Land Report

Number 104, Fall 2012 · The Land Institute

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

To receive Scoop, e-mail news about The Land Institute, write to Carrie Carpenter at carpenter@landinstitute.org, or call. Our Web site is landinstitute.org.

SUPPORT

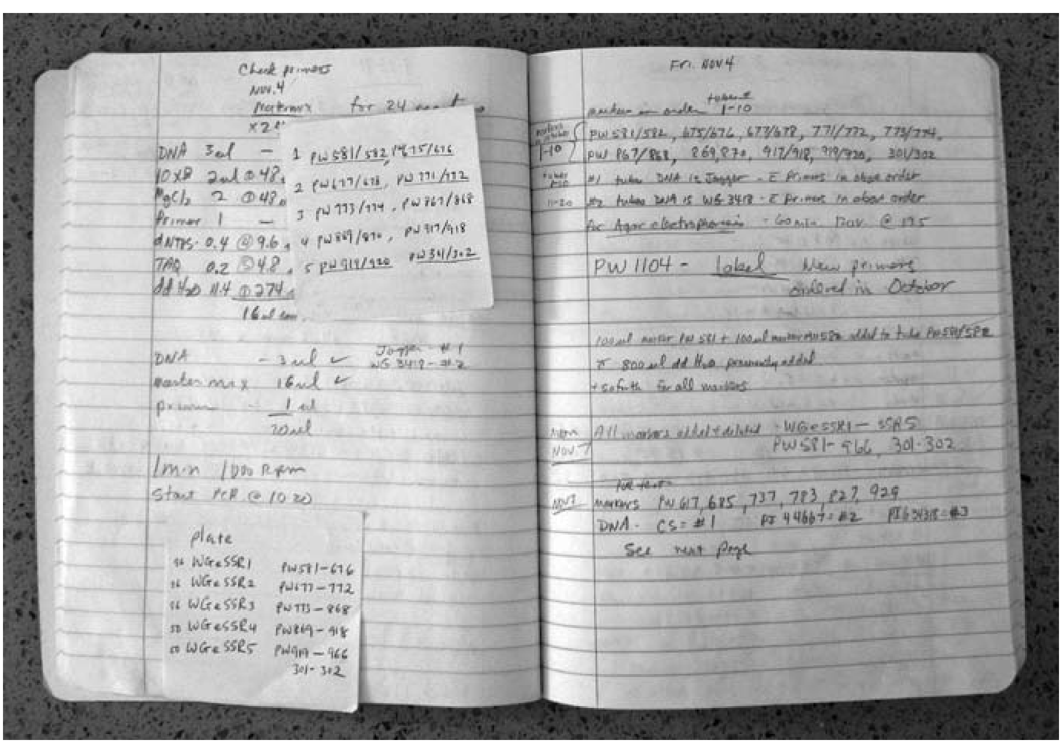
To help The Land Institute, see the contribution form on the back cover, or contribute online at landinstitute.org. Funders receive the Land Report.

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

Contents

Land Report 104, *Fall* 2012



Notebook for molecular markers in development of perennial wheat at The Land Institute. Cover: Prairie Festival bonfire at sculptor Bill McBride's "Hedge Fire Circle." For more about the festival, see page 7. Scott Seirer photo.

Hybrid wheat up Down Under

Researchers in Australia grew perennial wheat hybrids developed outside their country and environment, and saw an encouraging three lines, from The Land Institute and Washington State University, produce grain three years in a row. Analysis of a protein type suggested that most of the lines tested would make useful dough. Disease resistance was high. Writing in the journal Field Crops Research, the Australians saw these traits as a "great opportunity" for commercial success with perennial grain crops.

Of 125 lines planted in the first two years, 34 percent persisted to make grain the second year. After harvest of the total of 176 lines, some regrowth appeared in 61 percent. Three lines from the 73 planted in the first year, 2008, made grain three successive years. Whether they or the later lines could go on is unknown. The Australians' funding died.

But the study's lead author, Richard Hayes, is coordinating a new study to take seeds from plants successful in Australia and see how they perform in different environments around the world. Researchers will grow plots of modest size in eight countries: Great Britain, the Netherlands, Italy, South Africa, Nepal, Canada, Australia, and the United States. The Australians noted that the performance of perennial wheat hybrids differed greatly from at their origins,

Perennial sunflowers in fall bloom at The Land Institute. Res

earchers Sheila Cox and David Van Tassel, with a GPS receiver, prepare to find plants they want. For the story *see page 10.* *Scott Bontz photo.*

evidence of the significant influence of environment.

Genetic testing showed that for the ability to regrow, a wheat hybrid in the Australian program needed at least 14 chromosomes from the perennial parent. The perennials involved here, all wheatgrasses of the genus *Thinopyrum*, have chromosome counts of 14, 28, 42, and 70. The annual parents were bread wheat, with 42, and durum – pasta – wheat, with 28. Perenniality is a complex trait affected by many genes. Having that minimum of 14 chromosomes from the perennial side was no guarantee of regrowth, and the hybrids were highly variable across the board of traits examined, including yield, grain size, grain quality, and height of tillers, the side shoots. This reflected the diversity of their pedigree – and the genetic richness that researchers can tap.

Many of the lines in the Australian study were developed by programs in the Soviet Union, China, Mexico, and Argentina. Not all of these lines came from attempts to develop perennial wheat; breeders of annual crops draw on wild perennials for genetic strengths such as disease resistance.

Progress at home

For weeks Land Institute staff threshed and weighed seed from thousands of Kernza plants, and researcher Lee DeHaan was pleased to see that genetic effects relative to environmental influences appeared very large, at least several times greater than the ratio two generations ago. This means faster progress toward a viable perennial grain. “You get where you’re going,” DeHaan said, rather than sidetracking with plants that enjoyed good conditions one year, but don’t have superior genes. Another way to think about this is that with genetically identical plants, any difference seen in their growth will be environmental, and selecting among them would do little good. To find the difference in effect by genes vs. environment, scientists use calculations based on records of plants’ parentage.

Almost 1,000 Kernza plants begun elsewhere with seed provided by DeHaan came back to The Land Institute as part of genetic studies that also should speed crop development. Traci Viinanen, a University of Chicago graduate student, shipped about 400 plants that she started in a greenhouse, but for which she lacks field space in the city. These are crosses of DeHaan’s improved stock with wild plants lacking the improvements. Viinanen wants to learn the genetic control of these traits, such as whether there are many genes of small effect or few genes of large effect. This study is part of an effort to genetically map Kernza and develop genetic markers that will speed selection by predicting traits without having to grow plants to maturity in the field. Steve Larson, employed by the USDA at Utah State University, drove about 500 plants to Kansas after extracting DNA for mapping. He will also keep growing Kernza in Utah to compare the effects of environment on traits of interest. DeHaan and colleagues also are growing Kernza in Minnesota.

Wild plants “shatter” and drop their seed. Domestic plants should hang on to seeds until harvest. One of the challenges of developing perennial grains from wild plants is changing this trait. Researcher David Van Tassel this year reports finding in his plots of *Silphium*, a plant in the sunflower family, a few individuals highly resistant to shattering. Fellow researcher Sheila Cox had a hard time pulling the seeds off one head as she was preparing to weigh them. And Van Tassel observed other heads in the field in mid-October – at least two months after they were ripe – with no noticeable shattering.

These anecdotal discoveries can't be used for selecting plants. Shattering must be quantified in the same way for every plant being considered. For that, Chinese perennial rice breeder Fengyi Hu recently donated 10,000 tough nylon mesh bags. Tied over seed heads, these bags capture seeds shattered by wind, sun, rain, and frost, and they prevent birds from eating unshattered seed while the heads mature. When the heads are removed from the bags in the lab, the weight of the loose seed is compared with the weight of the seed still held by the head. Other important traits that can be measured from the bagged samples are the average number of seeds per head and average individual seed weight.

Van Tassel and Cox have placed about 8,000 of these bags on sunflowers that look promising for other reasons and need to be evaluated for shattering. The bags arrived too late to be used for this *Silphium* breeding cycle – *Silphium* flowers earlier in the year than the sunflowers – but the researchers look forward to using real data for this important trait in the next cycle.

Prairie Festival high point

The Land Institute's Prairie Festival drew a record 1,165 attendees. The previous record was 1,010. Registered, paying attendees for the events September 28-30 numbered 1,032. The old record, in 2010, was 931. Other attendees are staff members, volunteers, speakers, board members, and other VIPs. More then one-fourth of registrants were students, from at least four Kansas schools, and Augustana College in Illinois, University of Nebraska, University of Minnesota, University of Wisconsin, and Iowa State University. Attendees came from 38 states, and from Japan, Chile, and Canada.

For presentations, writer Wendell Berry and his daughter Mary Berry talked with environmental historian Brian Donahue about of high grain prices this year bringing the plow to hilly land long kept in grass, and of the value of perennial cover, and they argued for more farmers on and close to the land, and about policy and activism to get them there at a time when, Wendell Berry said, "The world is not their oyster." Ecologist Michelle Mack explained how ecosystems are helping sock away much of the fossil carbon that humans dump in the air, how that flow can reverse and accelerate climate change, and why the certainty of a warmer, rougher future makes important the development of resilient, perennial grain polycultures. Environmental studies educator David Orr called inaction on fossil fuels driving climate change "the biggest political failure in human history." He argued for how to bring camps together and told of steps being made in that direction at his hometown of Oberlin, Ohio. Along this line, physicist Eric Gimon explored "Decarbonizing the Grid." Indian journalist P. Sainath told how government policy and the industrialization of agriculture in his country drives farmers away from food crops to risky cash crops for export, and to stunning indebtedness and suicide. He sees them on the last frontier of the smallholder in farming, and he argued that Westerners should recognize that their support matters. Land Institute President Wes Jackson talked about the importance of historical imagination in seeing how things are, and what to do about them. A version of his talk begins on page 16. Jackson's presentation and the others' are on compact discs. See page 15.

Former farm manager dies

Jack Worman often had two things on his lips. One was a toothpick. The other was warm bemusement. Greetings were at once delighted and wry. He didn't yell too loudly at Tina Ray's mistakes when the neophyte horse driver helped him manage The Land Institute's farm, she wrote in the fall 1998 Land Report. "Most importantly," the former intern said, "working with Jack I have learned how to think." The institute's problems are unique and require creative solutions. Ray said, "Jack is a master at dealing with them."

Remembrance of his charm and ability brought an estimated 600 to Worman's funeral. He died of cholangiocarcinoma, a rare cancer of the bile duct, July 20. The Lutheran church in Salina steered hundreds away from the packed sanctuary and filled a gym, to which the service was broadcast.

Jack was born Marvin Eugene Worman in 1933 in Gypsum, southeast of what became The Land Institute. He spent his 78 years in Saline County but for Army service, which took him to Alaska. Worman worked in Salina first for Sears, in hardware, followed by shipping and receiving, and then at Graves Truck Line, as a dockhand and finally a driver. His pleasure and calling came in the basement of his house east of town for more than 40 years, where he crafted saddles and tack.

Worman also was a compact handler of one-ton horses. He bred and worked dappled gray Percherons and dark draft mules. He played soccer on a mule. For decades he'd handled truck cargo, but he embodied the Western horse hauler. The toothpick and light eyes lay under a gray Western hat with sloping crown. A story had him answer teasing about his gait that with balls like his, you too would walk bow-legged.

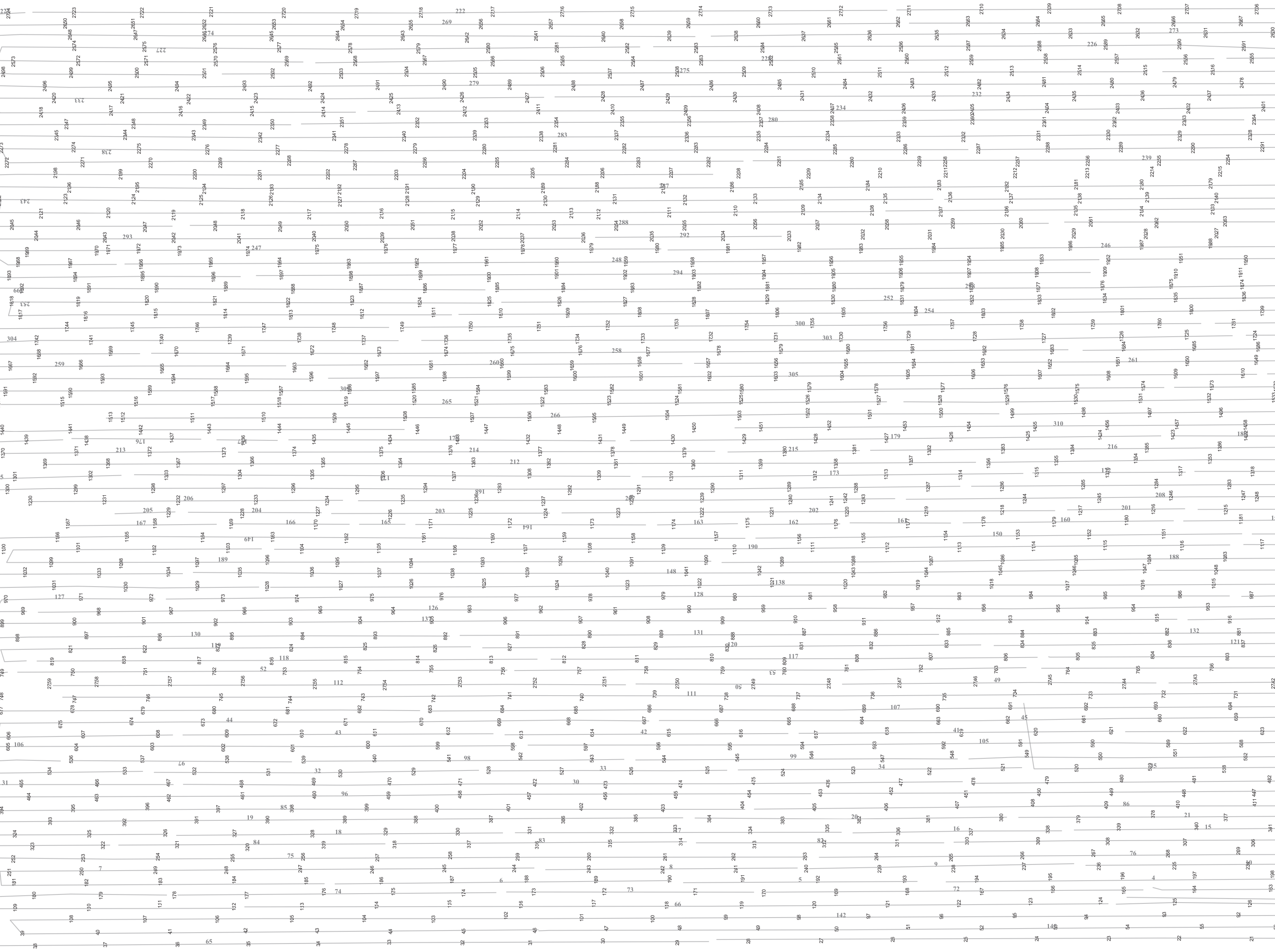
In 1992 Worman joined The Land Institute as farm manager for the decade-long Sunshine Farm project. Scientist Marty Bender measured and calculated the energy of farming, beyond fuel and feed, to nuts and bolts and the ore and coal used to make them. Worman tended the nuts and bolts of planting, harvesting, repairing. Some traction came from a tractor burning soy diesel. The rest came from his animals.

Presentations

- Kathryn Shattuck's interview with Wes Jackson appeared on the New York Times "Green" blog September 27. Her story from The Land Institute's Prairie Festival appeared in the Times' print edition, and online with a slideshow, October 2. That day the institute Web site, www.landinstitute.org, saw a record number of visitors, more than 900. On a typical day there are 30-50. The Times op-ed about a 50-year farm bill was followed by 400 visits. Following Shattuck's story a record number of visitors also signed up for the institute e-mail newsletter.
- Former Land Institute scientists Jerry Glover and Cindy Cox, along with institute collaborator John Reganold, of Washington State University, wrote in the September 20 issue of Nature magazine a commentary headlined "Plant perennials to save Africa's soils."
- Land Institute staff members spoke in Chicago and for a Skype presentation in Winnipeg, Manitoba.
- Wes Jackson made a presentation for TEDx, part of the TED program for presentations about technology, education, and design.

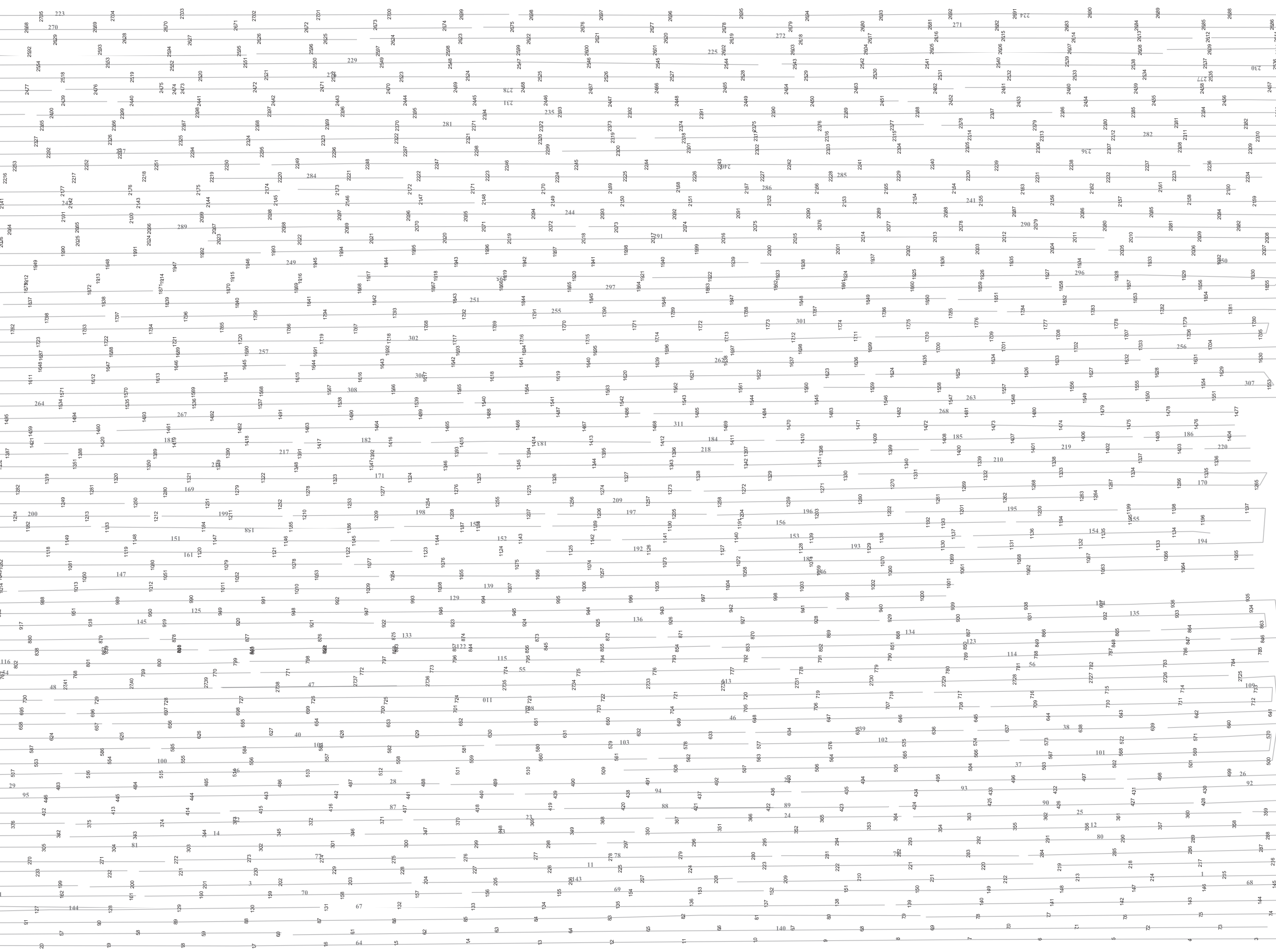
Land Institute researchers were returning in early November to China, where a colleague is developing perennial upland rice. Upcoming appearances: November 28-29 in Vancouver, British Columbia. January 17-19 in Santiago, Chile. February 21-23 in Fort Worth, Texas. April 4 in Champaign, Illinois. April 18 in Jonesboro, Arkansas. For more information, call 785-823-5376 or see Calendar at landinstitute.org.

How does the plant builder that is nitrogen get from a legume, whose root bacteria pull it out of the air, to another crop? When both plants are perennials? This fall Tim Crews, above, sowed fields to find out. The answer may prove key for The Land Institute to reform grain agriculture, from annuals grown with one plant species to a field, to perennials grown in mixtures of species, as in most natural ecosystems. Crews, formerly of Prescott College in Arizona, in September joined The Land Institute as research director. The other staff scientists are developing perennial grain crops. Crews will develop how best to grow them, together. Nitrogen transfer from legumes to other crops in the mix will be important for perennial grain polycultures to relieve farmers of using synthetic fertilizer, so costly in terms of environment, energy use, and pocketbook. More specific questions that Crews has about that transfer: How much nitrogen moves? How is nitrogen fixation by a legume limited by another important plant nutrient, phosphorus? How much of nitrogen transfer is by release from legume roots, and how much comes from fallen leaves or manure? Crews plans 10 treatments involving the crop legume alfalfa and one of The Land Institute's perennial grains in the making, Kernza, a k a intermediate wheatgrass. Even after millennia of crop rotation and more than a century of modern crop science, mystery clings to a crucial element for plant growth and human nutrition. Scott Seirer photo.



Navigating the numbers game

SCOTT BONTZ



The clumps in the map above are numbers representing some 300 families and almost 14,000 plants selected to develop a perennial crop sunflower. The lines show rows made by tractor and planter. Imagine the perennials growing to fill gaps and shade ground. The clumps merge. Now imagine walking the course of this field. Find standout plants for another generation of selection. Can you identify them? Because knowledge of lineage is crucial to quickly accrete traits and make a wild population into crop. A few years ago The Land Institute couldn't have managed this scene. Plantings numbered at most in the few thousands. And still labyrinths wrought error. Perennials initially set 3 feet apart blended. Plants and tillage buried identification stakes. Workers lost track in the dozens of rows and columns aimed for distinguishing plants by numbers along axes X and Y.

Communicating with at least 10 satellites, a GPS receiver directs Sheila Cox and David Van Tassel to one sunflower among thousands.

Scott Bontz photo.

But finding a prize with a trait you want for making a good crop plant, especially when working with the great genetic diversity of a rather wild population – finding that prize is a numbers game. The greater your numbers, the better your chances. You want to comb big fields.

The Land Institute boosted its numbers last year with acquisition of a mechanical planter. This tractor-towed device on which two sit and drop seedlings down chutes quadrupled what could be planted by hand – and spared workers of going to their knees or haunches for weeks at a time. But it deposits plants too randomly along X to work also by Y. And using that grid scheme was hard enough already.

The Land Institute needed a hawk's eye and an elephant's memory. It turned to satellites and their attendant computers on the ground. The map and the field it shows came from the Global Positioning System. GPS, developed by the military, is now widely used for navigation, including on tractors at farms and seed companies wanting precisely laid plots. But The Land Institute appears to be the first and only grain crop developer using it to find prize needles in haystacks.

"Other plant breeders have not needed to work with so many individually spaced plants because their crops are self-pollinated and can be planted by seed in dense, uniform, family row plots," sunflower researcher David Van Tassel said. "New crops like Maximilian sunflower and Kernza are outcrossing, and siblings often look nothing alike. Outstanding individuals would never be noticed if grown in the traditional rows." He went on, "Trees are also outcrossing, and tree breeders transplant large numbers of individuals. However, they are spaced far apart so that it is easy to find plants in a grid. They can also nail a permanent ID tag on the trunk, something not possible with The Land Institute's grassland perennials." Tree scientists also use GPS, but don't need the same precision.

Up and down the rows of his sunflower seedlings, Van Tassel strode with a six-foot aluminum pole capped by GPS antenna. Where each new sunflower family began he stopped to plant the pole and tap identification on a touch screen mounted mid-column. He managed a stylus the length of pencil stubs at library catalog desks, but half as thick. He said that in sun it's hard to read the screen, which traced his long path of right-angle S's. "Fortunately there's not a lot of information to enter here," he said. Just a few numbers for each family. But in total, thousands.

Lee DeHaan went a step further than Van Tassel did this year with his sunflowers, and identified by GPS the location of each plant of 13,700 in his field of Kernza. It took a lot of time. But with the spacing on record, he can run analysis such as effect on individuals of surrounding space and competition.

Van Tassel said DeHaan pioneered using GPS this way for crop development. In graduate school DeHaan had been exposed to Geographical Information Systems software, which uses data from GPS. "It just made sense," he said of adopting the system at The Land Institute.

On the ground, a GPS receiver calculates its position by signals from GPS satellites 12,600 miles above the Earth. The receiver uses transit time for the signals – with highly accurate clocks – to figure distance from each satellite, and then triangulation among the satellites to pinpoint its position. Three satellites might seem enough for this. But even a very small clock error multiplied by the speed of satellite signals – the speed of light – can produce large error. So there are 30 satellites, and, DeHaan said, the receiver communicates at any one time with at least 10. Further inaccuracy can come from signal benders in the atmosphere. The Land Institute corrects for this with a second receiver at its science building, gauged to fixed and precise latitude and longitude. The system is accurate to within 2 centimeters. It cost about $12,000.

DeHaan expanded on what Van Tassel said about their work with wild plants that outcross, unable to pollinate themselves, as do most crop plants. Crop plants also are genetically homogenous. Seed companies fine-tune populations of little variation. They evaluate entire plots. In DeHaan and Van Tassel's still rather wild populations, each plant is genetically distinct. With huge differences and lots of genetic variation, progress comes not by lumping populations, but by paying attention to individual plants.

The biggest change allowed by GPS is the expansion of scale, however, and with so many more plants, researchers can't gather all the data they used to. DeHaan said they must prioritize needs. But this can work. On the old grid system, researchers needed to count every plant just to keep track of location in row and range, so they might as well make notes on every plant. With GPS, DeHaan can walk quickly through a field and note just 1 percent of plants for a trait such as early maturity. "You can look at six rows at a time as you walk along," he said.

Of his sunflower field Van Tassel said, "This population is so large – approximately 13,000 plants – that there just isn't time to take data or harvest heads from every plant." He doesn't even know how many plants died after transplanting, because it would take so much time to map every loss. He and the other sunflower researcher, Sheila Cox, are taking data from several thousand of the most interesting plants. They won't know until samples have been processed in mid-winter which of these had the best combination of several rare and desired traits: reduced branching, large seeds, many seeds per head, and reduced shattering (seed drop). And next year the aboveground growth of these plants valuable for breeding will have been mowed or burned. But GPS will take Cox and Van Tassel to the right regrowth quickly and with confidence. DeHaan said that with the grid system, you'd be unsure. Are you in the right row? The right range? Was the worker who made the notes last year? With GPS, he

Prairie Festival recordings

September 29-30, 2012, The Land Institute

NUMBER	TITLE	SPEAKER
________	Progress report	Land Institute scientists
________	Fire, Ice, and the Future of Agriculture	Michelle Mack
________	Decarbonizing the Grid	Eric Gimon
________	The Farm as the Last Frontier	P. Sainath
________	A conversation with Wendell and Mary Berry	Moderated by Brian Donahue
________	Climates of Change: Resilience from the Bottom Up	David W. Orr
________	35 Years: A Past and Beyond, the Future and Beyond	Wes Jackson

Total individual CDs _____ × $15 = ________

Sets (one of each) _______ × $90 = ________

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 _____________________________

said, "You can walk right back to it."

A downside is the amount of training required. Even with two hours of instruction and then experience, a field worker calls DeHaan for help. And there's the downside to scale. "Anything you do 13,000 times over gets boring," DeHaan said.

But once you have the GPS map, finding one plant is easy and accurate. "That's exciting," he said. Before GPS, searching out plants to dig up was tedious and error-prone. Now he looks forward to it. "Having the right tool for the job is a pleasant and pleasurable experience."

The necessity of historical imagination

WES JACKSON

At 7:30 in the morning of November 25, 1940, Vice President-elect Henry A. Wallace opened the door of his Plymouth, which was more or less the Ford version of Chrysler, and left Washington, D.C., for Mexico. I imagine that Henry A. got on Highway 50, which now starts on the eastern shore of Maryland at Ocean City and ends in West Sacramento. At one time it stretched to San Francisco. So it was ocean to ocean, much of it through what once belonged to Mexico. This highway is a product of Manifest Destiny. And for a moment let's look at an early and fitting five mile stretch.Henry would have gone past the Washington Monument. Looking to his left he would have seen the Jefferson Memorial under construction over the previous two years. Then round a curve at the Lincoln Memorial. He would quickly pass tributes to all three presidents, who figured prominently in the history of US agriculture. Washington had been pas-

Cliff and Ferry Street. November 29, 1935, by Berenice Abbott. New York rose on a Manifest Destiny of exploiting forests, coal, oil, and soil.

sionate about farming. Jefferson thought farmers the most virtuous of people. He was passionate about horticulture and agriculture. He was also president at the time of the Louisiana Purchase in 1803, an addition that now represents over a quarter of the lower 48 states. Here was an earlier major product of Manifest Destiny. Lincoln, though preoccupied with the Civil War, signed the Homestead Act in May of 1862. In July he signed the Morrill Act, which led to the establishment of land grant colleges for every state. Apparently, after this period of land acquisition, we wanted to use it wisely.

By 7:45 that morning, Henry would already have crossed the Potomac, and then turned southward. To his left less than two miles away he might have seen the former grounds of the United States Department of Agriculture's primary research center at Arlington. Plant research had ended there the year before, in 1939, during his term as secretary of agriculture. It was moved about 16 miles to Beltsville, Maryland. We'll never know what Henry was thinking as he drove by. We can imagine that if any of the plant material still existed at the former site, it would not be for long, for in September 1941, some 10 months after Henry's drive to Mexico, bulldozers would begin the groundwork to build the Pentagon.

If his mind was at work on our history, he might have been thinking about expansion and settlement: Jefferson and the Louisiana Purchase, Lincoln who signed the act to occupy land with settlers. Did he wonder what kind of reception he would receive in Mexico, given that less than a century before we had provoked a war to take possession of an area half as large as what was then the United States? Did he think about the coast to coast highway he was on, and about the movement of US agricultural research to a place marginal to the halls of power? Perhaps he paid the monuments to the three presidents no mind, but he certainly knew that they were for men who saw the future of our country as inextricably tied to land and agriculture.

Henry A. Wallace was headed to Mexico to attend the inauguration of its newly elected president. He was gone 29 days. Why so long? Fluent in Spanish, he stopped frequently to talk to all sorts of people: campesinos, farmers – anybody, it seems. And after the inauguration he rode around Mexico with that nation's secretary of agriculture.

What did he see? The rural peasant was backward. Mexicans took 200 hours of labor to produce a bushel of corn. Back home in Iowa, it took 10 hours. Henry saw what he considered hunger and poverty. By all accounts he was a feeling man, and understandably wanted hunger and poverty eliminated. The outgoing Mexican president, Lazaro Cardenas, did too. His solution was major land reform to favor small farmers. But the new Mexican president would take measures to reverse his predecessor's emphasis on social reform. He would suspend efforts to redistribute land. To get more food with less labor and more bushels per acre would require more fossil fuel *technology*. Social reform could wait. Spanish-speaking Henry, founder of what became Pioneer Seed Company, also saw technology as a solution. It complicates the story to know that he had a strong history favoring social reform. In fact, he was considered too radical in these views to be Roosevelt's running mate four years later.

Henry arrived home in time for Christmas. Early in the new year of 1941, now vice president, he lost no time in acting on what he thought Mexico needed. He met with Raymond Fosdick, president of the Rockefeller Foundation in New York. He told Fosdick, "If the Rockefeller Foundation would undertake to help the Mexican people increase the yield per acre of corn and beans it would mean more to the future of Mexico than anything else that government or philanthropy would devise." The answer was more bushels per acre. Who among us, at that time, would have disagreed? Well, some in their time did. But here is where the buds of the Green Revolution began to swell.

This year marks the 35th anniversary of Wendell Berry's "The Unsettling of America." Wallace met with Fosdick 35 years plus one before Wendell's book appeared in bookstores in 1977. In that time we had WWII, the Korean War and Vietnam. Dwight Eisenhower was elected president in '52 and served eight years. His secretary of agriculture, Ezra Taft Benson, told farmers, "Get big or get out." The Korean War ended, but the cold war heated up. The spread of communism became a major threat. Strategic Air Command bases popped up. Missile sites surrounded Salina. Bombers with nuclear weapons took off daily from our runways. Farmers added commercial fertilizer and more industrial farm equipment. Farms got bigger. Dairies declined, chickens and cows and hogs moved to feedlots, fences came down. As farm families left, rural communities declined. Longtime food security dropped from the nation's consciousness. Also in that time, 50 years ago, in 1962, Rachel Carson published "Silent Spring." In the next half-century the pesticide industry accelerated, doubled and doubled again in both manufacture and sales. So did the commercial fertilizer industry.

Meanwhile, world population doubled, tripled in Wendell's lifetime. Nine years after "Silent Spring" came publication of "The Limits to Growth."

How do we explain all this? We can begin with the Homestead Act in May 1862 followed by the Morrill Act in July. The latter provided for the establishment of a land grant college in every state. In 1887 the Hatch Act established numerous agricultural experiment stations. In 1914 the Smith-Lever Act established the extension service so that farmers would have access to the most recent knowledge and research results. This is now called the land grant college system. The USDA and these state universities interacted, almost as one.

So in 1941, when Henry Wallace was with Raymond Fosdick, 79 years after the land grant college act, 54 years after the establishment of the numerous experiment stations, 27 years after the extension service, we had a mature, tested system predicated on solid science and yielding results. In the Rockefeller offices in New York, arrangements were pondered for the industrialization of Mexican agriculture. If grants and loans could be made, dams, canals, and smaller ditches could carry water for irrigation. Fossil-fuel-powered farm machinery could replace draft animals. Fertilizers, pesticides, and hybrid corn could boost yields. And from this Rockefeller seed money came the Mexican Agricultural Program, which in the mid-1960's became CIMMYT (Spanish acronym for the International Center for Improvement of Maize and Wheat), a prime mover in the Green Revolution.

In 1959, 18 years after Wallace and Fosdick conferred, five of us from the University of Kansas, four graduate students and a young professor, spent a month in Mexico to collect plants. The numerous Mexicans we met were friendly and generous wherever we went from the rainforest to the desert. They lacked nice houses by our standards, but I was struck more by how healthy, energetic, and friendly all seemed.

At least that is the way it appeared to me then, when I was 23.

Five years later, in August of 1964, my family and I drove to Raleigh, North Carolina. There I continued graduate work in the College of Agriculture, Department of Genetics, at North Carolina State, a land grant college. Many graduate students in genetics and crop science from foreign places were already there, but during my time their numbers increased. They were from Mexico, Brazil, Philippines, Japan, India, and elsewhere. We took classes together, learned about one another's experiments, played handball and basketball at lunch time. They had such names as Molina, Suzuki, Singh, Casas. They were the Rockefeller Fellows.

And who were our professors? The genetics and crop science faculty were mostly males who themselves had graduated from land grant universities: UC-Davis, Cornell, University of Nebraska, Iowa State, University of Wisconsin, Purdue. Barbara McClintock, who would eventually receive the Nobel Prize, for her genetics work with corn, had been there a year earlier to help train these Rockefeller students. A seven-story building near ours housed professors in the Department of Experimental Statistics, most of whom also were products of the land grant system. Besides teaching us statistics, they helped us with our experimental designs. A year or so before, Sir Ronald Fischer, the father of modern statistics, which had its origin in agriculture, had spent time on campus and in the pubs, often with graduate students.

So we earned our degrees and were ready for real work. The foreign students headed off to help make the Green Revolution at such places as CIMMYT, IRRI in the Philippines and ICRASAT in India and Africa, joining Rockefeller Fellows from other land grant universities, all of us influ-

Quarry in diabase near St. Peters Village, Pennsylvania, operated by Pennsylvania Granite. Diabase is a finely textured, igneous rock enced by the world view of the colleges of agriculture in the United States. We could have had Morrill, Hatch, Smith, and Lever stamped on our behinds. And, no surprise, the bottom line for the culture of success featured bushels and acres. The dominant culture's assumptions and how-to abilities came right out of the land grant colleges and the US Agriculture Research Service, with its central effort at what is now called the Henry A. Wallace Beltsville Agricultural Research Center. And within three decades yields of corn, wheat and rice doubled. In certain places the rice yield tripled.

We tend to believe that agricultural policy is the result of considered thought, by which perceived needs are weighed, and then a search is made for benign answers. We take much for granted. So in our success stories, we don't give Manifest Destiny its due. But where would we be without the Louisiana Purchase of 1803, the accession of the Northwest from the British in 1846, the land acquired through the Mexican War in 1848, the transcontinental railroad of 1869, the likes of Highway 50 from ocean to ocean, or the rise of the Pentagon on agriculture experiment station soil? The land grant colleges and the USDA are part and parcel of all of that.

Three of Wendell's nine chapters in "The Unsettling of America" have the word crisis in the title. The ecological crisis he sees as a problem of character (Chapter 2). The ecological crisis is a crisis of agriculture (Chapter 3). The agricultural crisis is a crisis of culture (Chapter 4). In the last 35 years none of these three crises has gone away. And now, we must anticipate a decline in the necessity to use fossil carbon, a decline in high-quality materials, and limits that climate change is sure to impose on a still-growing human population. Since food is

used for crushed stone in pavement, and for monuments. Gigapan composite photo by Maria Luisa Crawford.

our most basic need, we dare not ignore the assumptions of the Green Revolution. And after we have considered those assumptions, what do we have to offer?

In The New Yorker last January, Adam Gopnik wrote about the Spanish Inquisition. He said that "the pursuit of scholarly rigor too easily leads historians to erase any signs of the historical imagination from their work." He says that the historical imagination has the "ability to see small and think big." He cautions that just thinking big leads you to melodrama and fantasy, but "just seeing small makes you miss history altogether while seeming to study it."

Perhaps I have said more then I need to. But I have said it because our historical imagination, the ability to see small and think big, has never been more necessary. And I am not talking about thinking globally and acting locally.

No one I know has a stronger historical imagination than does Angus Wright, The Land Institute's board chair, when it comes to an analysis of the Green Revolution and the future of agriculture. In 2011 the institute hosted and Angus chaired a meeting of twenty-some professionals: a World Bank economist from the Netherlands, a member of the National Academy, an ecological agriculturist from Australia, a rural sociologist, several ecologists, geneticists, and historians. We deliberated how to advance our ecological agriculture agenda so that the foundation world would take it seriously. In the introduction, Angus reminded us that the Green Revolution was not entirely about agricultural modernization. He traced the roots of the campaign, which began in 1941, and highlighted that it "served as a calming role in the politics of Mexico." He noted that "involved in the issues were arguments about distribution versus productivity." Henry A. Wallace favored productivity, bushels and acres. Distribution of land would have featured a social adjustment in access to land. Largely forgotten is that the press invented the term Green Revolution as opposition to the "Red Revolution" of the time. Remember Churchill's Iron Curtain speech, the Korean War, the Vietnam War, the missile silos, the nuclear bombers.

Who was our political opposition? It came from countries who had no recent Manifest Destiny and whose economic wells had already been drawn far down. Our Manifest Destiny gave us good land favored by the Pleistocene and lots of fossil energy. We forget that, believing that our political and economic way alone was responsible for our success.

So there we were in mid-century wanting to hold off the Red Revolution. But a frequently overlooked fact is that the Green Revolution needed government promotion. It required a campaign to gain institutional support, and that required international coordination. The market could not make it happen.

Here are five underlying assumptions of the Green Revolution that Angus outlined:

- The problem is low productivity. Soil degradation was factored in, but as a cost in the ag economist's emphasis on input/output ratio. The gap between the social and the scientific was more or less ignored by the big players.
- Traditional techniques are more of an obstacle than a resource. We are teachers. They are the learners.
- Technologies are neutral. When persuasion fails, it is time to use compulsion.
- Agriculture is to serve as an instrument to achieve industrialization. Adoption of the Green Revolution package is essential. (Need more chemicals? Build a chemical plant.)
- Agriculture is not vitally linked to nature.

At the meeting we agreed that some of the operating assumptions are different now. First, while the Green Revolution required public support, there has been a shift toward the belief that the market will find solutions. Monsanto is banking on that assumption. Secondly, the Green Revolution relied from the start on intensification – more fertilizer, pesticides, irrigation. But now more value is assigned to disintensification. The big players now look harder at the ratio of inputs and outputs. This explains some of the GMO emphasis of Monsanto and the like. Third, more value now goes to social justice. The Gates, MacArthur and other foundations are trying to understand and meet the needs of the small farmer, particularly in Africa, India, and Southeast Asia.

Our historical imagination tells us that we can no longer solve our problems by acquiring more land or with nonrenewable resources. But it seems we inadequately appreciate how much our technological successes owe to the slack afforded by riches of a new continent. The vast resources of energy, soils, and other materials are too much ignored. Instead we claim technological "know-how." Given the context of the ancient agricultural systems and indigenous cultures we want to help, such as in Africa, achieving sustainable yields in the long term can come only with perennial grains. Modern agronomic methods dependent on credit for nonrenewable inputs such as fertilizer and pesticides make the farmers vulnerable. So, in short, as a solution Manifest Destiny is out. The fossil energy spigots will dwindle. And we must quit clogging the atmospheric sink.

The Land Institute has a point of view that is radically different from that of the dominant culture. We believe our future lies in saving our soils and water and relying on contemporary sunlight. To do this will require an agriculture based on the way nature's ecosystems, nature's economies, have worked over millions of years. This means that to replace annual grains we are developing perennial grains to be grown in mixtures so that the processes of nature can be brought to the farm. We will call on the knowledge that has been accumulating for more than a century in ecology and evolutionary biology. Ecologists will need to work with plant breeders. This project will take time, but once established, it will end soil erosion beyond natural replacement levels, and reduce chemical contamination of our land and water. Along with a modest use of biofuels, reintroduction of animal traction, and more people on the agricultural landscape, it will end agriculture's dependence on fossil fuels.

We have been asked how The Land Institute will move our perennial crops onto working farms. The first step will be to release them to any farmer willing to work with ecologists and agronomists. This would resemble the USDA extension model, allowing us to draw on local experience.

What about the yields of perennial crops? Won't we need to keep going back to the seed houses? The answer is "No." Geneticist Richard Lewontin at Harvard and others have found that by using quantitative inheritance, yields of open-pollinated corn could match that of hybrids. Farmers could sow their own seed. This is the sort of agriculture we are promoting precisely because quantitative inheritance is available to all, and, as in the past, yield increases are likely to occur time and again across the agricultural acreage of the earth.

I stress the need to bring ecology front and center. So far the history of grains has been the history of annual monocultures. Mitigating the consequences of using land

Late afternoon, Highway 2, Iowa. Duane Schrag photo.

this way has been the agronomists' burden. They can do no more than mitigate a disturbance worse than clear cutting a forest. We've succeeded getting our food out of disturbance regimes, but the cost has grown unacceptable. In contrast, ecologists have had the luxury to seek knowledge for its own sake. Ecology or the natural history tradition will require a different order of attention. Perennial grain mixtures will be needed not just to prevent soil erosion, but for energy conservation, tight nutrient cycling, biological nitrogen fixation, and pest management.

Now imagine a graph. Three upward lines represent our use of coal, oil, and natural gas. A fourth line shows carbon dioxide accumulating in the atmosphere. A fifth line shows the same for methane. All five lines have to do with burning fossil fuels. A sixth line shows our discarded stuff accumulating in landfills. A seventh illustrates population increase. The time will come when each of these lines will flatten and then decline, marking the end of growth. The aggregate of these arcing lines make what I call "The Hump."

Our research at The Land Institute has and will for awhile contribute to the rise of The Hump. Our greenhouse, our tractors, our pickup trucks, heating and cooling and lighting our buildings, our computers, our lab that allows molecular markers that speed breeding – all contribute to that rise. In fact, our efforts depend, to some small degree, on continued economic growth. For example, we need an additional greenhouse. And so now the big question: Are The Land scientists and their colleagues around the world creating perennial species and varieties that themselves will be dependent on all of those non-renewable inputs that were necessary to bring them into being? Will they still be dependent on the use of non-renewable resources? The answer is "No." And the reason is that we have not altered their "creatureliness."

The extractive economy will end, but the "creatureliness" of these perennial grain species will keep them viable and available for change through future breeding, the kind of breeding farmers practiced for millennia before the industrial revolution.

The industrial sector will have a more difficult time. It lacks "creatureliness." A flat plate solar collector cannot breed or clone another. Perhaps somewhere in its production highly dense energy will be needed. The scaffolding of industrial civilization, however shaky, will be necessary to the manufacture of solar collectors.

Creatureliness depends only on air, water, and soil. Creatures feature high information and operate at relatively low temperatures. Contrast the temperature of biological nitrogen fixation with the industry's Haber-Bosch process. In nature's ecosystems atmospheric nitrogen is harvested by the symbiotic relationship between legumes and bacteria using 21 enzymes at 4/5 of one atmosphere at soil temperature. Haber-Bosch, using natural gas as a feedstock, operates at 350 atmospheres and 400 degrees Celsius. Creatureliness, being information intensive, can operate at low temperatures. The industrial world tends otherwise. I won't say that on The Hump's down slope the industrial world will become impossible, but it will be more costly.

To maximize our historical imagination, a necessity as we cross The Hump, we will need to see small and think big about what happened, especially during the industrial revolution, but also, before that, during the 10,000 years that we may one day call "The Great Non-renewable Carbon Interlude." In that time soil carbon jump-started civilization, forest carbon made possible the bronze and iron ages, and coal, oil, and natural gas gave us the industrial revolution. (The plow allowed oxidization of carbon in the soil, freeing minerals for plant growth. But much of the carbon burned off as waste and added to greenhouse gases.)

So, as we exercise our historical imagination, we will need to be watchful and avoid the risk of melodrama and fantasy in "thinking big." And remember that seeing small has made us miss much of the critical history that brought us here.

The industrial revolution had started in England a full quarter-century before 1776. From early our nation's so-called progress has been tied to expansion of land and the benefits of fossil carbon and mineral resources. This land mass stretching before us from coast to coast at favorable latitudes was our last chance for a fresh start.

Henry Wallace's Plymouth was a modest vehicle. Highway 50 is still mostly a two-lane road. We have the Prius to replace the Plymouth, but the interstate highway accommodates speed that two-lane roads denied. We're spending right at $400 billion a year now on foreign oil. We bring in about one-third of that amount from our agricultural exports. The Pentagon has replaced an agricultural experiment station, and the defense budget has tripled in 10 years. And our country is more unsettled now than when Wendell wrote "The Unsettling." What will it take in the next 35 years to make the transition to a sunshine future?

"The Unsettling of America," with its double meaning, and Wendell's Jefferson Lecture at the Kennedy Center this year show the poet's historical imagination. For instance, Wendell has said that when we came to this continent there were people we called natives, but when they became surplus people, they were redskins. And after the Civil War we sent our military to kill them. With the exodus from farms and the demise of rural communities, farm families became the modern redskins. And when Ezra Taft Benson said, "Get big or get out," he didn't say where to get to. The 8 percent of our unemployed people are today's surplus. Until I read "The Unsettling," my imagination never saw that anyone could become a redskin. My historical imagination was limited.

Another example of imagination is when Wendell says that "we came with vision but not with sight, we came with visions of former places, but not the sight to see where we are." It took New England 200 years to produce a Thoreau who would see New England countryside with native eyes rather than the eyes of a European. Historical imagination at work.

Finally, in Wendell's Jefferson Lecture he talks about boomers and stickers, drawing on Wallace Stegner's distinctions between people who keep moving for opportunity and those who stay in and for a place. But Wendell carries it farther. Our institutions, particularly economic institutions, have rewarded the boomer and now we are all boomers. Wendell goes beyond, making clear that morality is not enough. He says we must stay put long enough in a place for *affection* to develop. His title borrows from E. M. Forster's novel "Howards End" when Margaret says, "It all turns on affection, don't you see?" We have to be dug in to have the affection to reverse the dismemberment all around us.

The historical imagination comes with discovery of the relatedness of the seemingly unrelated. And here is what Wendell says in his "Affection Talk," the Jefferson lecture:

"The term 'imagination' in what I take to be its truest sense refers to a mental faculty that some people have used and thought about with the utmost seriousness. The sense of the verb 'to imagine' contains the full richness of the verb 'to see.' To imagine is to see most clearly, familiarly, and understandingly with eyes, but also to see inwardly, with 'the mind's eye.' It is to see, not passively, but with a force of vision and even with visionary force. To take it seriously we must give up at once any notion that imagination is disconnected from reality or truth or knowledge. It has nothing to do either with clever imitation of appearances or with 'dreaming up.'"

He goes on to say that for us to have a responsible relationship to the world, we must imagine our place in it. This way we see it illuminated by its character and our love for it. We see the need for a preemptive sympathy for our fellow members of the world, human and nonhuman. And from that sympathy, he says, "we find the possibility of a neighborly, kind, and conserving economy."

And so where are we today after our success with Manifest Destiny? What came with the taking of this continent was soils, forests, coal, oil and natural gas, and dumping grounds, atmosphere as sink, ocean as sink, and land as sink. Now the sources of trouble, the fossil fuels, are sure to last longer than the sinks will allow. Filling of the atmospheric sink is a major threat. So not to clog the sinks we have to do what no other species has done: practice restraint.

As for agriculture, scientists at The Land and a growing number of colleagues around the world are at work to develop the creaturely, grain producing perennial polycultures on the other side of The Hump. This agenda will be informed by ecology and evolutionary biology with cultural assistance. We see this to be our necessary journey to a new Eden.

The writer is indebted to Carmelo Ruiz-Marrero's story about Henry A. Wallace in the fall issue of Synthesis/Regeneration magazine.

Field notes

THE GREAT ICE AGE HERDS were destined to vanish. When they did so, another hand like the hand that grasped the stone by the river long ago would pluck a handful of grass seed and hold it contemplatively. In that moment, the golden towers of man, his swarming millions, his turning wheels, the vast learning of his packed libraries, would glimmer dimly there in the ancestor of wheat, a few seeds held in a muddy hand.
– Loren Eiseley, "The Immense Journey"

WE KNOW THE VALUE of water when the well runs dry. – Attributed to Benjamin Franklin

CARRIED OVER INTO SOCIETY, mechanistic reductionism tracks the cause of tuberculosis to a bacillus rather than to slum housing, the cause of cancer to oncogenes rather than to industrial pollution, the cause of evolution to genic mutations rather than to co-development with larger surrounding systems. Science does not entertain the awkward possibility that reality might be distorted by giving priority to parts over wholes. – Stan Rowe, "Home Place"

BUT SEE THAT THE IMAGINATION of nature is far, far greater than the imagination of man. No one who did not have some inkling of this through observation could ever have imagined such a marvel as nature is.
– Richard Feynman, "The Meaning of it All"

OUR UNIQUENESS lies in our brains, tongues, and hands, that have allowed us to accumulate knowledge (or to decrease ignorance), building on the experience of previous generations in a way that no other species can. … And if we are alone in the universe, we are alone in the sense that we are our own masters, and have no one to blame but ourselves, for if the future is anywhere it is in our heads. – Colin Patterson, "Evolution"

NOTHING I LEARNED [in school] had any bearing at all on the big and real questions. Who am I? What am I doing here? What is the world? What is my relationship to it?
– George Gaylord Simpson, "This View of Life"

BEING WELL-ADJUSTED to a sick society is not a sign of health. – Wolfgang Theuerkauf

IT IS NOT POSSIBLE to do the work of science without using a language that is filled with metaphors. – Richard Lewontin, "The Triple Helix: Gene, Organism, and Environment"

THE PRICE of metaphor is eternal vigilance.
– Arturo Rosenblueth and Norbert Weiner, quoted in "Triple Helix"

NECESSITY *is* the mother of invention, and regulatory compliance is a powerful form of necessity. – Naomi Oreskes and
Erik M. Conway, "Merchants of Doubt"

THEY'RE MAKING more people every day, but they ain't makin' any more dirt.
– Will Rogers

Thanks to our contributors

PLEDGES

Pledge donors give through periodic deductions from bank accounts or credit cards, increasing our financial stability.

Eileen Althouse · Clifford & Rebecca Ambers · Angela Anderson · Alan Arnold · Lawrence & Mary Baldwin · William & Terry Baldwin · Greta Bernatz Chris & Mary Bieker · Harlan Bjornstad · Donald Blair · Charles & Dianne Boardman · Sheryl Breen · Robert & Janet Brown · Dhira Brown · D. Gordon Brown & Charlene Irvin-Brown · E. Charles Brummer · Will Brunner · Bernard & Cynthia Buchholz · Chad Burns · John & Eleanor Butler · Margaret & Edmund Campion · Janeine Cardin & David Ritter · Meri Carlstedt · Jim Carlstedt · James & Marianne Cassidy · Lorna & D. Caulkins · Cedar Valley Honey Farms · Benjamin Champion · Douglas Clarke & Bambi Semroc · Kenneth Cramer · Timothy & Sarah Crews · Alice Jo & Stanley DeFries Shawn Dehner & Jamie Purnell-Dehner · Al & Mary DeSena · Fred & Arlene Dolgon · Nathanael & Marnie Dresser · James & Mary Dudley · Blythe Dyson & Hannah Arps · Jean Emmons · James Erickson · Terry & Sam Evans · Eric Farnsworth · Rebecca Ferrell & Michael Golec · Lisa Ferro · John & Julie Franson · Jim & Annabel Fredrickson · Steven Freilich & Daphne Greenberg · Prescott Frost · Jared & Cindi Gellert · Samuel Goldman · Nils Gore & Shannon Criss · Howdy Goudey · Barbara Greenewalt · Shirley Griffin · Philip & Patricia Hahn · Patricia Hansen · John Hart & Jane Morell-Hart · Karen Harvey · David Haskell & Sarah Vance · David Heckel · Bjorn & Leanne Helgaas · Bernt & Suzie Helgaas · James Henson · Bette Hileman Thor Hinckley & Alison Wiley · David Hodges · David Hoff · John & Gloria Hood · Shae Hoschek · Mark & Linda Howard · Gary & Michele Howland Andrew Hryniewicz · Liz Huffman · Jon & Audrey Hunstock · Lee Hunter · Wes & Joan Jackson · Jean-Luc Jannink · Dorcie Jasperse · Christopher & Rita Jensen · Lawrence & Mildred Jensen · Eric Johnson & Michele Roesch-Johnson · Guy Johnson · Max & Helen Johnston · Jimmy Jones · Todd Juengling · Michael & Shawna Lea Karl · Robert & Judith Kelly · Bruce Kendall · Lincoln Kern · Ingrid Kirst · Keith & Amanda Kisselle · Leslie Kitchens · Walter & Barbara Koop · Mark & Jean Kozubowski · Mildred Krebs · Keith Krieger · Adam & Aubrey Krug · Tom Larson · Marietta & Alden Leatherman · Benedict & Ann LeFort · David Leitch · Frances Schneider Liau · Janice Lilly & Cary Buzzelli · Mark Lindquist & Kristine Schlangen-Lindquist · Jonne Long · Kenneth & Sherri Louis · Kevin Lowe · Sandra Lubarsky & Marcus Ford · Michelle Mack & Edward Ted Schuur · Kathleen Maddux · Gordon & Margaret Mallett · Grant Mallett & Nancy Tilson-Mallett · Rosette & Michael Malone · Joanne Marsh · Helen Martin · David Martin · Thomas & Nina Mastick · Ardean & Robert Maxey · Karin McAdams · Carl & Mary McDaniel · Christopher & Lynda McElroy · R. Michael & Debra Medley · Rachel Melis · Sara Michl · Howard Mielke · Bart Miller & Lisa Seaman · Suzanne Mittenthal · Robin Mittenthal · Bonny Moellenbrock & Michael Lowry · James Morgan & Teresa Maurer · Philip & Lona Morse · Margaret Moulton · Karen Nease · Frank Neitzert · Stanley & Ann Nelson Chris Neubert · Jayne & David Norlin · Richard & Elizabeth Norton · Zachary Nowak · Thomas & Nancy O'Brien · Julia Olmstead · Richard & Christine Ouren · Jerry & Carole Packard · Harold & Dorothy Parman · Gregory Parsons & Dorothy Johnson · Steven & Carolyn Paulding · C. Diane Percival · Joan Peterkin · Loretta Pickerell · Chris & Meghan Picone · Robert & Karen Pinkall · Allen & Charlotte Pinkall · John & Lee Pitman · John Pollack · Paul Post & Kay Kelly · Jerry Quance & Marcia Hall · Kevin Radzyminski · Thomas Rauch & Joyce Borgerding · Richard & Joyce Reinke Kenneth Rich · Jeannine Richards · David & Jane Richardson · James Rose · Wolfgang Rougle · Claire Schosser · Clair Schultis · Peter & Helen Schulze Tracy Seeley · Suzanne Shafer · Kathryn Shattuck · Frank Shaw & Alison Mary Kay · William & Cynthia Sheldon · Bob & Doris Sherrick · Susan Sievers Lea Smith · Ronald Smith · James & Katherine Smith · Eric Stewart · Amanda Stewart & William Smith · George & M. Rosannah Stone Bianca Storlazzi · Gail Stratton · Persis Suddeth · Gerald & Sandra Swafford · Toby Symington · Termini Associates · Bruce & Sharon Texley · David & Meg Thompson · Bob & Cheryl Thummel · Ruth Anna Thurston · David Toner · Valerie & Roger Vetter · Carol & William Walker · Kenneth & Dorothy Weaber · Richard Weaver · Robert & Judith Weeden · David & Barbara Wilson · Bruce & Kristina Wittchen · Kathleen Wold · Kevin & Diana Woods E. Parker Worley · David & Rita Wristen · Donna Wygle · John & Jane Young · Debra Young · Dane Zeller · David Zimmermann & Emily Marriott

IN HONOR

Adrienne Birt, from Tom & Isolde Birt · Matthew Cordes, from Mom & Dad · Gregory Costanza, from Lynn & Rod Morrison · Sam and Terry Evans, from Dave & Rita Wristen · Robin Gingerich & Tom Mersmann, from Louis & Harriet Caplan · Ruth Grace Maier, from Chuck Maier · Grant Mallet, from Frank and Erika Messmann · Lisa Minucci, from Lisa Gansky · Emily Oakley, from Bernard & Marcialyn Robinowitz · Kevin K. Price, from Barbara L. Price · John M. Simpson, from Grover B. Simpson, and Dave & Rita Wristen · Tennessee, from J. R. Anderson

MEMORIALS

Phyllis Dunn, from Patty Melander · Maynard Heckel, from David Heckel · Ralph Holland, from John & Catrinka Holland · Raymond McLain, from Bruce Connors · Ruthann Beyer Oelsner, from Geoffrey Oelsner · Robert Sudlow, from Geoffrey Oelsner

GIFTS

These friends made donations during June through September.

Marilyn Adam & Ralph Tauke · Calvin Adams · Al's OverHead Door Service Inc. · American Prairie Reserve · Sam & Beckie Anderson · Joseph & Hazel Anderson · Gary & Jean Anderson · Ray C. Anderson Foundation Inc. · The Annenberg Foundation · Anonymous · Craig Anthony Arnold · Eric & Melonie Atkinson · Kristie Avery & Jim Rothwell · DeWayne & Sherry Backhus · Catherine Badgley & Gerald Smith · Gregory Bamer · Bank of America Matching Gifts Program · Kenneth & Iralee Barnard · Trenton Barnes · Martin Bates & Janie Stein · Roger & Gretchen Batz · W. Reese & Donna Baxter Diane & William Beachly · Janice Becker & David Shaw · Mary Lou Bender · Mayrene Bentley · Robert & Elizabeth Berkebile · Dale Berry · Dennis & Marilyn Bettenhausen · Thomas & Beatrice Isolde Birt · Lowell & Robynn Bliss · John Blume & Karen Dryden · Gene & Christine Bowlen · Devon Brewer · William & Joan Brock · Jack Brondum & Patricia McGowan · Christina Brown · J. Christopher Brown & Denise Perpich · Owsley Brown Charitable Foundation Inc. · Robert & Patricia Bruchman · Kenneth Bruene · Gary Brunk & Joey Sprague · Nathaniel Brunsell · Paul Burmeister Sheldon Burr · Steve & Ginny Burr · Robert & Sara Caiola · Edward Callaghan · Patrick Cameron & Geneva Hershberger · Craig Cantrell · Louis & Harriet Caplan · David & Bonnie Carlson · Carolyn Foundation · Robert Cashman & Paulette Lewis · Lucia Cate · Samuel & Cynthea Caughron The Ceres Trust · Thomas & Sandra Champion · Jeff Clements & Nancy Heselton · Clif Bar Family Foundation · Michael Clow · David & Frances Coleman · Common Ground Farms LLC · Wallace & Nancy Condon · Bruce & Marti Connors · K. L. Cook · Eugene Cordes · J. Marc Cottrell · Edward Couchenour · Anne Cowan · William & Ann Crews · John & Vera Cromwell · Clark & Linda Cropp · Kenneth & Eloise Dale · William & Kristine Davis · Sabino & Janice DeGisi · Dean Denner & Cia Verschelden · Jill DeWitt · Torry Dickinson & Robert Schaeffer · Dennis Dimick & Kim Kostyal Merlin & Sandra Dresher · Carol & Robert Duggan · Naomi & Dirk Durant · Ecumenical Project for International Cooperation I · Martin & Sue Eddy Thomas & Ginnie Eddy · Howard D. Ege · Paul & Anne Ehrlich · Robert & Marilyn Sue Eichhorn · Philip & Becky Elder · William Elias · Neil & Barbara Elliott · Thomas Erger · Arlen & Lana Etling · Eugene Farley · Elizabeth Farnsworth · R. Lowell Fey · Yadi Flannery · Mariam Fleming · Ford Foundation Matching Gift Program · Kim Forehand · Foundation for Sustainable Forests · Barbara Francisco · Kevin Freed & Anne Russell · Mark & Renee Freeman · John & Olga French · Duane & Elizabeth Friesen · Jeffrey Funk · Richard & Janet Futrell · Lisa Gansky · Robert Gibson · Marilyn Glenn · Susan Gordon & Patrick Hamilton · Kenneth & Shirley Gowdy · Mark Graf · William H. Graves Family Foundation · Anna Graybeal · Greater Kansas City Community Foundation · William Green · Dale Griffith & Susan McDonald · Michael Grimm · Lisa Grossman & Kelly Barth · Toby Grotz & Kathryn Bradley · David & Michelle Gundy · Dale Hagman · Halliburton Giving Choices · Darrell Hamlin & Shala Mills · Walter Hanson · Harrods Creek Farm · John Hazlet · John Head & Lucia Orth · Amy Hemmer · Frederick & Cheryl Heppner · Alan Hering · William Hine · Joyce Hofman · John & Catrinka Holland · Hunter Hollins · Duane & Cecilia Holm · William & Suzanne Horn · William Horton · Hospira · June Howard · Charles Howe The Hunter-White Foundation · Matching IBM International Foundation · Gilford & Nelda Ikenberry · Debra Israel · Martin Jacobs · Edward Jacobson Family · Carole & Larry Jacoby · Jim & Susan Jantzen · Paul & Elaine Jantzen · John & Reinhild Janzen · Marla Johnson · Bruce Johnson & Barbara Hagen · Johnson Family One Earth Fund · David & Jean Jones · Troy Karlin · Elisabeth & Theodore Kasckow · Jeffrey Kasoff · Andy & Nan Kegley Dan Kenney & Maykin Dunn-Kenney · Edwin Kessler · Joseph & Lucille King · Kim Kirby · Kooters Geology Tools · Edward Kopta · Jill Korbelik Nic & Mary Korte · Cleo Kottwitz & Judy Parsons · Margaret & Tad Kramar · Stephen Krebs & Christine Povinelli · David & Heidi Kreider · Margo Kren · Wendell & Judith Kurr · Don & Imogene Kurre · Joel Kurz · David & Carol Kyner · Mary Ladner · Elmo Law · Ronald & Jean Lee · Eileen & Paul LeFort · Dee & Robert Leggett · Ralph Lentz · Dennis Lewis · Luyao Li · Kristine Light · Robert & Susan Liva · Lonetta Lollar · Brian Longfellow Alice Loyd · Eloise Lynch · Rodney & Sarah Macias · James Mahnke · Susanne & Walter Maier · Charles Maier · J. Bryan & Connie Mann · Dave Manning · Joseph Mantoan · Kevin Markey & Candice Miller · Mary Marshall · Danile Martens · Andy & Janelle Martin · Anthony & Patricia Martin Rebecca Martusewicz · Julie Maxson · Chris Mayda · William & Julia McBride · John & Virginia McCall · John McCamant & Paula Vandusen Newton McCluggage · Tom McClure · Fred McColly · Karen McCoy · Carl & Mary McDaniel · Jean & David McDermott · Lane & Janet McDonald Mary & Gary McDowell · James McFadden · Sara McKoy · C. Patrick & Martina McLarney · Patrick McLaughlin · Marilyn McNabb · Sidney & Beverly McVey · Karen Meier · Patricia Melander · Margaret Mellon · Merck Partnership for Giving · Leigh & Charles Merinoff · Frank & Erika Messmann Kate Meyer · Rex & Sally Miller · Robert & Kay Moline · Mary Moloney · Steve Morgan · Robert & Sharon Morgan · Jerome Morgan · Ann Morris Brian Mosley · Michael Mullis · Martha Murchison · Michael & Cheryl Murray · Deborah Murray & Jerome Dees · Michael Musselman · Anthony Nahas · Linda Mary Neal · Thomas Neet · Andrew Neill · Neiman Environments Inc. · William & Char Neumann · Melinda Nielsen · Rae Ann Nixon Carolyn Nolte · David & Janice Norlin · Jayne & David Norlin · Rita Norton · Janet & John Nybakke · Geoffrey & Leslie Oelsner · Debra O'Quinn

Marian O'Reilly & Stephen Lockwood · Jack & Susan Oviatt · Stephen Palmer · Jacquelyn & Bruce Palmer · John & Sharon Palmquist · Karl & Elizabeth Parker · Allen Parleir & Elia Woods · Edward & Seliesa Pembleton · R. Abner & Kathryne Perney · Jeannie Peters & Chuck Rose · Maggie Pettersen · Stephen Philbrick · Lisa Piazza · David & Betty Pollart · David & Jill Pollock · David & Beverly Porter · Portland General Electric · Juanita Potter · Ramon & Eva Powers · Thomas Prebyl · Barbara Price · Thomas & Sandra Pritchard · P. J. Quell & Larry Davis · Trucia Quistarc · Steven & Pamela Read · Evelyn Reed · John R. Reeves · Matt & Tia Regier · Cindy Regier · Douglas & Judi Reid · Vicki Richardson · Wilma & Richard Righter Michael & Kathleen Riordan · Gordon & Barbara Risk · Henry Robertson · Bernard & Marcialyn Robinowitz · Douglas Romig & Lori Graham · Jean Rosenthal · Vincent Rossignol · Michael Rues & Ann Wakeman · Karen Ruff Noll & Michael Noll · Eric & Christine Rumsey · T. A. Sampson Matthew & Molly Sanderson · Mark & Madge Saville · The Scheerer Family Foundation · George & Sherry Schloemer · Jan Schultz · Cara Schuster Diana Scott · Matthew Seeger · Scott Seirer · Stuart Shell & Dana Freeman · Mary Helen Shortridge · Mel Shuman · Grover & Mary Beth Simpson Simpson Foundation · Curtis Sloan & Helen Duritsa · Gerald & Eda Smith · Stephanie Smith · Marjorie Smith · SOR Inc. · John Steggall & Martha Quenon · Richard & Peggy Stein · Betty Sterling · Paul & Colleen Stock · Victor Stoliarchuk · Howard & Margaret Stoner · Naomi Strand & Virgil Augustine · Selka Straughn · Marjorie Streckfus · Doug & Cathy Strubel · Donovan & Marla Stucky · Liatris Studer · Connie & Karl Stutterheim Robert Sundene · Robert & Mary Super · Joshua & Kimberly Svaty · William Szal · James Tarnowski & Judy Berkshire · Edward Tasch · Ed Taylor James T. & Rosa Lea Taylor · Gary Tegtmeier · Rich Thibodeau & Catherine Bibb · Margaret Thomas · Margo Thompson · Robert Thompson · Ronald & Lois Todd-Meyer · Beef Torrey · Barbara Tracy · Patricia Traxler & Patrick Wallerius · Trinity Episcopal Church · Unilever U.S. Foundation Inc. Walter & Joyce Utroske · Christopher Valentine · Patricia VanderBeke · Patrick Vanek-McGillivray · Sidney & Virginia Vetter · Elizabeth Vollbrecht Diane & Robert Waddell · A. Paul & Mary Wagoner · K. T. Walsh · Eldon Wancura · Laurie Ward · Thomas Warner · Carroll Webber · Robert & Patricia Weber · Doug Weller & Nancy Arnoldy · James Wellman · Marianne Wells · Gary & Alberta Whitenack · Miriam Wiebe · Glenn Wiens Ray Wilber & Cathy Dwigans · John & Anne Wilson · Robert & Ursula Withrow · Don & Bobbie Woerner · World Stewardship Institute · Wright-Ingraham Institute · David & Rita Wristen · Bruce & Margaret Wyatt · Arthur & Linda Youngman · Louise & James Zaffiro · Theodore & Vera Zerger Mark Zimmerman · John Zimmerman · Zimmerman Family Foundation Inc.

DONORS OF TIME AND GOODS

Charles Alt-Duell · Nancy Arnoldy & Doug Weller · Marty Bates · Tyndol Brundage · Melanie Catlin-Sweeney · Sarah Crews · Mike Everhart · Kelli Exline · Bill Fekas · Paula Fried · Brenda Goll · DeMay Grunden · Jennifer Grzegorzewski · Brigid Hall · Amy Hemmer · Tim Hobson · Liz Huffman Joan Olsen Jackson · Adam Krug · Aubrey Krug · Pat Letora · Norma Mangual · Curt Marshall, United Country Theurer Auction/Realty, LLC · Andy Martin · Janelle Martin · LaNay Meier · Mary Mertz · Ann Marie Morris · Kathleen Pierson · Karen Pinkall · Martha Rhea · Emily Rude · Saline County Fair Board · Donna & Gene Sandberg · Heather Smith · Janie Stein · Howard Stoner · Noni Strand · Marla Stucky · Benjamin Thomas · Jan Wilson

The writers and artists

Scott Seirer is The Land Institute's managing director. Berenice Abbott (1898–1991) was best known for her photography of New York City in the 1930's. She also made photos to illustrate physics, and invented photographic devices. Maria Luisa Crawford is a professor emerita of geology at Bryn Mawr College and curator of the college mineral collection. She takes composite pictures of geological and scenic features around the world. Duane Schrag works in The Land Institute's development office.

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 3-11-12, this is your last issue. Please renew your support.

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

LR104