Land Report

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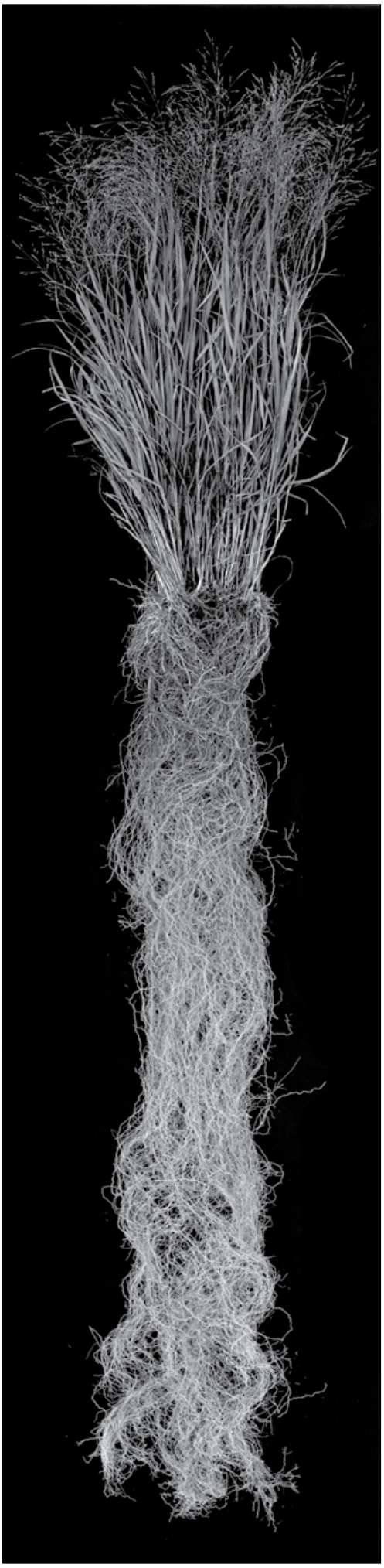

Resilience: A Positive Substitute for Growth

Wes Jackson

Call It Climate *Disruption*

Soil's Stand-In

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Cover
A 6-foot man whose feet were at the base of this switchgrass plant's leaves and stems could look straight across to the seed heads. Below his feet the perennial's roots would continue 10 feet more. That mass and stature both secure and work with soil, which is vital to feeding us. But soil is hard to sell as an endangered species. Roots are sexier and may help make the connection. For more, see page 20. Steve Renich photo.

Features

Regulars

Neglectum
The summer *Land Report* should have included with the poem *The Farm on the Great Plains* this credit: Copyright 1959, 1998, the estate of William Stafford. Reprinted from *The Way It Is: New & Selected Poems*, with the permission of Graywolf Press, St. Paul, Minnesota.

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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.

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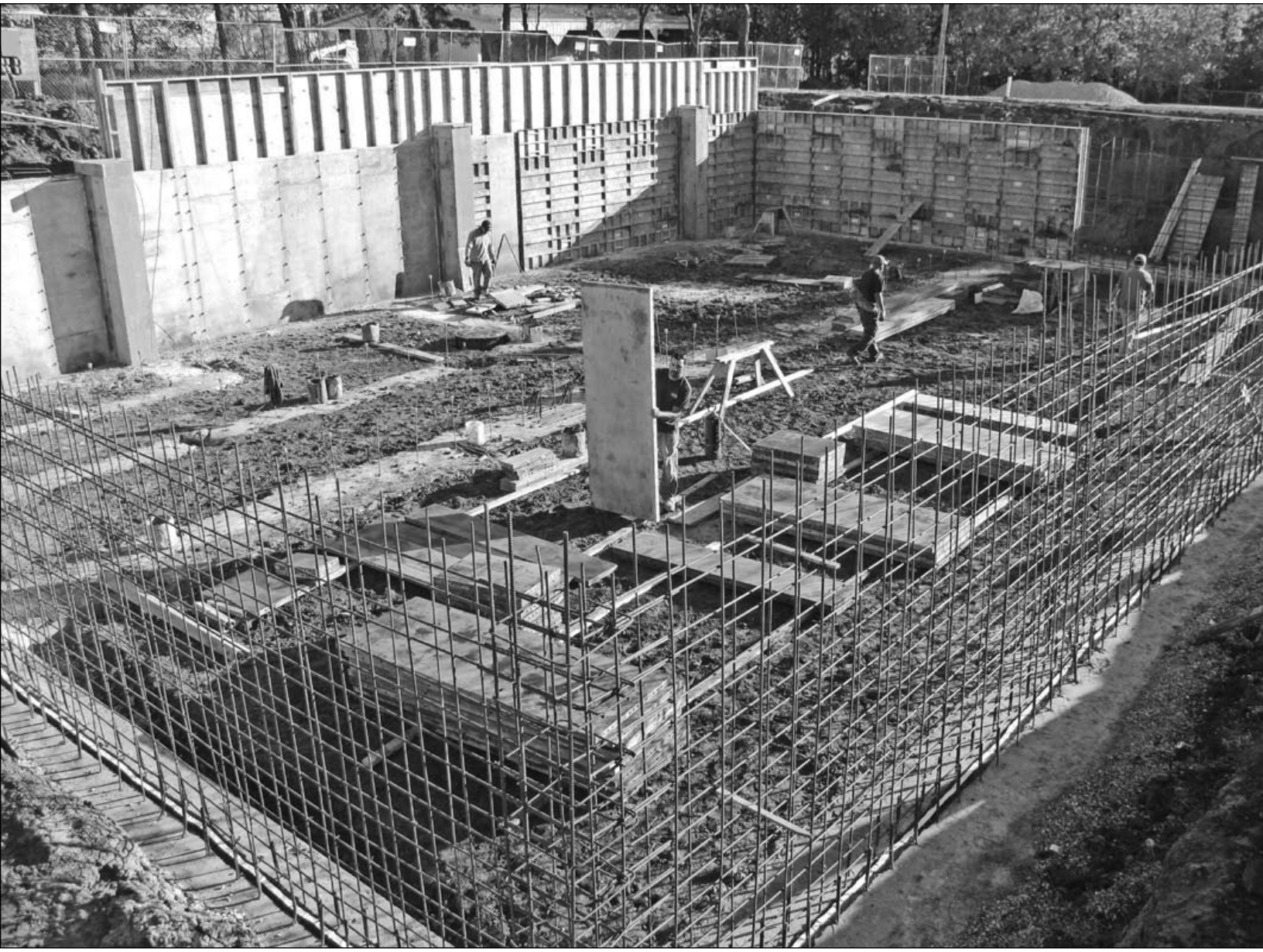
At The Land

Barnyard Language

At a monthly lunchtime meeting, Land Institute staff members report what they've been doing and what's new. For example, Joan Jackson, from development, would tell how much money has been raised in the $3 million capital campaign for a new research center and other building improvements. By the October meeting, that was $2.25 million.

At the September meeting, plant breeder David Van Tassel told how packing equipment in the metal barn on The Land Institute's 72-acre farm made it difficult to reach gear stored in the middle. First he must start the engines of things he doesn't need and move them out. And at some point he must move them back. This all takes time from productive work in the field. Van Tassel finished his



Forms come off basement walls of The Land Institute's research center. Spring should see the building done. Scott Bontz photo.

complaint with a constructive question: Is there a way to make equipment access easier and quicker?

Mechanic Ron Kinkelaar shot back two words: pole shed. A pole shed is basically a barn without walls, and the capital campaign includes building one. Co-workers near him understood Kinkelaar's blunt response. But Van Tassel was across the room and thought he might've heard something else – an earthy counter that might come from a man in charge of equipment when hearing a critique of how he stores it. After slight pause, and, in the memory of some, with a slight pitch forward in his seat, Van Tassel intoned as question a two-syllable word for something else often found on a farm, and which nearly rhymes with pole shed – say it fast.

Laughter is a great peacemaker. And enough of the two dozen people in the room had heard both men right that their laughter tumbled any coming rumble.

There are two lessons here. If you visit The Land Institute and think you hear someone say something close to "pole shed," carefully interpret by context and intonation, and if necessary ask for clarification. We're happy to talk. And please consider the extra, smoothing benefits that may come from giving to The Land Institute capital campaign.

Construction for the campaign's priority, a new research center, began in late summer. Concrete was poured into foundation forms September 30. The campaign needs $750,000 more for improvements to the greenhouse, described in the summer Land Report, and to the office. Anyone who has visited that office, in what originally was a house and in many ways still looks like one, knows that you must stand in a hallway until someone finds a place where you can sit for conversation, and with nowhere to view our plant samples and root photographs. (For more about those big pictures, only in the small scale of a magazine, see page 20.) That will be solved after completion of the capital campaign. The campaign also will make office space more efficient for the work of staff members, plus make space for new members without costly building add-ons. And it will raise that pole shed.

$1 Million for Perennial Wheat at Michigan State

Starting with Washington State University and Land Institute seed, Michigan State University will conduct a $1 million, four-year project to help develop perennial wheat. The funding is from the US Department of Agriculture.

The Land Institute's work has been about breeding. Michigan State's program will focus on how to farm perennial wheat well. That will include weed management, row spacing, fertilizer regimen, and best planting and harvesting times. "There's a lot that we don't know" said Steve Culman, a former Land Institute graduate fellow. He is managing the work at the W.K. Kellogg Biological Station in Kalamazoo County, about 115 miles west of Detroit. The project also will calculate the economics that farmers would face, and devise a way to reach farmers through extension agents.

Another graduate fellow, Brook Wilke, planted seed from Washington and The Land Institute in fall of 2006. Some of the plants survived well in Michigan, which, wrapped by huge lakes, has more moderate winters and summers than Kansas. The wheat also yielded respectably, Culman said. But the plot was less than one acre – too small to show what would happen on a farm. To find out, Sieglinde Snapp, an associate professor of crop and soil science, applied for the USDA grant.

Michigan researchers will plant an acre this fall with seed from the latest breeding. Next year, with more rigorous study than was possible under previous funding, they will harvest seed and with it plant out several acres. There is wide genetic possibility to draw from in making perennial wheat. But Culman said there is little seed yet from each of the promising lines. Building the supply will take generations of plants.

Culman said that problems from agriculture are worsening, and the more help with developing perennial grain crops, the better. He wants to see built a kind of critical mass for the work and for increasing awareness among researchers, farmers and the public.

Climate & Energy Project

Recent highlights of our Climate & Energy Project's work to promote renewable energy and energy efficiency:

■ To keep Kansas voters in touch with congressional work on renewable energy, CEP launched www.renewkansas.org. Renew Kansas offers timely reports on energy policies affecting the Plains, plus vote tracking and e-mail alerts about legislative developments. Four weeks after launch, the site had registered over 9,000 hits, and over 800 people had signed up for alerts. More than 10 news outlets started following Renew Kansas on Twitter, as did several other groups with interests in energy policy.

■ Take Charge Challenge is a yearlong competition among six Kansas towns to reduce energy use. Since the contest began in April, together the towns have saved more than $180,000 simply by changing to compact fluorescent lights. In a project called "Vampire Loads," schoolchildren will learn about the electricity still consumed by appliances that are turned off or in standby mode, and how to address the problem with power strips. CEP also works with large industrial users to improve the energy efficiency of buildings and operations. Via the Boy Scouts, Take Charge communities will distribute kits to help seal homes against energy loss during winter.

■ Kansas Interfaith Power and Light continues offering energy audits to member congregations, and is developing a series of energy and creation care sermons that will be available online.

■ The Kansas chapter of the Blue Green Alliance collaborated with the Department of Commerce to host

a workshop for manufacturers who want to retool for the wind industry. The alliance also sponsored a "green jobs" tour of Topeka, Wichita and Kansas City for more than 120 environmentalists and labor union leaders.

■ Executive Director Nancy Jackson talked about energy and water at a hearing of the Kansas Legislature, and was appointed to the Citizens' Utilities Ratepayers Board. CEP is also participating in the Kansas Corporation Commission's rules and regulations process for a renewable energy standard, plus net metering and interconnection standards. A renewable energy standard requires utilities to generate a certain amount of power from renewables. Net metering and interconnection standards allow homeowners, schools and businesses to generate their own power from small solar or wind and to sell it back to the grid.

■ Each week 1,250–1,500 readers visit blog.climateandenergy.org, and www.climateandenergy.org recently updated its energy savings tips. CEP also provides energy information to news media throughout the state.

■ Kansas Gov. Mark Parkinson honored CEP in the annual Governor's Energy Achievement Recognition Awards. It was recognized as leader among nonprofits working on renewable energy.

New Board Chairman

After leading The Land Institute's Board of Directors for 10 years, Conn Nugent, saying he faced other demands, asked to step down. He will remain on the board. The new chairman, beginning January 1, will be longtime board member Angus Wright. Land Institute President Wes Jackson praised Nugent for serving the organization well through its period of largest growth. At the Prairie Festival he called Nugent an "indispensable intellectual source." Nugent is executive director of J.M. Kaplan Fund in New York. He previously led Citizens Union of the City of New York and International Physicians for the Prevention of Nuclear War. Wright, who grew up in Salina, is professor emeritus of environmental studies at California State University, Sacramento, and author of *To Inherit the Earth: The Brazilian Landless Movement in the Creation of a New Brazil* and *The Death of Ramon Gonzalez: The Modern Agricultural Dilemma*.

Presentations

National Public Radio science reporter Richard Harris profiled The Land Institute's work on the October 21 edition of *All Things Considered*. For Harris' address to the Prairie Festival, see page 10.

The summer *Land Report* said that Wes Jackson, Wendell Berry and Fred Kirschenmann met with Agriculture Department officials in Washington to promote a 50-year farm bill for returning land to soil-preserving perennial cover. While the ink was drying on the magazine July 22, *The Washington Post* ran a short interview and photo, headlined "3 Wise Men, Planting Ideas Where It Counts."

Biscuits served on the October 5 *Martha Stewart Show* used flour from one of The Land Institute's developing perennial grains. Stewart visited Ted Turner at one of his Montana bison ranches, and Turner's chef made bison-shaped biscuits from Kernza. Kernza is a trade name developed for intermediate wheatgrass, which breeder Lee DeHaan is both domesticating and crossing with wheat. Stewart's blog shows her holding a biscuit, and says, "By planting grains that are perennial, you cut down on plowing and the potential of creating a dust bowl." But it will be years yet before Kernza is available to farmers.

This column notes where Land Institute staff members have talked and will talk about their work. It usually doesn't tell of the many interested parties who come to The Land Institute, where the education is available all year. Here's a bit about one visiting group this summer. Eastern Mennonite High School, Harrisonburg, Virginia, brought 25 students who were on a 25-day bus trip across the nation and back for what teacher Myron Blosser called "dissonance education." The students met, among others on ecological divides, with a man from a mountain being removed for coal, and with the CEO of the removal engineering company. They visited redwood preservationists in California and slept over with a family that had logged in Oregon for generations. They toured a confinement dairy farm in Minnesota and had breakfast with Amish farmers in Ohio. Blosser said, "Maybe mediation is more important than bandwagoning." And he didn't want students to remain in a classroom, passive.

Land Institute staff members spoke at conferences and colleges in New Mexico, Iowa and New York. They also visited China to talk with Chinese and Australian breeders of perennial grain – see page 6.

Upcoming: November 16, University of Chicago. December 3–4, Stone Barns Center, Pocantico Hills, New York. January 20–23, EcoFarm Conference, Pacific Grove, California. March 15, Illahee Lecture Series, Portland, Oregon. April 11–12, Xavier University, Cincinnati. April 12, Glen Helen Ecology Institute, Yellow Springs, Ohio.

For more, call us or see Calendar at landinstitute.org.

P.S.

The Iowa visit noted above was Wes Jackson in Coon Rapids to commemorate Soviet Premier Nikita Khrushchev's visit to the farm of Roswell Garst 50 years ago. More than 20 Russians attended, including the agriculture secretary. Also present was his American counterpart, Tom Vilsack, and the former premier's son, Sergei Khrushchev, now an American citizen. Back at The Land Institute, Jackson briefed Managing Director Ken Warren:

Jackson: Khrushchev did a lot of the translating between me and the secretary of agriculture.

Warren: You mean Vilsack?

For more on Jackson's engagement with Russians, see page 14.

The grass on this hill in south China is not a securing perennial cover, but annual rice. In a couple of years it and erosion will exhaust the soil. Many years more will pass before the slashed and burned forest recovers – only to then fall again for planting rice. Hu Feng-yi holds what could eventually both feed the farmer and hold the soil: perennial rice, with the spreading, long-lived underground stems that annual crops lack. David Van Tassel photos.

First International Perennial Grain Breeding Workshop

David Van Tassel

In a major expansion of The Land Institute's vision of soil-conserving, grain-producing agriculture, in September scientists from three continents gathered in Kunming, China, to exchange data and seeds. The workshop was hosted by the Yunnan Academy of Agricultural Sciences.

Bright red Chinese characters scroll across the LED display as we enter the elegant conference room. English text catches our attention: "First International Perennial Grain Breeding Workshop." Perhaps because none of us had ever really expected to see "perennial grains" in lights, we stop and stare. We take photos.

The godfather of perennial rice, Tao Da-yun, opened the conference, particularly welcoming the international delegates. Da-yun, working in Thailand in the 1980s, made the world's first and only perennial and fertile hybrid between rice and a wild perennial African species. He now directs the academy's Food Crops Institute, which houses the perennial rice breeding program that The Land Institute has supported financially for three years.

We tread carefully, single file, on narrow dikes that divide paddies at the year-round rice breeding nursery on tropical Hainan Island. A misplaced shoe will quickly be buried in 12 to 18 inches of gray, anaerobic muck. Most rice grows in level, frequently flooded paddies. Three clumps of grass have nearly taken over a paddy. These are from Da-yun's hybrid. They are clearly healthy, long-lived and aggressively spreading. They are also almost completely seedless. Our guide, rice geneticist Hu Feng-yi, assures us that most of the plants in the perennial rice program are not as invasive. He leads us from paddy to paddy, many containing several thousand plants. Each plant was transplanted by hand. It's a good thing that Feng-yi and his team are such workaholics: The first set of about 6,000 plants yielded only two plants that made both seeds and the underground stems lacking in normal, short-lived rice. The breeders make progress by letting these few fertile plants self-pollinate over several generations, and by crossing them back to annual rice. They also are developing genetic maps and markers to speed selection, before plants go to the field.

"We will look back on this workshop as the international launching of the perennial grain revolution," Land Institute research director Stan Cox told the group. Stan and Feng-yi organized the meeting. Later in the day, Land Institute plant breeders gave presentations about their work in Kansas. Don Wyse, of the University of Minnesota, told how he and his students are breeding perennial grain sunflower and flax. Len Wade, of Australia's Charles Sturt University, described how 10 perennial wheat breeding lines from Washington State University, The Land Institute and the Australians' own work have survived to produce second seed crops. Land Institute wheat breeder Lee DeHaan has provided Len material from more recent breeding. The Land Institute also has supplied the Yunnan Academy with seed. They showed only a handful of wheat and sunflower plants, but had a vast greenhouse area growing sorghum, and some of the lines looked very good – in some cases even better than in our fields. This is not a formal breeding program. As with so many projects and prospects discussed at the conference, there is the challenge of funding.

As the plane drops below clouds, among lush hills appear rivers colored like chocolate. Erosion. We have flown from Kunming to an isolated region near Thailand, to see where perennial rice could first and most dramatically cut soil loss. Rice here is far less productive than the paddy rice in Asia's agricultural heartlands. But it is grown on sloping ground even without terraces, which are tremendously costly. After hours of driving on narrow, twisty roads, we emerge from young rubber tree plantations that feed China's growing demand for car tires. A green field falls away from the road. It is dotted with charred stumps. We meet a wiry farmer. His challenges: The unprotected soil and nutrients will wash downhill between rice crops. In a couple of years the spent field will be abandoned and he will have to cut another patch of forest, burn the stumps and hoe up the ground. The benefits of a perennial crop that holds tightly to both soil and nutrients are obvious.

The Chinese conference audience amazed Stan by staying through talks in English that many couldn't understand. But there followed an even more uplifting conclusion: Several of Feng-yi's colleagues requested speaking slots at the last minute. Conversations the previous day had excited them about perennial grains, and they wanted to brainstorm. Small-grain breeder Yang Ju-hua expressed interest in perennial wheat. Subsistence farmers would be very interested in perennial wheat because erosion is severe on highland wheat fields, he had told Lee earlier. And because most of the wheat is used directly by the farm family, he said, perennial wheat could be adopted in China long before it is commercially viable in Australia or the United States. His photos of tiny wheat fields on steep, eroded hillsides made his sense of urgency clear.

A show of hands at the Prairie Festival for action to check human addition to greenhouse gases. The "350" written on the barn with perennial grasses – complete with carbon-sequestering roots – is a level of atmospheric carbon dioxide that many scientists estimate is needed to avoid catastrophic climate change, and the number chosen for the activist group founded by writer Bill McKibben, 350.org. The preindustrial level was 280 parts per million. The level now is 385. Scientist and festival speaker George M. Woodwell said we should shoot for below 300. For more about sending a message with perennial plants, see page 20. Dennis Dimick photo.

Call it Climate *Disruption*

Scott Bontz

Two visiting scientists, one also a politician, sought radical change to stop climatic disruption of the world's biological and human economies. A journalist reported grimly on that prospect, though he sought hope in what cannot be predicted. About 500 listeners seemed to take all this well – no audible teeth-gnashing. As attendees of The Land Institute's Prairie Festival in late September, they knew much of the bad news already. But gathering inspires a fight.

And to start his talk at the festival, George M. Woodwell said, "I am going to call for a revolution – an intellectual revolution, at least. I'm calling for a new world view."

Woodwell's view of the world is broad and deep. He founded and led for 20 years Woods Hole Research Center in Falmouth, Massachusetts, and helped found the Natural Resources Defense Council, the Environmental Defense Fund and the World Resources Institute. He has written about the effects of nuclear war, the global carbon cycle, biotic impoverishment and the importance of forests to the world as a whole.

Woodwell, speaking for the annual festival's Donnelley Lecture on Restoration and Conservation, said, "We're moving into a new world … a new biophysical circumstance." He included as a cause of this change industrial agriculture, and cited a September 18 *New York Times* story about agriculture poisoning water. Woodwell has said industrial agriculture is headed toward a cliff.

But his talk focused on how climate change will affect the globe, and how it is impossible for a shredded ecosystem, or a nation that depended on it, to recover without massive outside help, something the planet can't get. Woodwell doesn't use the expression climate change. He says climate disruption. Speakers that followed him seized on his phrase as more fitting. "We are changing climate right out from under the life of the earth," Woodwell said. For example, "The forests just aren't in the right place anymore." They're falling to diseases and pests

that once stayed in lower latitudes. And tropical diseases are spreading.

Another example: New Orleans, post-Katrina. "New Orleans is now a relic," Woodwell said. It has no intrinsic capacity to rebuild a government or an environment that works. It was destroyed by a storm built by heat piling up in the Gulf of Mexico. The amount of damage was extraordinary, Woodwell said, but with a warmer atmosphere rubbing off on the water, that accumulation of power will happen again.

Haiti was devastated before news of climate disruption. The poorest nation on the Western Hemisphere has a dysfunctional landscape. It suffers under poor management and overpopulation that have stripped it of forests. Rain shifts the track of rivers across unguarded slopes. Silt in the runoff chokes fisheries. Woodwell said that civilization as we know it requires a functional government and a functional economy, which requires a functional landscape, which Haiti doesn't have. The only thing to save it would be other nations providing direction and tens of billions of dollars.

In the tropics, at least Haiti's temperature change under climate disruption will be relatively small. Woodwell explained: A major portion of the solar energy reaches earth and sea in the tropics. It evaporates water for global circulation, and the energized vapor moves toward the poles. Its condensation warms the higher latitudes. Woodwell said, "The warming is highly differential." The average temperature on land and sea round the globe is up only about 1½ degrees Fahrenheit from preindustrial level, but locations at 45 degrees latitude have reported increases of 5–7 degrees, Woodwell said, and the polar regions see more change than in temperate zones.

Also, boreal forests and tundra cover much of the high latitudes. About a third of land metabolism occurs in the Northern Hemisphere's boreal forests, Woodwell said. Warming them just a degree increases their rate of respiration, of burning off carbon compounds to the atmosphere. Tundra is rich in methane, which has a greenhouse effect many time stronger than carbon dioxide's.

If the United States preserved its old-growth forests, setting aside all those on government land, and the rest of the world did likewise, and all land shorn of trees was reforested, Woodwell said, half of the carbon dioxide that humans are adding to the atmosphere each year could be absorbed while the new trees gained mass. He said the rest of reductions would have to come from burning less fossil fuel. That share could be cut by 20–35 percent almost overnight, he said, by simple steps such as turning off unnecessary lights and ending frivolous energy use – steps that would also save money. Answering written questions after the festival, he said this will require a national plan led by the president – and persistence. More savings, such as increasing the efficiency of buildings and using solar energy to heat water, could come in short order and bring fossil fuel reduction to 50 percent, he said.

But heat lags behind carbon accumulation. So Woodwell said we must go back well under the 350 parts per million CO_2 in the atmosphere now sought by ambitious control advocates. That would be much further than the 450 parts per million that has been the aim of governments. The level before the industrial revolution was 280 parts per million, and Woodwell said, "We should be aiming for less than 300 parts per million. I'll settle for 300. But we must reach it very soon."

"The alternative is to slip into what I call the Haitian abyss," he said – "the circumstance that we can't pull ourselves up by our bootstraps."

Life in the seas and on land all work together to run the world, Woodwell said. We know relatively well how the world works economically, and somewhat politically, but, "We have an inchoate, floozy view of how it works as an ecological system," and we can't compromise this system any more than we can the law of gravity.

"We have to think of the world as a park," and treat it that way, he said. "We have to preserve the integrity of the whole earth. … The alternative is hell, literally, and in our own time."

A Newsman's Appraisal

National Public Radio science reporter Richard Harris is not optimistic about achieving Woodwell's goal. Carbon dioxide in the atmosphere is nearing 390 parts per million, with business as usual going strong. Talk is of reducing emissions 80 percent by 2050. Harris said this will get us nowhere near 350 parts per million. He said sea level is forecast to rise 2 to 6 feet, the Southwest's current drought might stay permanent, and the Tibetan plateau's glaciers, a water supply for much of Asia, might be gone in a couple of decades.

Harris covers the science and the politics involved, and he said the physical world is changing relatively fast, but political and societal changes are slow. If the United States eliminated emissions tomorrow, the problem would not be solved, Harris said: China must match America. Together they account for about half of emissions from burning fossil fuels. On top of this, he said, how can the world's 2 billion poor raise their standard of living without burning fuel like the West? That broader context makes the problem even harder.

We can conserve energy by lifestyle change, but Harris said this is a lot to expect. There are renewable energy sources, but they can take us only so far. Likewise for nuclear power and carbon dioxide capture. An easy solution to talk about is raising the cost of dirty energy, he said, but to implement this is politically difficult.

Harris said more people know more than ever about climate change, but they are actually less willing to act. "Knowledge is not necessarily power in this circumstance,"

he said. In a poll, Americans put as their top concern the economy. Number 20 on a list of 20 was climate change. Thirty percent rated it a major problem. Harris suspects that people think it's too big a problem to think about.

He considered in his festival talk three approaches to climate change: at the world level, in Washington, and at home. At the 1992 global environmental conference in Rio de Janeiro, the Bush administration signed an agreement to address climate change. It took five years to negotiate a treaty. The Kyoto Accord arranged for participating nations to set timetables for reducing carbon dioxide emissions. We're in the middle of the time span set for reaching those goals. But since 1997 China's emissions have skyrocketed, and India is expected to become a major emitter. Harris said Kyoto's failure was twofold: The U.S. Senate would not sign without some say in the language, and the accord essentially let off the developing world.

Nations met again two years ago in Bali, and scheduled for Copenhagen this December negotiations of an accord that will supersede Kyoto. Harris said there are 200 pages of accord text now, and participating nations have put brackets indicating objection around almost every sentence. "I think things look completely bleak for this right now," he said. Scientists say we can't afford more carbon dioxide in the atmosphere. But diplomats say that's not the way human endeavors work. Harris said preparing an agreeable treaty takes more than two years.

On to Washington: The Waxman-Markley energy bill

Displayed at the Prairie Festival was this illustration of breeding annual grain crops with wild perennials in The Land Institute's work toward perennial grain crops. At left is annual grain sorghum. At right is its relative, *Sorghum halepense,* also known as johnsongrass. The center plant came from breeding grain sorghum and *S. halepense,* breeding the result with a different grain sorghum, and then two generations of self-pollination. Many such hybrids look like this: much taller than either parent, with greater total mass, and seed production somewhere between. Shorter plants can be selected from the progeny of such crosses, and finally breeders will want this, so the crop puts much more of that energy into grain production rather than competitive growth. Important to note here are the white rhizomes – underground stems – at the bottom of the center plant. Rhizomes can survive the winter below ground, sprout in spring and ensure perenniality. The wild plant on the right had a much larger mass of rhizomes, but they were lost when it was dug up. Scott Bontz photo.

that passed the House in June was the United States' first big legislative try to address climate change. Proponents say that at least it will make things better than before. Others doubt it will work. The bill has about 2,000 pages, and through it are details to buy votes – favors, loopholes and escape valves – because there was no broad consensus available. Harris said one analysis concluded that development of energy alternatives actually would be better fostered without the bill.

The House bill will have to be melded with the Senate version being negotiated now. Harris said that because of the current financial mess, the Senate is concerned about creating a market for trading of carbon with fancy derivatives, and cautious about an energy law's effects on the economy. He thinks it highly unlikely that Congress will have a bill before the meeting in Copenhagen – and so, as with Kyoto, the United States will lack a clear platform from its elected representatives to take to international negotiation.

Back home: Harris did a test himself. He persuaded his editors to let him report on an energy audit of his house in Maryland. Then he bought a plug-in strip that didn't feed the TV when it was off. He replaced light bulbs with efficient fluorescents, bought a freezer that would pay for itself in a few years, built storm windows and obtained a meter to read outlet flows. He charted his bills, and had the satisfaction of seeing a 25 percent drop in electricity use. "But just flying out here to see you probably blew all my carbon savings for a year," he said – or maybe several years. Anyway, the effect was not great.

He said there was more he could do. Stop eating meat, since animal farming consumes more energy per human food calorie than does growing grain. Drive less and walk more. "Raising energy's price doesn't mean you have to pay more," he said. But convincing a broad cross-section of Americans to do this will be a tall order.

There is more we might do, Harris said. There are proposed mechanical solutions to cool the atmosphere, such as seeding it with sulfur and building large arrays of mirrors. These ideas sound crazy, he said, but scientists now are seriously considering them. (Woodwell dismissed them.)

Harris called more comforting the thought of inventing our way out of the problem. If something cheaper than fossil fuels is devised, people will switch, with no arm-twisting. The market will take care of it. But this transition could take decades.

A shortcut would be for government instigation. The market didn't initially demand computer chips, but the Defense Department saw promise in them, and became the venture capitalist for creation of Silicon Valley. The government also invested in research that drove agriculture's green revolution. "Lo and behold, the institutions delivered," Harris said. The government could, not secretly but without fanfare, pay for development of alternative energy technology regardless of the current market.

Another solution would be for societies to think differently about their place in the world. He hasn't found anyone who knows how to accomplish such a massive perspective shift. The advertising industry knows how to manipulate behavior, he said, but the kind of change demanded here will require playing to noble instincts. He thought such change might take not 30 or 40 years, but 100.

On that last depressing note, Harris said that after he gave a similar talk at a college, a professor said, "Give these kids some hope." Harris finds hope in these things: The science is clearer than ever. And though all of the individual solutions might be hard, they are not mutually exclusive. "In fact, it's not a good idea to choose just one strategy," he said. Pursued together, they can add up. Finally, "Things look really hard today, but it's really hard to see the future. … There are surprises out there. Let's be open to them. And maybe this story will have a surprise and happy ending."

A Politician's Advice

Mike Phillips began his talk with a list of words he liked: Whipple's monkeyflower, Las Vegas dace, whiteline topminnow, deepwater cisco, silver trout, sugarspoon, narrow catspaw, Tennessee riffleshell, Flint's common stonefly, fig seed diving beetle, easy yellow-faced bee and Martha. Then he said what they had in common: All were names of species gone extinct. Phillips leads the Turner Endangered Species Fund.

Martha was the last passenger pigeon. Billions of these birds that once clouded American skies were killed without study. When Martha died, she was frozen in a block of ice, sent to the Smithsonian Institution to be skinned and stuffed, and for a time was displayed.

Phillips also noted Ishi, the last of a California Indian tribe, discovered and taken from the Sierra Nevada foothills to the University of California in 1911 for examination by anthropologists until he died of tuberculosis in 1916. His brain was removed for further study.

Phillips said these stories show our fascination with the rare. He said that if habitat destruction trends continue, we'll enjoy much more such opportunity. He also said that with severe loss of populations and species, humans will suffer, from lack of plants for medicine and flood control, and of crop pollinators. The Turner fund has become interested in climate disruption because that is playing into species endangerment and extinction. "The picas are already at the top of the mountain, the polar bears already at the top of the world," Phillips said. "They've got nowhere to go."

In his home state of Montana, it's 6–7 degrees warmer than it was 30 years ago. Models forecast that there will be

no snow in Missoula 50 years from now, and in Bozeman, his hometown, 75 years. The coolest summer will be warmer than the hottest summer now.

Phillips was trained as an ecologist, and before joining Turner, he reintroduced red wolves to parkland in the Southeast and restored gray wolves to Yellowstone. In 2006 he threw himself in with another pack of wolves by election to the Montana House of Representatives. Phillips argues that individual initiative won't be enough to save us from climate change. He said, "We have to have something from on high to institutionalize a high price on carbon."

But climate change faces a hard sell in legislatures. Phillips said lawmakers haven't even mustered the intellectual curiosity to discuss it. The language involved can be dense. And the decades of lag between cause and the experienced effect, and from steps toward solution and seeing relief, is so great. "They don't enjoy the rewards, so they don't do much," Phillips said. It's also hard to appreciate the immense scale of the problem. On top of this, legislators lump together newspaper reports and peer-reviewed scientific journals. And then, he said, "They don't pay attention to the science. They barely pay attention to the newspapers." Another Montanan, climate change Nobel laureate Steve Running, dismisses the deniers of humans being the cause. Phillips quoted him: "The science is done." States don't do anything, saying they can do so little, and that action must be federal. Phillips said Kathleen Sebelius fighting new coal plants in Kansas and Arnold Schwartzenegger in pioneering California have shown that states have a role to play. Lastly, Phillips said, legislatures are hamstrung by petty partisanship.

He said that to succeed, a plan for reducing climate change must connect conservatives and liberals pragmatically and fairly. Its tapestry must be woven with recognition of how energy permeates the workings of nature and the human world: "It's the greatest connective activity of all time." The plan must embrace ecological economics, with full accounting of effects instead of ignoring "externalities." And, Phillip said, for enforcement the plan must be given full police power.

Phillips told the festival audience that as voters they must convey that it is well past time for change in energy policy. When confronted with someone who is critical of using computer models to predict climate change, he suggested, respond by saying models have the inevitable imperfection of a predictive tool, but they all have something to teach you. He said, "The models are wrong. But they describe a pattern that is certain."

Above all other dangers to come from climate disruption, Phillips said, is furthering isolation of wealth. He said upsetting of ecological patterns will widen the gap between rich and poor countries, and between individuals, and make the proportion of the poor even larger. He said that environmental refugees of climate change will disproportionately be the poor, which eventually will drive social strife the likes of which the world has never seen.

For audio recordings of these Prairie Festival talks and the others, in their entirety, see page 19.

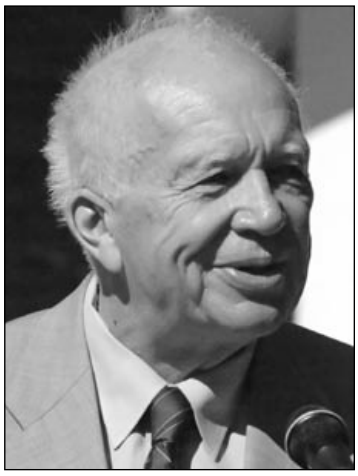
Trampling Out a New Vintage

For the Prairie Festival, Land Institute perennial grain crop breeders face a perennial challenge: to make entertaining education about their incremental progress in a decades-long process. This year senior scientist Stan Cox capped the reports, which emphasized the importance of an unfettered flow of seed and information among plant breeders, with a tribute fashioned after Lincoln's *Gettsyburg Address*. Here you'll have to imagine the accompaniment, by scientist and bass David Van Tassel, and Van Tassel's two boys, Cedar and Luke, humming *The Battle Hymn of the Republic:*

Fivescore and seven centuries ago, more or less, our ancestors brought forth on this planet the first domestic food crops. With that, they became the first plant breeders. They and the plant breeders who followed them down through the millennia have been dedicated to the proposition that every pollen and egg cell is created unique and free. It is because of that that we exist and are met here today, and will be eating lunch in a couple of hours.

Without those who came before, our work here would not be possible. Now the great task remaining before us is to take up our predecessors' unfinished work, to take those genes that provide us with food and combine them with genes that nourish and protect the soil through perenniality. That same free and open flow of germplasm that brought humanity to this historic crossroads will be needed to make that future possible.

The world may or may not note or remember what we say here, but we must never forget that our fate is tied to the fate of those seeds and plants that 500 generations of plant breeders have handed down to us. And let us resolve that the genetic legacy carried by those seeds and plants shall not perish from the earth.



Above, Iowa corn breeder Roswell Garst, with radio, and Soviet Premier Nikita Khrushchev, in jacket and hat, at Garst's farm in 1959. These two unlikely friends saw that most big problems eventually can be solved as long as people have food and water. But they promoted an agriculture that spawned unimaginable trouble. Joe Munroe photo, courtesy of the Garst family.

At left, Sergei Khrushchev, who as a young man came on his father's trip, and later immigrated. Here he speaks for the 50th anniversary event in Iowa. He also interpreted for Russian delegates and The Land Institute's Wes Jackson. Jan Flora photo.

Resilience: A Positive Substitute for Growth

Wes Jackson

At the end of August this year in Coon Rapids, Iowa, there was a celebration of the 50th anniversary of Nikita Khrushchev's visit to the Roswell Garst hybrid seed farm. Sergei Khrushchev was there, as he had been with his father half a century earlier. There were 25 or so Russians present, including the secretary of agriculture and the ambassador to the United States.

I gave a talk. In it I said the Soviet premier and Garst could not have foreseen the dramatic changes that would come over the next 50 years as a result of industrial agriculture that the two men promoted. This includes the nitrate and pesticide pollution of drinking water, the dead zones in the sea and a green revolution tied to fertilizer made with fossil fuel. Without that synthetic nitrogen, Vaclav Smil estimates, 40 percent of humanity would not be here. Also as a result of the industrial mindset, we now face energy and climate crises that will require extraordinary political will to solve.

We might succeed, I said. But once soil has eroded there will be no technological substitute. And in spite of all our efforts so far, soil erosion and other landscape degradations are increasing globally. In a few places it has been slowed by minimal till or no-till farming, but with this so-called fix, pesticides accumulate. We are poisoning our soils to save them.

I then went on to propose a solution that both of our countries can embrace, emphasizing that if we cooperate, success will come faster. Annuals grown in monocultures dominate agriculture. But essentially all of nature's ecosystems feature perennials growing in mixtures. We need to breed perennial grains. I told five stories to support why I hoped the Russians in particular would be major players in this effort for a new agriculture:

■ In the 1870s, Vasily Dokuchaev was given the task of describing the structure, origin and evolution of the deep rich grassland soils of western Russia. Classifying them had been elusive. From observations made in over 6,000 miles of travel, Dokuchaev concluded that "soil exists as an independent body and has its own special origin and properties unique to it alone." He identified five factors that govern formation of soil: climate, parent material, organisms, topography and time. His conclusions were a scientific revolution, and earned him the title of father of soil science.

■ Nikolai Vavilov, born in 1887, was internationally known as an agronomist, botanist, plant breeder, geneticist and plant geographer. He had a big-picture view of our earth, both geographically and in time. Early in his career he set out to determine where the cultivated plants originated. He traveled worldwide and made massive collections. His published conclusions set the standard for all subsequent investigations. Plant breeders still turn to them. His passion and intellect were supported by a rich Russian culture notable for its love and honoring of natural history.

■ Theodosius Dobzhansky was a Ukranian who became a U.S. citizen and is regarded as the most important evolutionary biologist of the 20th century. In 1937, he published his landmark book *Genetics and the Origin of Species*, in which he was the first to successfully integrate understanding of evolutionary problems, from his naturalist perspective gained in Ukraine, with experimental genetics, from his more recent experiences in America.

■ During the 872-day siege of Leningrad, hundreds of thousands of people died from hunger. There was every reason to believe, given its huge quantity of seeds collected from all over the world, that the Institute of Plant Industry would be overrun by the hungry people. But the institute's staff guarded the collection. And in the midst of the seeds, they too starved. The collection remained untouched.

■ Finally, there was the work by Russia plant breeders to make wide crosses between species and varieties. Their desire was to speed crop plant evolution. One of their efforts was to develop a wheat with "perennial character." Dr. Tsitsin, who summarized this work, said "among the primary features of the perennial and feedcorn wheats we are currently putting through selection is *their ability to develop a powerful rooting system*, a factor rather important for the maintenance and betterment of the soil structure,

but one of prime importance for the regions susceptible to wind erosion." (Emphasis mine) Tsitsin acknowledged that "it will be some time before the newly bred varieties can be cleared for production." He went on to say, "The fields under perennial wheat need not be replowed, the stubble will be highly snow-retentive and thus very likely to promote the accumulation of soil moisture. In sum, these factors will provide for *sustained and progressively increasing fertility of the fields*." (Emphasis mine.)

One wonders what happened. Why did the work on perennial wheat not continue? Perennial wheat development was a part of a larger program in the Soviet Union. It was pursued, more or less, as a sideline, because 1) Farmers and governments need assured high yields every year, so the bulk of research funding went to that end, and 2) Any research effort of a long-term in agriculture is the first to be cut when funding is reduced.

I proposed to the Russians visiting Coon Rapids that our two countries jointly undertake a massive breeding program devoted to perennializing the major crops currently responsible for occupying at least two-thirds of the agricultural land of the planet and for two-thirds to three-fourths of our calories – mostly grains and legumes. The Land Institute would offer to the common effort free germplasm and more than 30 years of experience with perennials. We have hybrid prototypes of perennial wheat, sorghum, sunflower and other crops.

Cosmonauts and astronauts shared a tiny capsule in space. But they brought with them food raised on the soils of our earth. It seems that we have to be reminded that Earth is in space too, as much as are Mars and the moon. Why do we neglect the Earth's food producing system? Why do we allow it to be damaged by erosion and toxic chemicals, all the while depending on fossil fuels that we are rapidly using up? Why do we tolerate this deficit spending?

If we began today, together, to move agriculture from an extractive to a renewable economy, perhaps 50 years from now at the Coon Rapids farm would be celebration of the 200th anniversary of Darwin's *Origin of Species*, the 100th anniversary of the friendly meeting between Nikita Khrushchev and Roswell Garst, and the 50th anniversary of our effort to end deficit spending of ecological capital. And I said maybe this day also will be seen as the moment we began to make nature's economy the standard by which to judge our agricultural economy.

After I finished the talk and after Sergei Khrushchev finished his talk, we all had lunch on the Garst lawn with the same menu as 50 years earlier. It was a beautiful day. At the end of lunch Sergei pulled the Russian secretary of agriculture and me together, and I extended my plea for a cooperative effort between the USDA and the Russians because of their rich history. The secretary finally said, "I need to be blunt with you. We don't have the scientists." I said, "Well yes, I know about the great purge in genetics during the Stalin era when some 3,000 were forced out of genetics work because of Lysenko." "No, no," Khrushchev said, "Not Lysenko, Yeltsin. They all left."

We exchanged pleasantries, exchanged cards and went our separate ways. By 2 in the afternoon Joan and I were headed home, both ruminating on what had transpired. I thought back to that era following Gorbachev with Yeltsin and remembered an Associated Press article I had read in 1997 about a Russian welder who, with his wife, milked cows, fed a pig, gathered eggs and tended a garden, living off of what they grew and selling surplus. And each morning the welder headed off to his longtime job in a state-run auto repair factory, despite not being paid for three months. The writer was concerned with what motivated this man and other Russians to work for nothing. A message not explicitly mentioned in the article was that nature's economy in combination with traditional culture made this family *resilient*. Not only did this resilience continue to feed the people, it sustained the industrial economy.

Imagine nearly anyone but the Amish going with no wages in the United States for three months, now that our traditional rural economies have been mostly undone. The collapse of the Soviet empire represents the first major failure of the industrial mind. Both countries' systems have sought to concentrate power, and in so doing have greatly reduced the number of people on the land and in small communities, along with the attendant cultural knowledge that makes for resilience.

What is needed for all of us, we Americans, the Russians and the rest of the world, is to increase our resilience thinking while we have slack. We have slack. Haiti does not have slack.

The first requirement necessary to move into a resilience mode is to acknowledge the reality of limits. I recommend a book called *Scientific Mythologies,* by James A. Herrick. He writes of two powerful engines of cultural influence – speculative science and science fiction. People fail to make a distinction between the two, and this has a way of eroding our understanding of the limits of the ecosphere to sustain us. A state senator in this state told me my problem was that I was not thinking galactically.

Not everyone is denying the reality of limits to economic or population growth. In academic circles now is something of a groundswell of formal thinking about resilience. This began less than 20 years ago, and there is now a Resilience Alliance. Ecologist C.S. "Buzz" Holling at the University of Florida is one of the pioneers. In 2002, he and Lance H. Gunderson published a book called *Panarchy.* A smaller and more readable book is *Resilience Thinking*, by Brian Walker and David Salt. In the foreword of *Resilience Thinking*, ecologist Walter Reid had this to say:

Virtually all of our current environmental and resource management policies seek to reestablish the balance between supply and demand. We create laws and regulations such as fishing quotas to reduce use of certain fragile resources, develop new technologies such as drip irrigation or enable the more efficient use of other resources, or find new ways to manage ecosystems that enhance the production of resources such as the application of fertilizers.

These steps are all needed, but there is one catch: They won't solve the problem.

Reid goes on to use an analogy:

Imagine you are on a boat docked in a calm harbor and you want to quickly carry a brim-full cup of water across a stateroom without spilling. Now imagine the same situation but with the boat in rough seas. In harbor, the solution is simple: just walk, quickly, but not so quickly that the water spills. At sea, speed is a secondary concern; now the real challenge is to find secure handholds and footholds and to flex your knees to absorb the roll of the boat. In harbor, the solution is a simple optimization problem (walk as fast as possible but not too fast); at sea the solution requires you to enhance your ability to absorb disturbance – that is, enhance your resilience against the waves.

Since the time of the agricultural revolution, the problem of environmental management has been conceived to be an optimization problem, like the example of carrying the water on the boat in the harbor. We have assumed that we could manage individual components of an ecological system independently, find an optimal balance between supply and demand for each component, and that other attributes of the system would stay largely constant through time.

But, as we learn more about ecological and human systems, these assumptions are being shattered. Ecological systems are extremely dynamic, their behavior much more like the analogy of a boat at sea. They are constantly confronted with "surprise" events such as storms, pest outbreaks, or droughts. What is optimal for one year is unlikely to be optimal the next. And, the structure and function of the systems continually change through time (and will change even more rapidly in the future as global warming becomes an ever-stronger driver of change.)

Quite simply, the basic framework underpinning our approach to environmental management has been based on false assumptions. In a world characterized by dynamic change in ecological and social systems, it is at least as important to manage systems to enhance their resilience as it is to manage the supply of specific products. In other words, we must apply "resilience thinking."

So here is the expression – resilience thinking – adapted by the increasing number of people who acknowledge the limits to growth. Once explained, we all know that such thinking is not new. Some call it "hedging your bets." And countless farmers in traditional societies have done it for millennia.

This brings to mind another book, by Joseph Tainter, called *The Collapse of Complex Societies*. Tainter notes that societies that go with their success only and abandon marginal ideas or ways of being go down the fastest. The key is to keep alive variety, which helps increase our imagination about possibilities. Plant breeders practice this. What is seemingly useless germplasm this year may have resistance to some pest in a future decade. They practice resilience without calling it such.

And our financial system practices a Ponzi scheme without calling it such. I propose that we throw a tickertape parade for Bernard Madoff because he showed a small part of a much larger Ponzi scheme.

In the September 14 issue of *The New Yorker* is a 21-page article by James B. Stewart called "Eight Days: The Battle to Save the American Financial System." It is about what happened in September 2008. The author has pieced together various events and conversations about what he calls the "most important week in American financial history since the Great Depression." It should come as no surprise that nowhere in those 21 pages is there mention of rain forest being cut, dead zones due to agricultural runoff, climate change, the population explosion climbing to 7 billion, soil erosion or chemical contamination of our land and waters. Nothing about the 40 years from 1960 to 2000 in which population doubled, nothing about the sixfold increase in economic activity. Nothing about how green revolution technologies and fertilizer were used to increase food production two and a half times.

Those 21 pages had to do with money, the metrical device used to help us track in a quantitative way the transactions of society. It is largely a form of accounting. One can come away believing that none of this had anything to do with deficit spending of the planet or greenhouse gases or the fisheries collapsing.

But if we don't deal with preventing growth, both in population and economic, and adopt the standard of resiliency, and live within our means, we will get where we are headed. Do we have the ability to practice restraint? I'd hate for us to feel as helpless as the Russian secretary of agriculture and say, I have to be blunt with you: There's nothing we can do.

Adapted from a talk at The Land Institute's Prairie Festival. *For a recording of the complete address, see page 19.*

Garbage In, Resource Out

Scott Bontz

Ed Newman will talk trash. He lives trash. Much of his house is made with a sturdy product that others came to see as trash. Trash is in the eye of the beholder. Newman wants you to see trash as entrepreneurial resource. He helped install a machine to compost Ohio University's cafeteria food scraps. Trash becomes fertilizer in two weeks. He now aims to eliminate or divert as much as 80 percent of all the school's waste away from disposal as trash. And he has his eye on the perfect score. He told the school magazine *Outlook*, "Look at it from the standpoint of workplace injury. You don't hear people saying, 'We only want to have 20 people injured this year instead of 160.' Just like in nature, we want all materials 100 percent utilized. We're trying to emulate natural processes."

Newman, a former Land Institute intern, has worked hard and well at this as the school's recycling and refuse manager. Last fall the National Recycling Coalition gave him its annual award for outstanding environmental and community leadership.

In a phone interview, he used as example Land Institute President Wes Jackson's work toward a lasting agriculture by means of perennial grain polycultures. He said, "I'm doing the same thing, trying to do the same with our consumption and disposal habits." He sees recycling as one component of a holistic approach: "It fits very well in the whole sustainability movement." Wind and solar energy, and to some extent even conservation, are sexier, he said. But Newman mans the trash trench, to effect recycling and other consumption and waste disposal reforms locally, statewide and across the country.

In 2001 he and his counterpart at another Ohio school, Miami University, began a 10-week competition between them to promote recycling. RecycleMania surprised Newman with exponential growth. This year 510 schools from all 50 states, the District of Columbia, Canada and India participated. They recycled or composted almost 35,000 tons. For more about this, see recyclemania.org.

His school still throws away 70 percent of its trash. Newman argues that it's worth recovery. For trash there are the costs of both collection and dumping. For recycling there can be collection cost, but none for dumping, and some material sells. He said, "Solid waste management is really a resource management issue."

Newman was toward the end of study for an environmental biology degree at Ohio when a professor suggested a Land Institute internship and arranged a talk with Jackson. "It was sort of an afterthought," Newman said. "I was sort of a recycled student, you might say." Within days he'd left Athens, Ohio, for Salina, Kansas. In 1980, four years old, The Land Institute hadn't refined its focus so much to perennial grains, and among Newman's jobs was experimenting with aquaculture. He also helped maintain a once-neglected bee hive. (He still keeps bees.) And he made visits to the recycling drop site in Salina.

In 1984, Athens began Ohio's first comprehensive curbside collection of recyclables. Newman was involved as an employee of the Athens City-County health department's solid waste program, and by helping found a group called SORT, for Southeastern Ohio Recycling Terminal. "When I came to OU in 1990," he told *Outlook*, "I was already stricken with the trash bug."

His work included enforcement of dumping laws, and among the tons of things he found treated as trash were bricks. He saw enough thrown away bricks that they inspired his study. He learned of the brick industry's history in the region. He found the International Brick Collectors Association and triennial brick swaps. He read of the Kansas doctor who sought to stem tuberculosis with bricks imprinted, "Don't spit on sidewalks."

The Athens area has lots of bricks, including in roads, and when Newman would see a truck being loaded with them for disposal, he'd direct it to his piles. "Some people collect stamps," he said. "I collect bricks." He estimated that he has 40,000 to 60,000 bricks in various places, and about 3,000 kinds of bricks. The outside wall of the first floor of his house is reclaimed pavers. Reclaimed bricks also make his driveway and walkways. "These are really durable materials, made from environmental capital spent a hundred years ago," he said. "You can't pass something like that up." And, he said of the pursuit, "You learn more about geography, culture, history."

Before the recent economic plunge, developing nations like China and India added to demand for resources and kept the price of recyclables high, Newman said. Regularly recycled materials such as metals became quite valuable, and even marginally recyclable plastics and bound books became attractive. Demand for recyclables has fallen with the economy. But Newman says it's still worth more to collect and recycle materials than it is to throw them away.

He advocates tax and business incentives to promote collection, processing and adding value to material locally or regionally instead of shipping it overseas. Example: Compost organic materials for spreading on local farm fields. His school's food scrap composter might eventually

serve farmers, though for now the product will enrich school grounds.

Newman tries not just to manage what comes out, but influence what goes into the system. He said the school's new purchasing director is openminded about buying recyclable products, and the school in general embraces the idea of buildings made of less poisonous and more reused and recyclable materials, and which work more efficiently. He seeks purchase policy that considers packaging, whether equipment is reparable, and things like whether copy machines can print on both sides of paper.

And instead of just preaching, Newman wants to play into Americans' psyche with their enjoyment of competition. He wants to go beyond enlisting colleges, and pit against one another grade schools, businesses, communities and even states. He wants to approach the NCAA about announcing the results at games, and hopes that sports media will follow.

"These are interesting times," Newman said. "A lot of the status quo way of looking at things is being called onto the carpet. If there is a time for change, it's now. I have high hopes for that."

Soil's Stand-In

Scott Bontz

For life, soil is the dark matter for which physics only hypothesizes: unseen, but holding everything else together. We look between our feet and notice only a dirty skin. A farmer might think deeper, of a superorganism on which we and our fellow land dwellers stake our lives. Still, each year our fields, annually cropped and seasonally bare, slough millions of tons to the sea. An evolved esthetic and sympathetic capacity for other creatures, plus luxury brought from mining those fields, let us cry over loss of tigers and big trees. But short of cinematic catastrophe like the Dust Bowl, disintegration of our large but largely microscopic supporting culture in the earth brings to our eyes not a speck or tear. Land Institute agroecologist and soil scientist Jerry Glover has concluded, "Soil in itself is low-voltage."

In digging, though, he has found a charismatic, connected poster child. This icon not only lies beneath the grass and forbs that cover soil, but is cloaked by soil itself. It is the deep and massive architecture of perennial plant roots. A spade and determination can yield a handful of this binding fiber. But have you seen a plant's whole network, spanning the width of a man and several feet taller? Revealed this way, a perennial grass plant's roots appear as the circulatory system of a giant. Or like a 3-D map showing every trickle, creek and stream adding up to a Mississippi. Glover said, "Roots really spark the imagination."

I saw this while watching high school students at a presentation of what The Land Institute does and why. The teenagers finally broke their stone silent reception when the speaker held a black cloth bundle like a top hat, grasped a protruding head of dry grass and pulled out about 10 feet of roots. Whoaaa.

The plant was intermediate wheatgrass, a wild perennial that breeder Lee DeHaan is both domesticating directly and crossing with wheat to make a perennial grain crop. Glover grew this wheatgrass specimen to display. He has more than 30 more representatives, of 14 species. There are other perennials, there are annual crop plants for comparison – most of them relatively short and scrawny – and there are results of breeding between species.

Several specimens have traveled around the nation for showing. Miles wear on an organism built for one place, so staff members sometimes instead take life-size photos. But

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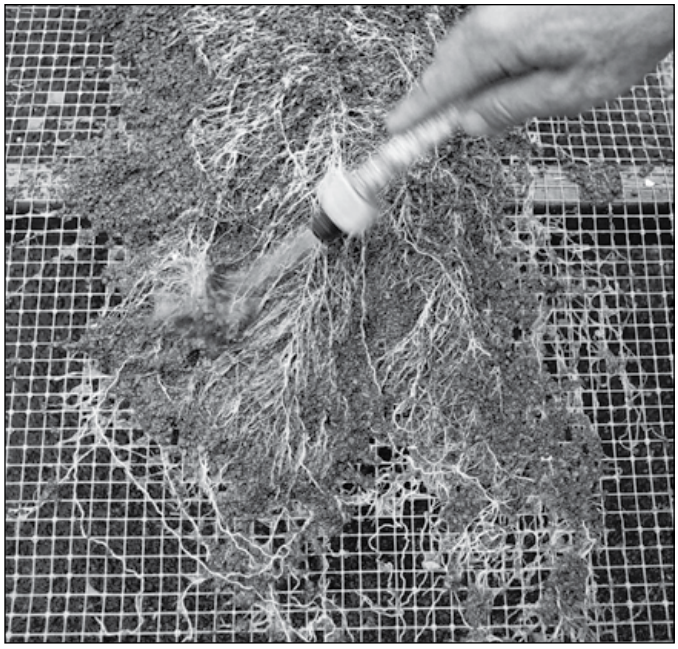
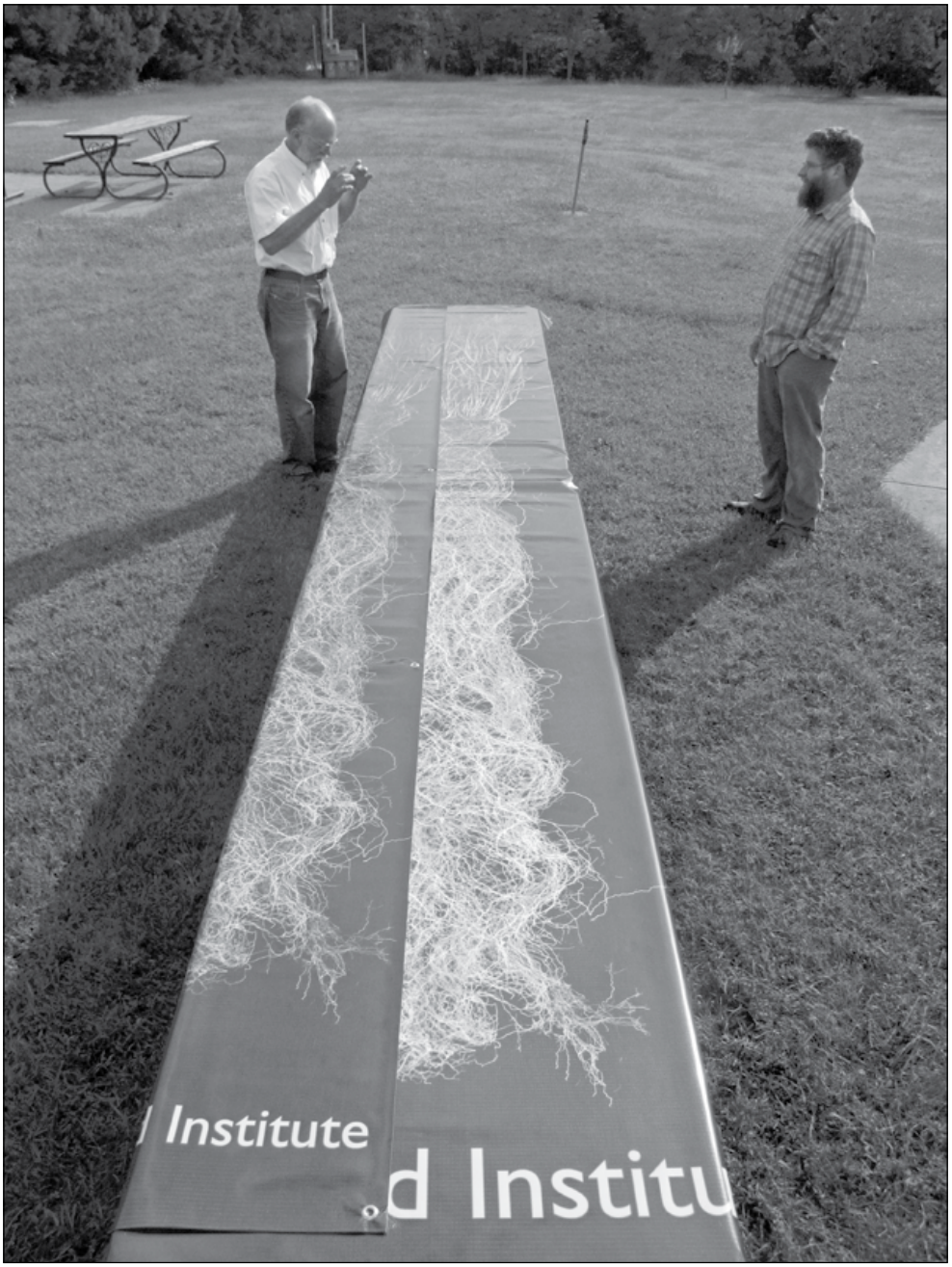
The opposite page shows above- and below-ground growth of compassplant, a perennial native of prairie. In this case the plant was raised in a plastic tube filled with growth medium that can wash away. Revealed is the subterranean tissue connecting what we see, and might harvest from a grain crop, to soil's water, nutrients and community of fungi, worms and microbes. The images printed here are about one-tenth life size – the roots are 9½ feet long. Steve Renich photo.

John Mai steadies a plastic pipe after Ron Kinkelaar pulled it with the tractor from a larger tube in the ground. The plant is Indiangrass, a prairie perennial. The Land Institute uses more than 50 of these growth tubes and is building a collection of more than 200 plants for display. Scott Bontz photos.



The tubes are halved lengthwise for easy removal of the plant and growth medium. The halves are taped together again for reuse. In the top photo, Mai washes away from annual wheat a growth medium similar to kitty litter. Below, he makes a final, fine cleaning of wheat plants.

After washing and drying, roots soak in a preservative solution of glycerin. But the roots remain delicate, and enough handling during travel breaks them up. The tops also dry brown. So while plants are fresh and green, Steve Renich, center here in the greenhouse, with soil scientist Jerry Glover at right, also takes detailed photographs. Renich's camera is mounted top center of this picture, in a device called Gigapan. A program steps the camera through rows and columns of dozens of pictures. A computer later stitches them into one image. The curving table keeps plants up to 16 feet long at constant distance from the rotating camera so they don't appear to recede toward their ends. You can see some of Renich's whole-plant pictures by going to gigapan.org and searching for stever.



Life-size pictures of whole plants are printed on vinyl rolls. The pictures travel to presentations, and so spare plants from repeated folding and unfolding.

continued from page 21
these don't match the impression made by real fiber. Glover now plans to grow at least 200 root specimens for a large exhibition. Instead of packing the roots into suitcases, they would enjoy museum quality care and museum display.

Glover was inspired to begin revealing roots by John E. Weaver, a University of Nebraska plant ecologist. In the first half of the 20th century Weaver dug pits in the soil and meticulously drew the penetrating roots. Glover tried such excavations but found they took him away too much from other work.

Then he learned that University of Minnesota researchers had grown roots in plastic pipes filled with a growth medium called Turface. It's much like cat litter, and washes away more easily than soil – though cleaning a big prairie plant's roots still takes hours. The school would sell specimens prepared this way and preserved, but labor and materials made them costly.

Glover economically refined the method. He placed larger, 12-inch pipes permanently in the ground to serve as sleeves, and so ease installation and pulling of 10-inch pipes filled with Turface. And he made duct-taped clamshells of those smaller pipes so plants and growth medium spill out rather than require uprooting. He began with 10 pipes, each 10 feet long. Now 50 nestle just west of The Land Institute greenhouse. There are also 10 pipes 3 feet long for growing annual crop plants to various stages of development.

Glover first grew roots in tubes for basic education about how plants work underground to supply the familiar vegetation above. "I wanted for people to start to think that things are going on down there," he said. He wanted them to realize the scale of perennial plants as "operators," from their microscopic tapping of soil water and nutrients, to the massive foundation and infrastructure they help make for the cultures we call ecosystems. Annual grains, the alternative that civilization has pursued for most food, are comparatively feeble and wastefully short-lived. Glover said, "Humans simply aren't well adapted to operate on the scale of millimeters and minutes required to manage essential processes such as nutrient cycling and water management. Our annual crops are reliant on us for much of their nutrient needs and to keep weeds at bay."

The roots-in-tubes project grew and evolved into something with broader aim. Glover came to imagine roots collected and displayed together as a gateway, "perhaps our most effective tool in educating about soil." He wants to go beyond hanging a single plant against a wall, to grouping masses for navigation as an underground forest, "a compelling tunnel of root architectures" that should help viewers imagine soil as a 3-D matrix permeated with life. They'd also see descriptions of soil organisms and the importance of how roots and soil interact.

Glover proposes this tunnel through a Past, Present and Future. Entry at the Past would introduce prairie vegetation. Glover said, "People are really captivated by native plants." But the relation has remained at the surface. In the display, to sight the plants' crowns people will look toward the sky. Around them roots will cascade 10 feet or more toward the floor. The perspective will narrow in the Present, showing the shallow roots of annual grain crops that have replaced so much of the world's dominate, perennial vegetation. In the Future viewers will arrive at results of Land Institute breeding, and again see deep roots, but this time anchoring more croplike stems, leaves and seed.

Glover imagines including in the display "soil monoliths," picture window sections of soil. He's also working with *National Geographic* photographer Jim Richardson for pictures of roots exposed by soil pits in the field. Examples of this are in the September 2008 issue of *Geographic*. Richardson also showed photos at The Land Institute's Prairie Festival this September.

May this combination help better connect human minds to that vital dark matter, so we and it can support one another for long to come.

On the Production of Distance

Jesse Nathan

No, I have nothing to say. I'm tired.
Withered. Weird. A lonesome man in Kansas.
God lost in the extremity of memory:
My cup of curdled milk,
my gasp to recordings of accordions.
Memory, a pheasant in a fox's jaws,
a man weighed down by rocks and laws:
I implore you, plodding midnight stranger,
be a chart, a cracked decrepit ranger,
be a wind, a key, a scope
of bone I aim to trace the route
smoke climbs to clouds.

Let's Grow a New Crop of Farmers

Lisa Hamilton

When the Agriculture Department released its 2007 census recently, the news appeared surprisingly good: For the first time since World War II, the United States did not lose farms, it gained them – 75,810, to be exact, for a total of 2.2 million.

But on closer inspection, the numbers aren't so hopeful. The discrepancy stems from this tricky question: What is a farm? The census has changed its definition nine times since 1850, most recently to "any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year."

This loose definition is meant to err on the side of inclusion, but ultimately it just errs. Take, for example, the four chickens I keep in my back yard. I sometimes sell eggs to neighbors, and at the going rate I could make $500 a year. If I got four more hens, my suburban home could qualify as a farm.

Silly, right? But where do you place the lower limit – or the upper limit? The Cargill feedlot in Lockney, Texas, consists of 60,000 cattle kept in dirt yards and fattened on feed grown elsewhere. Is that a farm? While the census says yes, most Americans would say no.

So then, what is a farm? To answer that, we must first ask: Why do we care? Really, why is it good news when farms – and, more importantly, the farmers who run them – increase?

There are sentimental reasons, of course, but there is also a practical reason. Farmers are valuable because they bring human scale to our massive food system. Think of how many people, in the wake of each new salmonella scare, turn to the farmers market. We do so because we know that farmers bring oversight and ethics to food production, contributions that only individual humans can offer.

In the future, farmers' importance will only grow. Their intimate, human-scale knowledge of the land is what will allow agriculture to adapt to climate change. And as the cheap energy that industrial agriculture depends on disappears, it is farmers, with their small-scale innovation and sheer manual labor, who will feed us. Why do we care about having more farmers? Because deep down we know they are essential to a functioning food system.

So I offer this new definition of a farmer: someone who grows crops in sufficient quantity to be a true commercial entity, yet is still close enough to the ground to bring human scale and values to the process. Not the backyard chicken enthusiast, nor the corporation behind the feedlot, but the individual human on the land, growing our food.

Revisit the census with this definition, and the good news vanishes. The USDA's reported increases occurred exclusively in farms with yearly sales of less than $2,500 or more than $500,000 – that is, the backyard operations and the corporate-scale businesses. In every other category, the numbers dropped or, in one case, stayed the same. Between 2002 and 2007, the United States actually lost 43,603 real farms.

To stop this hemorrhaging, we must shift from blindly encouraging production to investing in a system that values farmers and propagates them. We need to help new farmers obtain markets, land and credit. And we must inspire nonfarmers to enter the profession. Imagine, for instance, a program that puts interns on farms – an AmeriCorps for agriculture. In this "AgriCorps," participants would learn the skills of farming and experience the lifestyle; hosts would receive valuable labor to bolster their businesses.

Such a program would face an obvious objection: AmeriCorps offers volunteers to public service organizations, but most farms are private businesses. Why should the rest of us help support them?

But maybe we need to reconsider that line of thinking. By defining farms and farmers as purely economic entities, we condemn them to a system that inevitably eliminates them. What if instead we began to see farmers as the public servants they are, and enabled them to be the public servants we need: stewards of our soil and water, pillars of our rural communities, and guardians of our food. Perhaps by redefining what farms mean to us, we can help their numbers grow – this time, for real.

Prairie Writers Circle commentaries go to about 500 newspapers around the country. The essays are at landinstitute.org, under Publications. They are free for use with credit to The Land Institute.

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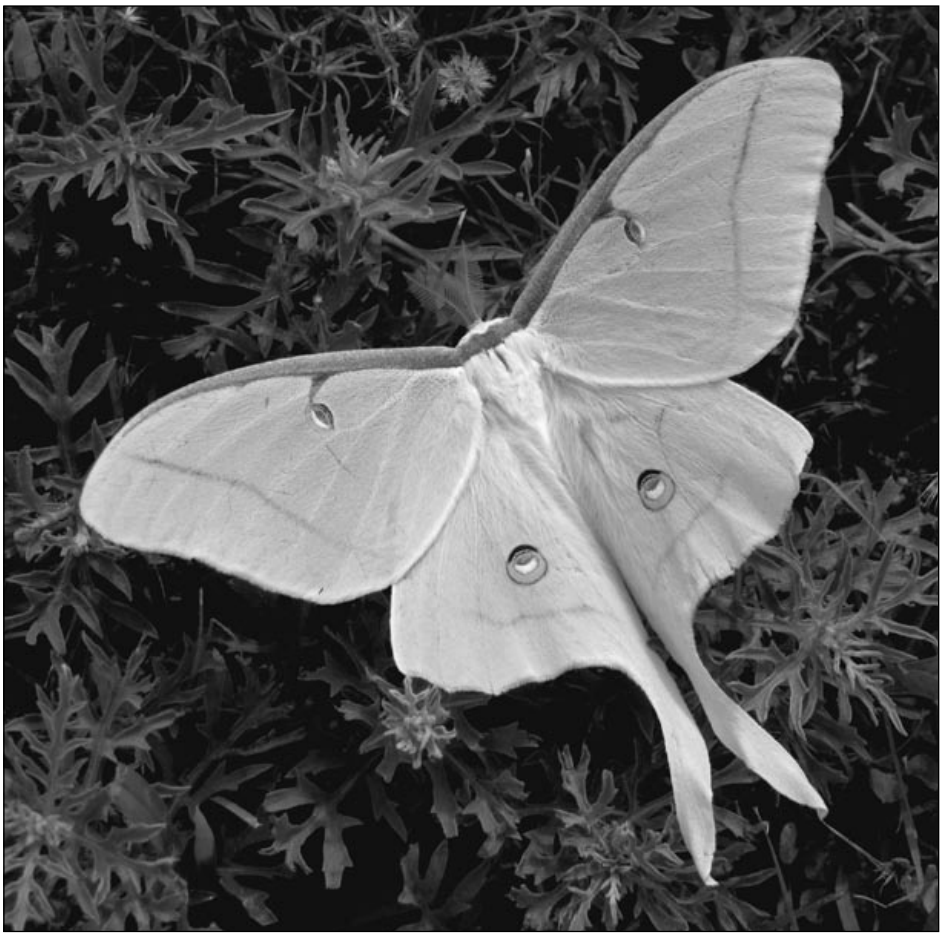

Luna moth. Scott Bontz photo.

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Bindweed

Jesse Nathan

Faced with a scene of cloud white flowers
Job asks the crow, What do you see?
Sheep spreading, replies the crow,
across the earth's surface.
Convolvulus arvensis, answers Job,
common to Kansas.
Twenty feet, he says with a shrug,
is where the roots sleep.

They try to gauge how much it would take
to extirpate. Think of it, says the crow, its shocked
roots rising, its jagged strings of plant.
It'd look like sheets of ice, says Job, cracking.
God loves sheep, says the crow, beaming.
They are silent. They breathe.

Anyway it's just clouds, they say.
It's just white flowers, they say.

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Stan Cox is senior scientist at The Land Institute, and author of *Sick Planet: Corporate Food and Medicine.* His book about air conditioning, *Losing Our Cool,* will be published next spring. Dennis Dimick is an editor at *National Geographic*. Jan Flora is a sociology professor at Iowa State University, and a Land Institute board member. Lisa M. Hamilton, of California, is the author of *Deeply Rooted: Unconventional Farmers in the Age of Agribusiness.* Wes Jackson is president of The Land Institute, and author of books including *Altars of Unhewn Stone: Science and the Earth.* Jesse Nathan is the author of a chapbook of poems, *Dinner*, and an editor at McSweeney's Publishing. He grew up on a farm in Kansas and lives in San Francisco. Steve Renich is The Land Institute's operations manager. David Van Tassel is a Land Institute plant breeder.

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