

Ellen Davis

In her development of a "biblical theology of land," she also connected the situation of the Israelites, almost all of them farmers, and repeatedly struggling with political powers, to modern conflicts over land, food, and power. "The Bible mostly comes from a society, or societies, in economic transition, and for many, severe economic straits," Davis says in the draft of a talk scheduled for The Land Institute's Prairie Festival September 26-28. She calls the Bible the most fully developed collection of agrarian literature before 50 years ago.

At the Yale library she explored the soil science section, and on one spine found indication that the title writer understood what the Bible was talking about: "Meeting the Expectations of the Land," edited by Wes Jackson, Wendell Berry, and Bruce Colman. When Jackson, president of The Land Institute, came to lecture at Yale's Forestry School 19 years ago, Davis sat in. "I can't even tell you what it was about," she said. "But it made perfect sense to me."

Davis now teaches at Duke Divinity School in North Carolina. Her subjects include standard material: the Old Testament and Hebrew. But her job title, created for her by Duke, is Amos Ragan Kearns Distinguished Professor of Bible and *Practical* Theology – emphasis added – and she seeks to address the question about a text that is millennia old: "What difference does it make?" She won't call the Bible "relevant," which she considers phrase cadging to decorate an argument made in other terms. "Rather, my point is that the Bible helps us see things in a way we might not otherwise do," she says. "It opens up new dimensions of our thinking and thus might prove to be indispensable as a source of fresh approaches to urgent matters."

The King James version of Psalm 23 has the poet lie down in green pastures. Davis says the Hebrew is more direct: they are *grassy* pastures. Grass is food for sheep. The psalm puts us in their role, needful and in this case blessed. In her talk Davis will explore this further, along with how the Bible is "relentlessly realistic" about the human

situation, including that first eating violation, and how it draws our lineage all the way back to the land, which is not an "it," not a commodity, but a covenant partner. Churched and unchurched alike can gain by looking at this literature from 2,000 to 3,000 years ago, Davis said. It focuses on what it is to be human, "a uniquely knowing creature in a world we probe and manipulate and change, but do not, cannot control."

To convey this kind of insight Davis has written books including "Scripture, Culture, and Agriculture: An Agrarian Reading of the Bible" and "Getting Involved with God: Rediscovering the Old Testament." Her working title for the Prairie Festival is "Land as Kin: Renewing Our Imagination," allusion to the Bible repeatedly showing that land is humanity's ancestor. Adam was created from the fertile soil, *adamah*.

"The Bible can be helpful because it is imaginative literature in the strongest sense," she says. By this kind of imagination she means intellectual faculty for serious relation to anything not completely known or deducible from observed fact. Not the imagination of fantasy or "airport novels," but stock of our culture, and appealing to our intellect. It is also hard work. Davis said she asks her classes of up to 175 beginning students if they were ever warned that to read the Bible well is difficult. "Almost no hands are raised to that question," she said. "In most cases they came to seminary because someone thought they were a nice person."

Land, water, and livestock permeate the Bible with food for thought today, Ellen Davis says. Scott Bontz photo.

Like food, like philosophy

Producers of both work creatively at system foundations, and feed us

Bill Vitek believes people come to The Land Institute's annual Prairie Festival because, under a world-changing juggernaut, they are desperate. They want signs that not all is lost. "They're hungry for hope," he said. They find some of their inspiration in The Land Institute's work to develop an agriculture that works more like a natural system. Vitek says they can also find hope in philosophy, where there is ongoing development of a system that also cues from nature. He'll lay this out at this year's festival September 26-28. He sketched it in an interview.

Bill Vitek

Vitek, who teaches philosophy at Clarkson University in far northern New York, dairy country, said philosophers and farmers are alike. Farmers are confident they can provide more than themselves with food. Philosophers are confident they can feed others ideas. Philosophers and farmers also both work at system foundations. So their effects are radical – things like creation of civilization, and elevation of individual over community.

Vitek thinks Prairie Festival-goers would agree the current system for how we interact with the natural world, as something to be subdued or ignored, is proving a failure. He thinks correction requires more than statutory adjustments. "We must go back to the roots to have a real foundational change," he said. In farming this may take replacement of the predominating annual monocultures with perennials grown in mixtures, like most natural ecosystems. In philosophy it entails recognizing that the creativity that feeds us is shot through these systems, and that it is not sustaining if we try too hard to reduce and tame it.

"Walking" was an essay that Henry David Thoreau first gave as a lecture in 1851, predating The Land Institute's start by a century and a quarter. Here is where Thoreau says, "In wildness is the preservation of the world." Vitek sees this as the beginning of a foundational shift, where philosophy starts toward a system that is ecospheric, recognizing the entire world as a system, one that is productively integrated. Heraclitus in ancient Greece and Baruch Spinoza in 17th century Holland saw more this way. But their ideas did not prevail against the scientific and philosophical ones of Spinoza's near contemporaries Francis Bacon and Rene Descartes, which brought about a reductionist, mechanistic worldview, and relinquishment of the greater good to the self-sufficient "I." Here, not with industrialism and fossil fuel, is where the modern world and its problems began, Vitek said. It is against this that Thoreau threw down the gauntlet, and since his challenge, science and philosophy have built on his view.

Thoreau didn't say "wilderness." He was not so concerned with place as with

process. This process is the creativity in the natural setting that we called wild. It is also in each of us, and in our cultures. Vitek said that in his Prairie Festival talk he will tie Thoreau's wildness to Alfred North Whitehead's "philosophy of organism," where every element of nature, down to the smallest amount of energy, in quantum mechanics, is alive and open to a kind of choice. Nature's creativity lies in these moments of freedom in all things, and over eons it creates diversity. From one element there develop 100, from one species millions; new properties like consciousness emerge; agrarians come to research perennial grains; and Bill Vitek comes to trade in ideas and plays jazz piano.

Wildness – what Whitehead calls "the creative advance" – produces new forms and tries them out, in nature and in our human systems. "In nature, think of the myriad species of plants and animals, and the ever-creative flu virus," Vitek said. "In human systems think capitalism versus feudalism, or the call for an ecological economics coming out of our academic institutions."

In each of these systems there is a balance between stability and change. Vitek said humans have become adept at managing systems for their own benefit. By the 19th century, Thoreau already saw the replacement of a wild creativity with bureaucratic sameness, technological efficiency, artificial inputs, and a pursuit of happiness

Starting indoors thousands of Silphium plants from the sunflower family, each with a pedigree, and then transplanting them to the field requires studied coordination. So will growing them along with other perennial species in a farm that mimics prairie, for a new agriculture. The larger culture that agriculture works within is coordinated by philosophy, Bill Vitek says, and if we radically change that thinking, we can change our way with the world for the better. Scott Bontz photo.

that produced "quiet desperation." Aldo Leopold saw this replacement, too, and described it in his essay called "Odyssey." He follows an atom picked up from limestone by an oak root and cycling through organisms for countless generations in the time of bison and prairie Indians. After arrival of the plow and rending of a system built over millennia, he watches another atom trip in one century from bedrock to sea bottom, lost for further creativity.

Vitek doesn't want to simply say that wild is good, stability is bad. He sees that culture needs some tameness. But he said the failure of our current worldview largely is its "lockdown-ness." It is too reductive, constrictive, and controlling, which finally stifles creativity, limits options, and increases misery. An option is to humbly go with a wild flow that we can learn from but never fully understand, and which finally cannot be tamed. "We need to allow ourselves to be surprised," said Vitek, who, with Land Institute President Wes Jackson, edited a book called "The Virtues of Ignorance." For a culture to succeed it must let natural or ecospheric wildness work, Vitek said. "Whether in ecosystems or social systems, we need to keep that wildness network open." This idea is beginning to seep into the social and natural sciences, he said. He thought perennial agriculture furthest along. Medicine is recognizing that many of the bacteria that outnumber the cells in our bodies 10-to-1 aren't there to make us sick, but to make each of us a biome. Even thinkers in industry are modeling processes and products after natural organizations. Vitek said it might be years before politics follows, however, and ecospheric philosophy has far to go before it permeates the material culture.

Transformation of worldviews took centuries after Bacon and Descartes planted their ideas. "World views die hard," Vitek said. Whitehead thought that they might wreak their worst damage while they linger awaiting replacement. But there is precedent for worldviews more ecospheric, among people without agriculture. And the current atomizing of relations is propelled by fossil fuels, which even some proponents of global capitalism are recognizing as dangerous to the human economy. A June 24 report produced by a bipartisan group of former Cabinet officers, lawmakers, corporate leaders, and scientists says climate change could cost the country billions of dollars over the next two decades.

So the time might be ripe for firming up a responsive "coordinating philosophy," as Whitehead called it. Every culture has a coordinating philosophy, whether its members see it or not, Vitek said. One example is monotheism. Another is global capitalism. Vitek said that without such a deep address, changing light bulbs or the law or policies will have limited effects. "Until we get a coordinating philosophy that undergirds our emerging ecospheric worldview, we're not going to get much progress. Food and philosophy go together, if we're talking about transformation."

He said the good news is that with the work of Thoreau, Charles Darwin, Whitehead, Leopold, and other scientists and thinkers, including James Lovelock, who called the entire planet one organism, we already have some of the basic ingredients for a transformative ecospheric philosophy. "The work is largely invisible in our everyday lives, and this will have to change," Vitek said. "But when a new creative form catches on, transformation across sectors can quickly follow." He sees the new work vying for the lead in both agriculture and coordinating philosophy in coming decades. He calls it the "perennial imagination."

Thanks to our contributors

GIFTS

These friends made donations during January through May.

Stephen Adams · Agri-Dynamics Inc. · Gena Akers · Emily Akins & Sergio Moreno-Denton · L. S. Allen · James Alwill · Kristin & William Amend · Angela Anderson · Christopher Anderson & Suzan Fitzsimmons · Anonymous · Blythe & Hannah Ardyson John Armstrong · James & Mary Ann Arnett · Alan Arnold · Craig Anthony Arnold · Stefanie Aschmann · Bruce Bacon · Julene Bair · Bakewell Family Fund · Marian Bakken · Matthew & Erica Bakker · Lawrence & Mary Baldwin · William & Terry Baldwin Kathy Baldwin-Heitman & Buster Heitman · Baltimore Community Foundation · Gregory Bamer · Robert & June Bargar Andrew Barker & Ana Ruesink · Robert & Charlotte Baron · Robert Barrett & Linda Atkinson · Basalt Foundation · Ruth Basney Jonathan & Sarah Baum · John & Letitia Bayer · Eugene Bazan · Diane & William Beachly · Roger Beck & Eric Anderson · George & Katherine Beggs · Chuck Beile & Laura Hampton · Stephen & Judith Bemis · Carolyn & Roger Benefiel · The Benevity Community Impact Fund · Bennington State Bank · Charles Benscheidt · Daniel Berg · Edward Berg · Don & Helen Berheim Greta Bernatz · Dale Berry · Chris & Mary Bieker · Edith Bingham · Bingham Family Charitable Trust · George & Marie Anne Bird Harlan Bjornstad · James Black · Blackie Foundation · Keith & Mary Blackmore · Steven & Jane Blair · William & Dianne Blankenship · Peter & Eleanor Blitzer · John & Gretchen Blythe · Charles & Dianne Boardman · Patrick Bohlen & Julie Mitchel Robert & Sharon Bone · Deborah Borek & David Jenkins · Steven Borgelt · John & Rosanne Bornholdt · Jeff Bowen & Mary Beth James · Lloyd Brace · Charles & Ann Bradford · Marjorie Braker · Edward Braun & Jean Krusi · Lois Braun · Linda Bray · Sheryl Breen · Jill Bremyer · Gordon Brennfoerder · J. Ford & Diane Brent · Ronald & Judith Britt · William & Joan Brock · Barbara Brown · Cheryl Brown · Christina Brown · D. Gordon Brown & Charlene Irvin-Brown · Dhira Brown · Marilyn Brown · Robert & Janet Brown · Thomas & Ruth Brown · Owsley Brown Charitable Foundation Inc · Brown-Forman Corp. · E. Charles Brummer John Buchanan · Bernard & Cynthia Buchholz · David & Sandra Buckner · Buckskin Valley Farms · Tara Burch & Nathan Kingsley Robert & Ann Burger · Chad & Laura Burns · Steve & Ginny Burr · David Burris & Meredith McGrath · John & Eleanor Butler Jaehyun Byun & Margaret Sawyer · Laura & Michael Calwell · Margaret & Edmund Campion · Janeine Cardin & David Ritter Forrest & Virginia Carhartt · Stephanie & Mike Carlin · Jim Carlstedt · Jack & Martha Carter · James & Marianne Cassidy Michael & Marcia Cassidy · W. F. & Ruth Cathcart-Rake · Lorna & D. Caulkins · Michel Cavigelli & Martha Tomecek · Cedar Valley Honey Farms · Benjamin Champion · Margaret Gay Chanler · Roland & Jacqueline Chapman · Jingyang Chen · The Chicago Community Foundation · Jacques Chirazi · George & Marilynn Chlebak · Theresa Cichocki · Clark, Mize & Linville Chartered · William Clarke · Roland Clement · Robert Clubine · Frank Coady · Coastal Conservation League Inc. · Jean & John Cobb · Enid & C. Lewis Cocke · Elin & Ronald Colglazier · Collins Family Education Foundation · Edna Collom · The Colorado Episcopal Foundation · Community Foundation of New Jersey · Cath Conlon & Mark Jennings · ConocoPhillips Matching Gift Program · Mary Cooper · Ira & Deborah Cox · Martin & Laurie Cox · Nancy Craig · Kenneth Cramer · Nancy Creamer · Edith Cresmer · Timothy & Sarah Crews · William & Ann Crews · Walter & Mary Czech · Larry Daggett · Robert & Anna-Margaret Dale · Siva & Krishna Damaraju · Mary Damm · Donna Danyluk & Ian Ward · Ryan Daum · Evelyn Davis · Helen Davis · Richard & Eleanor Dawson · Rodney & Jeannette Debs · Andy & Linda Deckert · Alice Jo & Stanley DeFries · Shawn Dehner & Jamie Purnell-Dehner · The Denver Foundation · Brian Depew · Gerald Depew & Dorothy Lamberti · Nancy Deren · Al DeSena M. Cassandra Dickson & Christopher Larson · Robert Didriksen · Lori & Tim Diebel · Margaret Dietrich · Kara Diffey & James Peacock · Tracy & Michael Dileo · R. Edward & Carol Dodge · Fred & Arlene Dolgon · William & Pat Dorman · Nathanael & Marnie Dresser · Margaret & Frank Drinkwine · Marjorie Duck · James & Mary Dudley · Eileen Duggan · Katharine Dunlevy & George Seeds · Ralph & Roma Earles · Brandon & Heather Ebert · Neil & Barbara Elliott · Eldon & Susan Elmore · Jean Emmons Casey Epler · James Erdman · Thomas Erger · James Erickson · Sam & Terry Evans · Clinton Everhart · Judy Fabry · Claude & Sandra Falls · The Fanwood Foundation/West · Eric Farnsworth · Ferndale Farms LLC · Pete Ferrell · Rebecca Ferrell & Michael Golec · Rebecca Ferrera · Fidelity Charitable Gift Fund · Andy & Betsy Finfrock · The First Presbyterian Church · Margaret & William Fischang · Thomas Fitton · Douglas & Barbara Flack · Susan Flader · Jeffrey & Mary Fleming · Laurence Flood Foundation · Jan & Cornelia Flora · The Flora Family Foundation · Theodore & Marlene Forke · Merle & Mavis Fossum · Dana Foster · Foundation for Deep Ecology · Nicolas & Gisela Franceschelli · David & Janis Francis · John & Julie Franson · John & Mary Frantz · Chris & Leanna Frasier · Steven Freilich & Daphne Greenberg · James & Lisa French · Jean French & Benjamin Fischler · John & Olga French · Prescott Frost · Fry Masonry · John & Susan Fullerton · Fullerton Family Foundation · Joshua Garrett-Davis · Gaubatz Family Fund · George & Mavis Gehant · Karl Geislinger · Jared & Cindi Gellert · Mark & Pat Gilbertson

Eric & Emma Gimon · The Glenmede Trust Co. · Marilyn Glenn · Susan Goering · Samuel Goldman · James & Rebecca Goodman Google Matching Gifts Program · Nils Gore & Shannon Criss · Thomas Gottsleben & Patricia Livingston · Howdy Goudey Donald & Betty Graf · Mark Graf · Elizabeth Granberg · Nancy Gray · Greater Kansas City Community Foundation · Greater Salina Community Foundation · Daniel & Norma Green · Laurie & G. Garner Green · Barbara Greenewalt · Shirley Griffin Charles & Patricia Grimwood · Marion Griswold · Dean & Betty Groves · Philip & Patricia Hahn · Margaret W. & Dr. Thomas B. Hall Fund · Halliburton Giving Choices · Christine Hammond · Melinda Hancock · Joyce Hanes · Nathalie Hanhardt · Patricia Hansen · Nathan Harder · Saralyn Hardy · Benjamin & Lucy Harms · Karen Harris · Eric & Ellen Harris-Braun · Eric Hart · Karen Harvey · Robert & Nancy Hatch · Delmar & Laverna Hatesohl · Lois Hayes · Palmer & Lydia Haynes · William Randolph Hearst Foundation · Jacob Hebert · Peter Hegeman & Patricia Egan · Jerry & Rosemary Heidrick · Bernt & Suzie Helgaas · Bjorn & Leanne Helgaas · James Henson · Eric & Mary Herminghausen · Stella Herzig · Abigail Higgins · Bette Hileman · Margaret Hilton Thor Hinckley & Alison Wiley · Will Hinnefeld · Sarah Hinners & Christopher Pasko · Irma Lou & William Hirsch · Douglas L. & Shirley U. Hitt Giving Fund FAFN · Penelope Hlavac · Cathy & Ihor Hlohowskyj · David Hodges · Stanton & Carol Hoegerman David Hoff · Chris Hoffman · Craig & Henrike Holdrege · Glen & Leslie Holt · Robert & Lynne Holt · John & Gloria Hood Ralph & Lou Hoover · Steven Hopp & Barbara Kingsolver · Shae Hoschek · Hospira · Mark & Linda Howard · John Howe · Gary & Michele Howland · Liz Huffman · Mark Hulbert & Merideth Tomlinson · Dean & Nicki Hulse · Hunnewell Elevator Inc. · Jon & Audrey Hunstock · Lee Hunter · Linda & Terry Hurst · John & Laura Hussey · Michael & Hedy Hustedde · ImpactAssets Inc. Jean-Luc Jannink · Kristi & Bernd Janzen · Richard Jenkins · Charles & Gerry Jennings · Christopher & Rita Jensen · Jewish Communal Fund · Bruce Johnson · Cylus & Donna Johnson · Eric Johnson & Michele Roesch-Johnson · Guy Johnson · Max & Helen Johnston · Alice Jones · C. Lee Jones · Jimmy Jones · Charles & Sally Jorgensen · Todd Juengling · Michael & Shawna Lea Karl · Jude Kastens · Jim & Sue Keating · Harold & Brenda Keller · Richard Keller · Robert & Judith Kelly · Thomas & Lorna Kilian · Kelly Kindscher · Pamela Kingsbury · Ingrid Kirst · Keith & Amanda Kisselle · Leslie Kitchens · John Kleinwachter · Mark Klett · Jeff & Paula Knox · Stephen Kobasa & Anne Somsel · Bernard Kobes · Elias Kohn · Donald & Marianne Koke · Walter & Barbara Koop · Edward Kopta · Jill Korbelik · William Kostlevy & Marilynn Patzwald · Mark & Jean Kozubowski · Mildred Krebs · Connie Kreider · Margo Kren · Keith Krieger · Linda Kroupa · Adam & Aubrey Krug · David & Carol Kyner · Robert & Mary Lancefield · Melissa Landon · Loren & Elizabeth Larson · Thomas Larson & Diane Lux · George Lawrence · Winfred Leaf Marietta & Alden Leatherman · Jan Leeman · Benedict & Ann LeFort · LeFort-Martin Fund CCF · Dee & Robert Leggett Patricia Lertora · Nels & Liz Leutwiler Foundation · Frances Schneider Liau · Liberty Prairie Restorations · Matthew Liebman & Laura Merrick · Curtis Liesenfelt · Janice Lilly & Cary Buzzelli · Mark Lindquist & Kristine Schlangen-Lindquist · Christina Litwiller · Jakob & Tamar Loewenberg · Robert & Janet London · Jonne Long · Kevin Lowe · Richard Lowitt · Sandra Lubarsky & Marcus Ford · Anne Lubbers · Ludlow-Griffith Foundation · John & Lee Luebbe · Karen & Gordon Luetjen · George & Shelden Luz · Rodney & Sarah Macias · Michelle Mack & Edward Ted Schuur · Kathleen Maddux · Thomas Mahoney & Madeline Maxeiner · Grant Mallett & Nancy Tilson-Mallett · Rosette & Michael Malone · Richard Malsbary · Kevin Markey & Candice Miller · Joyce Markle · Angela & Roger Marsh · Joanne Marsh · Marsha & Ric Marshall · Robert & Nancy Marshall · Anthony & Patricia Martin · David Martin · Francis & Christine Martin · Helen Martin · Thomas & Nina Mastick · William & Robin Matthews · John & Susan Maus · Ardean & Robert Maxey · Robert & Janet Mayers · Karin McAdams · William & Julia McBride

McBride Family & Aspen Business Center Foundation & Laurie McBride · Mary McCall · Fred McColly · George McConnell Carl & Mary McDaniel · J. Kyle McDowell · David McKee · Richard & Marjorie McManus · Michael & Laurel McNeil R. Michael & Debra Medley · Hollis Mehl · LaNay Meier · Curt Meine · Tom & Anne Melia · Merck Partnership for Giving William & Nancy Michener · Sara Michl · Howard Mielke · Gerald Mikkelson · Kathy & Preston Miles · Bart Miller & Lisa Seaman · Eric & Mary Miller · John Miller & Sandra Bot-Miller · Kenneth & Beth Miller · Mark Miller · Marisa Mitchell · Robin Mittenthal · Suzanne Mittenthal · Bonny Moellenbrock & Michael Lowry · Anne Moore · Jeanne Moore · Donald & Ann Morehead · James Morgan & Teresa Maurer · Minor Morgan & Sylvia Alvarez · Philip & Lona Morse · Margaret Moulton · Brody Mullins · Dave Murphy & Lisa Stokke · Frank Neitzert · Rupert & Delores Nelson · Stanley & Ann Nelson · Christopher Neubert Arthur & Connie Neuburger · Herbert & Pamela Neumann · New Priorities Foundation · The New York Community Trust · Ada Niedenthal · Galen & Rudene Niedenthal · Mike & Sara Niemann · John Nienstedt · Jorge & Patricia Nobo · William & Shirley Nolting · Kurt Nordback · Jayne & David Norlin · Frank & Jeanne Norton · Richard & Elizabeth Norton · Rita Norton · Zachary Nowak · Janet & John Nybakke · Matthew O'Asaro · Thomas & Nancy O'Brien · Laurie O'Connor · Michael & Kathleen Oldfather · Opins Co-op · Oracle Corp. Matching Gifts Program · Cody & Bruce Oreck · Richard & Christine Ouren · Lee Overton · Owen Owens · Arthur & Debra Ozias · Jerry & Carole Packard · Nancy & Joseph Paddock · Beverly Palmer · Karl & Elizabeth Parker · Gary & Eileen Parks · Harold & Dorothy Parman · Gregory Parsons & Dorothy Johnson · Patagonia Inc. Steven & Carolyn Paulding · Kenneth & Ana Pecota · Gordon Pedersen · Zachary & Laura Peek · Keith & Sharon Penner Gregory Penniston · C. Diane Percival · Jerry & Terese Perkins · Joan Peterkin · Carol & Brian Petersen · John & Merle Peterson Joseph Pew · Pew Charitable Trusts Matching Gifts · William & Cynthia Pfannenstiel · Pfizer Foundation Matching Gifts

Prairie Festival recordings

September 27-29, 2013, The Land Institute

NUMBER	TITLE	SPEAKER
_____	Wild Earth Economics: Rethinking Economic Evolution	Lisi Krall
_____	Progress report and artist's talk	Scientists, Philip Heying
_____	Is There a Ration Card in Your Future?	Stan Cox
_____	The Importance of Beauty	Sandra B. Lubarsky
_____	Regenerative Capitalism	John Fullerton
_____	Will Becoming Local Here Get Us There?	Tim Crews
_____	Education and the Anthropocene	Peter Brown
_____	The Future of Food	Mark Bittman
_____	David vs. Goliath: Appropriate Analogy for Our Time?	Wes Jackson

Total individual CDs _____ × $15 = _____

Sets (one of each) _____ × $120 = _____

Total _____

We accept checks and money orders for US funds, and Mastercard, Visa and Discover. Card purchases can be by mail, fax or phone. Place orders to The Land Institute, 2440 E. Water Well Road, Salina, KS 67401. Phone 785-823-5376. Fax 785-823-8728.

Name _____

Address _____

City _____

State _____ ZIP code _____

Phone _____

☐ Mastercard ☐ Visa ☐ Discover

Card number _____

Expiration date _____

Signature _____

Program · Leroy Philippi · Michael Phillips · Loretta Pickerell · Chris & Meghan Picone · Martin Ping · Allen & Charlotte Pinkall Robert & Karen Pinkall · Odessa Piper · Susan Pokorny · Portland General Electric · Paul Post & Kay Kelly · George & Alice Potts Cleveland Powell & Krista Miller · Eric Powell · Kimberly Pressley · Thomas Pruiksma · Al Pugsley · Jerry Quance & Marcia Hall J. Patrick & Judith Quinlan · Peter Quinn · Kevin Radzyminski · Victoria & George Ranney · Victoria & George A. Ranney Jr.

I want to be a perennial friend of the land

Here is my tax-deductible gift to support Land Institute programs

Please print

Name _____

Address _____

City _____ State _____ ZIP code _____

I authorize The Land Institute each month to
☐ Transfer from my checking account (enclose a check for the first monthly payment)
☐ Charge my credit or debit card
☐ $125 ☐ $75 ☐ $55 ☐ $15 ☐ $5 ☐ Other: $_____ Deduct on ☐ 5th of month ☐ 20th of month
Monthly giving: We will transfer your gift on the date you select, until you decide otherwise. You can change or cancel your donation at any time by calling or writing. We will confirm your instructions in writing.

I authorize a one-time gift of
☐ $5,000 ☐ $500 ☐ $250 ☐ $125 ☐ $50 ☐ Other: $ _____

Payment method: ☐ My check, made payable to The Land Institute, is enclosed.
☐ Charge my ☐ Visa ☐ Mastercard ☐ Discover

Account number _____ Expires _____ / _____

Signature _____

Clip or copy this coupon and return it with payment to
The Land Institute, 2440 E. Water Well Road, Salina, KS 67401 LR 109

Fund · Thomas Rauch & Joyce Borgerding · Harris & Betsy Rayl · Robert Raymond · Steven & Pamela Read · L. David & Ann Redmon · Stanley Reed · Mark & Martha Reese · Don & Barbara Reeves · Raymond & Barbara Reinert · David & Wendy Reinhardt · Richard & Joyce Reinke · Rembe Enterprises · Research Products Company · Kenneth Rich · Jeannine Richards David & Jane Richardson · Peter Riggs · Mary Rivkin · RLM Construction Inc. · John Robertson & Janet Bouley · Scott & Teresa Robeson · Bernard & Marcy Robinowitz Family Fund of the Tulsa Community Foundation · David Rodgers · John Rogner · Rex & Carol Romeiser · James Rose · Ella & Michael Rossitto · Wolfgang Rougle · Robert Rubin · R. Rubin Family Foundation Inc. Stephen & Lynne Ryan · Niklaus Salafsky & Julia Segre · Salina Rotary Club · Sarna Salzman · Zibaa Sammander · John & Dori Samson · Eugene & Donna Sandberg · Scott & Ruth Sanders · Sanders-McClure Family Fund · Wayne & Lou Ann Sangster Eugene Savage · Marjorye Savage-Heeney & Barney Heeney · Janice Savidge · Gregory Scharf · Joy Schell · Dennis & Linda Schlicht · Anne Schmidt · Carol Schmitt & W. Propst · Jonathan & Gail Schorsch · Claire Schosser · Kash & Anna Schriefer

Ralph Schultz Family Foundation · Jon & Jane Schulz · Peter & Helen Schulze · Schwab Charitable Fund · Kent & Penny Scott Robin Sears · Tracy Seeley · Cecil & Gloria Settle · Suzanne Shafer · Kathryn Shattuck · Frank Shaw & Alison Mary Kay · William & Cynthia Sheldon · Florence Shepard · Timothy Sherck · Bob & Doris Sherrick · Jordan Shifriss · Mary Helen Shortridge Elizabeth Sidamon-Eristoff & Hunter Lewis · Susan Sievers · Robert Sigmon · Greg Simmons · Grover & Mary Beth Simpson John & Carolyn Simpson · Martha Skillman · Tim Skwiot & Kirsten Kiesel · Barrie Smith & Marcy Smalley · Boyd & Heather Smith · Brenda Smith · Daryl & Sue Smith · Freddie Smith · James & Katherine Smith · Jane Smith · Lea Smith · Lola & John Smith · Ronald & Kahrmelle Smith · Amanda Smyth · Richard & Mary Smythe · Charles Snakard · Michael Snow · Courtney & James Spearman · Paula Speer · Janet Sperry · Eric & Mary Louise Stahl · Gordon & Frances Stallings · Rebecca Stanfield Jennifer Stanley · Stanley Family Fund · Lucia Stanton · Marshall & Janice Stanton · Kateri Starczewski · L. Joe Stehlik · Claude Stephens & Erin Henle · Michael & Alexandra Stephenson · Amanda Stewart & William Smith · Julia & Craig Stidham · Ann Stillman · Jonas & Judith Stoltzfus · Bianca Storlazzi · Allen Stovall · James & Michele Stowers · Palma Strand · Paul Strasburg & Therese Saracino · Gail Stratton · Joyce & Greg Studen · Persis Suddeth · Timothy & Karen Sullivan · Janet Sutley · M. Suzuki Gerald & Sandra Swafford · David & Paula Swetland · J. David & Jacqueline Swift · Toby Symington · Lisa & Richard Symons Stewart Taffe · Constance Taylor · George Taylor & S. Candice Hoke · Gary Tegtmeier · Jonathan & Wendy Teller-Elsberg Termini Associates · Bruce & Sharon Texley · Richard Thomas · Thomas H. Willey Farms · David & Meg Thompson · Edward & Jacquelyn Thompson · John Thompson · Bob & Cheryl Thummel · Ruth Anna Thurston · Geneva & Henry Tilbury · TomKat Charitable Trust · David Toner · Richard & Marney Toole · Topeka Community Foundation · Andre & Ruth Toth · Douglas Towne Trinity Episcopal Church · Mary Tucker & John Grim · Erik Unruh & Maria Zielinski · Jan & Margaret van Asselt · Marjorie & Lynn Van Buren · Elizabeth & William Vandercook · Marcia Veldman & Steve Cotter · Valerie & Roger Vetter · Elizabeth Vollbrecht · Carol von Tersch · Debra Voth & Ken Gaeddert · Verlon & Elaine Vrana · Carol & Hulse Wagner Fund of the Wichita Falls Community Foundation · Rebecca Wagner & Daniel Forsythe · Graham & Anne Walker · Pamela Walker · Raymond & Floriene Walker · Wallace Genetic Foundation Inc. · Robert Walter · Richard & Barbara Ward · Nancy Warner · Thomas Warner Randal & Suzana Waterhous · Richard Waxman · Dorothy Weaber · Richard Weaver · Robert & Judith Weeden · Marc & Kathleen Weinberger · Gary & Mary Anne Weiner · Doug Weller & Nancy Arnoldy · Robert & Kim Wemer · Andrew & Jeannette Westlund · Frank & Helen Wewers Family Fund · Brent & Ruth White · Matt White · Linda Wiens · Wilderness Community Education Foundation · Cynthia Willauer · Julia Willebrand · Suzanne Williams · Williams College Libraries Gabriel Wilmoth & Catherine Walsh · David & Barbara Wilson · John & Anne Wilson · Tom & Jan Wilson · Bruce & Kristina Wittchen · Kathleen Wold · Anthony Wolk & Lindy Delf · Dorothy Wonder · Mark & Pamela Woodard · George & Katharine Woodwell · Charles & Marilyn Wooster · Elizabeth Wooster-Petrik · Work Family Estate Trust · Mari Wright · Wright-Ingraham Institute · David & Rita Wristen · Thomas & Karen Wuest · Donna Wygle · George & Margaret Yarnevich · Robert & Janet Yinger · Debra Young · J. Lowell & Ruth Young · John & Jane Young · Arthur & Linda Youngman · Ruth & Mark Zalonis · Randall Ziglar · Robert Zimdahl · Ann Zimmerman & Dexter Eggers · John Zimmerman · Zimmerman Family Foundation Inc. · David Zimmermann & Emily Marriott

IN HONOR

Janet Bunbury, from Elisabeth Shaw · Bob Conn, from David Downing · Hannah Frank, from Constance Taylor · Walter Hanson, from Timothy & Sarah Crews · Will Hinnefeld, from Jerry & Suzanne Hinnefeld · Leigh Merinoff, from Todd & Barbara Albert, Susan & Herman Merinoff · Leigh & Charlie Merinoff, from Andrew & Abby Crisses · Susan Pokorny, from Sarah Fleming Glenn Reynolds, from Merilie Reynolds · David Wheaton, from Kathleen Fisher · David Wristen, from Richard Mitchell, Gary Tegtmeier, Laurie Ward

MEMORIALS

Lyle & Helen Clow, from Michael Clow · Donald Duvick, from Selma Duvick · Bernd Foerster, from Enell Foerster, Kent & Beth Foerster · Kenton Graber, from Bettina Graber · Maynard Heckel, from David Heckel · Paul Huling, from Jean Huling · Amy Kellogg, from Barbara Lacy, Jan & Steve Randle · Grover Mitchell, from Harriet Hodges · Dan Shattuck, from Kathryn Shattuck Mary Whitehead, from Fred & Carol Whitehead

THE LAND INSTITUTE

2440 E. Water Well Road
Salina, KS 67401

Nonprofit organization
US postage paid
Permit No. 81
Salina, KS 67401

If the date on your label is before 11-1-13, this is your last issue. Please renew your support.

Cooper Union's Great Hall, site of talks by Abraham Lincoln and Frederick Douglass, was the scene of New York Times columnist Mark Bittman interviewing The Land Institute's Wes Jackson and writer Wendell Berry. For more, see page 6. Scott Seirer photo.