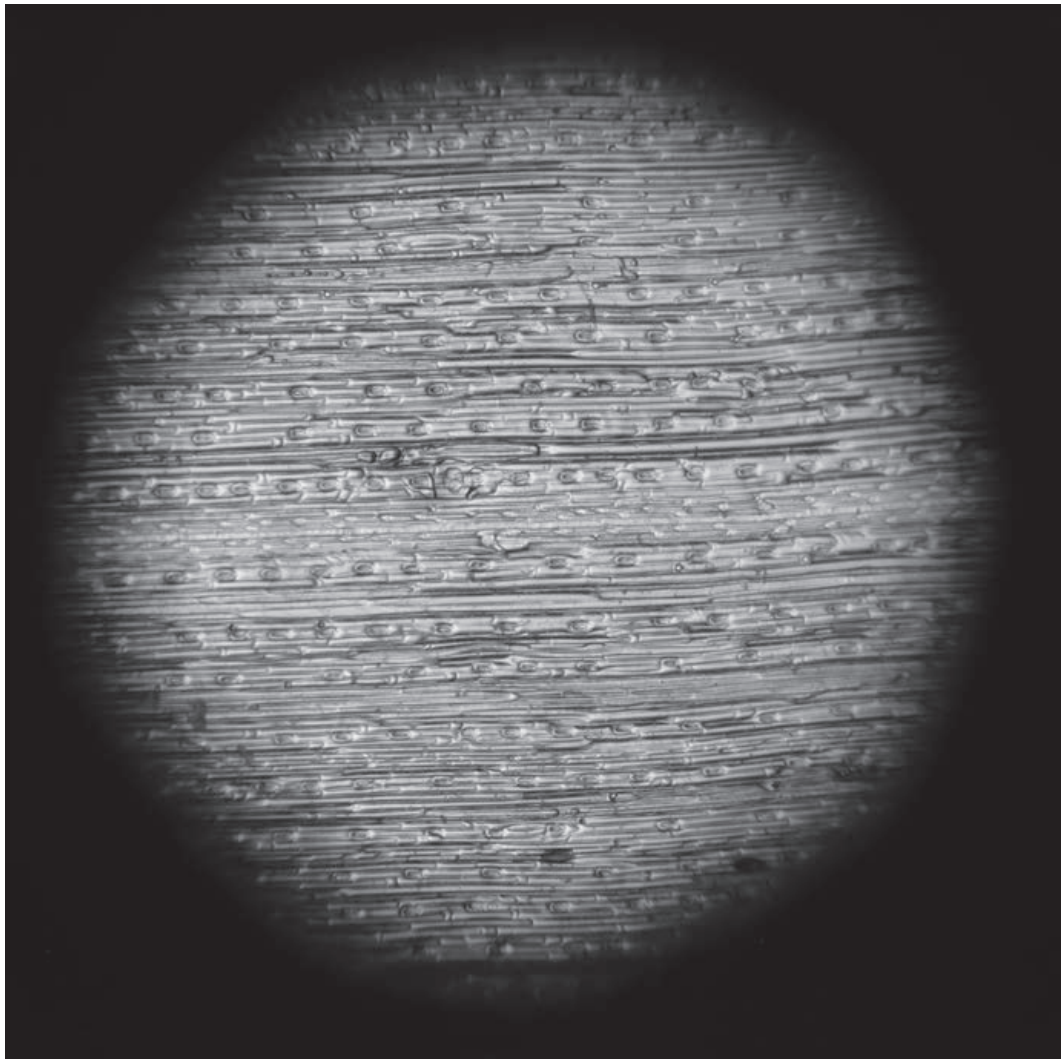
Land Report

Number 129, Spring 2021 · The Land Institute



About The Land Institute

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

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

LAND REPORT
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Cover

Microscope picture of imprint from a leaf of perennial wheat. The leaf was painted with nail polish, which after drying was picked up with clear adhesive tape and placed on a slide. Apparent dents in the long lines are cell junctures. The small ovals are stomata, through which gases are exchanged. Any resemblance to large, gaseous planets is coincidental. Scott Bontz photo, and on page 5.

Leave it

We took carbon like no other species, and like no other we must learn restraint

ROBERT JENSEN

Humans have made a mess of things – by now that should be readily evident to anyone willing to face the avalanche of studies and statistics that describe the contemporary ecological crises – and still as a species we have not committed to a serious project to clean up the mess. That profound failure might lead some to misanthropy; it is tempting to conclude that the species is hopeless and just give up on people (though that would imply giving up on oneself, if one is part of the group "people", and it's not clear what that would mean).

Wes Jackson suggests that instead we should go easy on ourselves, which may seem surprising given his critique of so many of our species' failures for the past 10,000 years. Should we not be tougher on ourselves, pushing each other to change not only social policy but also personal behavior? Yes, we need to hold each other accountable. Yes, we have to hammer out rules of behavior to promote sustainability and justice. But let's be clear about just what we are asking of ourselves, how revolutionary the task before us truly is.

Jackson, who co-founded The Land Institute, describes life as a scramble for energy-rich carbon. We have made a mess of things by getting exceptionally good at what all organisms do – going after that carbon. We have gotten so good at carbon-seeking that if we don't change our ways, it's not clear how much longer the ecosphere will put up with us. *We* need to be both harsh on each other, and kind to ourselves as well, because *we* face a unique challenge – *we* must become the first species to impose limits on itself, the first species to curb its scramble for carbon by a collective act of will.

One question to ask before tackling that challenge is …

Who is "we"?

Humans today do not all consume the same amount of energy, nor have all humans throughout history. When it comes to ecological destruction, "we" know that "we" are not all part of the same "we". There are important differences – among individuals within a single society, and among societies – in energy consumption, resource exploitation, waste production, and overall contribution to ecosystem instability. Many of those differences are the product of violence, coercion, and fraud (whether legal or illegal), as some people take more with no moral justification. That must always be resisted.

But what if we were to create a more just world, and eliminate such glaring inequality? It is tempting to believe that from there the solution lies in simply identifying low-energy societies from the past, or communities in the contemporary world that live a lower-energy existence,

and then building the political will to reproduce them in the dominant culture. But such an approach would be a dead-end – not because it would be hard to build that political will (which is true enough) but because it misunderstands the nature of the problem. We can learn from the low-energy societies and experiments within conventional societies, but those good examples don't offer a strategy to move forward from where we are (high-energy, unsustainable) to where we need to be (low-energy, sustainable). First, the lives of billions of people around the world is dependent on high-energy infrastructure, and the necessary transition will, to say the least, not be easy. Second, we can't pretend that people will overnight find it easy to avoid the temptations of dense energy, individually or collectively.

True, that the profoundly unsustainable nature of human economic activity today is to a large degree the result of the European conquest of the world over five centuries and a rapacious transnational corporate capitalism. But as Jackson reminds us, those temptations of dense energy are powerful for humans because we are organic creatures – human nature is carbon nature. While much of today's irrational consumption is driven by capitalist propaganda (that is, advertising and marketing), fossil fuels and other sources of energy also make people's lives easier in many ways that are not frivolous. There is of course variation in people's assessment of their needs, contrasted with wants or desires, but capturing and using dense energy for comfort and pleasure is not an activity unique to imperialist and capitalists.

To be clear: for those of us with a disproportionate share of the world's wealth who are responsible for a disproportionate share of ecological destruction, the argument for change is strongest. But in trying collectively to find a way out of the mess we've made, the assigning of different levels of responsibility for the mess is only a first step.

Renouncing First-World dominance is a start, as is imagining a world beyond capitalism's obsession with growth and consumption. The end of those systems are necessary but not sufficient conditions for change. No culture has a plan for transitioning from an unsustainable high-energy global society of eight or nine or ten billion people to a sustainable low-energy society with a dramatically lower population. This is a new challenge with no road map available. Lessons from low-energy societies will undoubtedly be valuable, but there is no way to flip a switch and return to a previous era's living arrangements. No one person, ideology, or culture is going to provide us with a template for dealing with what lies ahead.

If we start with an awareness of the scope of the change needed and the lack of a plan, we can at least be clear about the direction in which we need to move, which takes us to the challenge of being …

The first species that will have to impose limits on itself.

For the past couple of decades, Jackson has believed that no meaningful progress is likely without a global cap on our use of carbon, along with a rationing system to ensure a just distribution of the resources we use. We all collectively will have to choose to live with less of just about everything – less energy burned, fewer metals mined, a dramatic decrease in gadgets – and enforce those limits through public policy. That's not exactly a winning campaign slogan for politicians, who typically run on a promise of "more". But

Jackson isn't deterred. "A cap on carbon with rationing", he repeats, as often as possible. Why push so hard for what seems so implausible, at least in his lifetime?

If we want to plan rationally for our future, we have to assess the likely trajectory of not only climate change but the other ecological crises unfolding. If we abandon the technological fundamentalists' faith-based claim that we will invent our way out of the crises, then we have to think about how to down-power. We have to understand that our 10,000-year run of "success" in the scramble for energy-rich carbon – starting with our exploitation of the carbon in the soil through agriculture – is actually our greatest failure.

Jackson highlights the painful irony

The young Wes Jackson, front, with his parents and five siblings during World War 2. "Thrift and frugality were long in dying for such people, but even I could see extraordinary change under way," Jackson says in his new book, "Hogs are Up". Now thrift and frugality are needed not because we have so little, but because we've used so much.

of being human in this moment: our unprecedented success at getting at that carbon has allowed us to dominate the planet in a way unlike any other species. As a result, we must do what no other species has ever had to do, or could even contemplate doing: we must limit our carbon-seeking through collective will power, recognizing that there's no guarantee it's possible.

When other organisms expand beyond sustainable levels, they are kept in check by natural processes involving predators, disease, and limited food supplies. Humans have temporarily transcended those limits through increasingly sophisticated exploitation of carbon in soil, trees, coal, oil, and gas, but this condition is temporary – unchecked human growth will be checked eventually, whether we do it ourselves

Our Boy's Bread

KIM STAFFORD

At fifteen he planted wheat
below the kitchen window –
cheered the sprouting, gold
green against the spring sun …

then suffered when rust tinged
the leaves, when storm winds
buffeted the dancing stems, tested
a seed with thumbnail and tooth,

then when the ears were prickly
and gold, bent down as if blessing,
clipped them one by one into a basket
and together on a stormy September day

we threshed chaff from kernel between
our palms then fanned the chaff
pouring from bowl to box, found
deep in the basement the Corona mill

I bought by the Whole Earth Catalog
in 1972 to grind our crop of two cups,
to knead, raise, and bake a dusty moon-
loaf he broke with three friends

by candlelight as the storm
of autumn shook the trees
and war brewed and congress
shut down the government,

and we braced ourselves
for his departure soon
as we came home to find
four friends feasting.

From the new book "Singer Come from Afar," Red Hen Press. The writer teaches at Lewis & Clark College in Portland, Oregon.

or leave it to nature. If we want a decent human future, we must not wait for nature but impose limits on ourselves and each other. A cap on carbon gives us a shot at sustainability, while rationing makes social justice possible.

How will we do it? What is the appropriate level of the cap? How much energy can we afford to burn over what time period? What kind of rationing system will work best? And how to get any of this implemented in a world full of people who still want more?

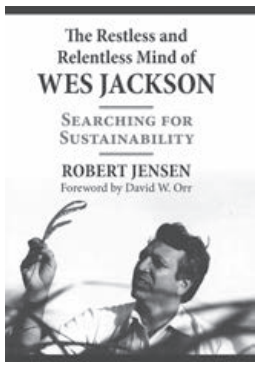
Don't ask Jackson for too many details. No one else has definitive answers, though his Land Institute colleague Stan Cox has done important work to lay out the scope of such a project, in a book called "The Green New Deal and Beyond". But Jackson is a firm believer in making a commitment to achieve an outcome before we know how to do it. The bigger the problem, the less we know about how to solve it and the more important it is to make the commitment, even if there seems to be no solution within reach.

Is it rational to hope for a policy that no one can yet imagine? The better question: is it rational to continue to avoid planning for the most likely future only because it is difficult?

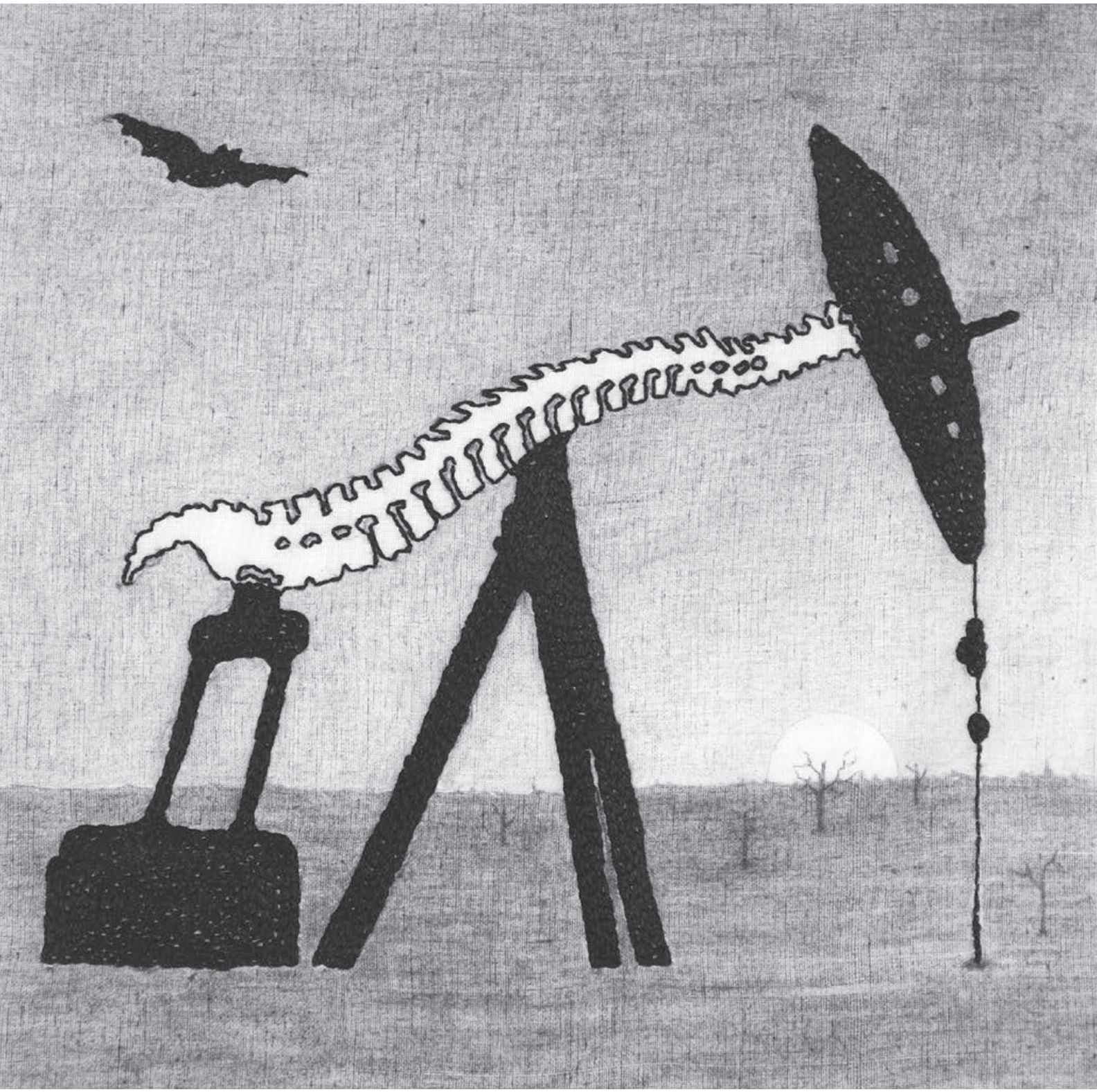
It's tempting to blame this failure on, in no particular order: rich people, really rich people, people who desperately want to be rich, Walmart, Amazon, Exxon Mobil, climate-change deniers, conservative politicians, all politicians, campaign-finance laws, imperialism, white supremacy, or capitalism. There's no shortage of targets, and all share in responsibility. But let's not forget the role of our shared human-carbon nature, our carbon-seeking nature. Some would say that if that really is our nature, we are doomed to fail. Jackson flips the argument: an honest assessment of these realities at least improves the odds for rational planning.

If rational planning at the national or international levels is impossible at the moment, remember Jackson's focus on communities. What can be accomplished at lower levels does not solve the problem but demonstrates that we are competent to run our own lives. In the absence of the political will to pass a cap-on-carbon with rationing in Washington or the United Nations, we can look for opportunities at home. Let a hundred flowers bloom, and be careful not to dismiss any idea too quickly. Jackson doesn't talk about how to "save the world" – we're the ones who need saving, not the world, he says – but rather how to limit the damage we do and try to make possible a "soft landing" for humans in the future.

At this point, we're all making it up as we go along. We can learn from people who have lived in low-energy societies, but those living arrangements do not offer a blueprint for how to power down, how to reduce the population of people and our things. We are facing a transition that has not been made before, and it's going to be a wild ride. But we stand a better chance of making it to the other side if we abandon the Industrial Worldview that got us in this mess.



Robert Jensen taught journalism at the University of Texas in Austin. This is from his new book "The Restless and Relentless Mind of Wes Jackson", published by the University Press of Kansas.



Civilization, heal thyself

We aren't helpless victims of bats and a virus if we recognize ecological limits

STAN COX

Humanity's transgression of ecological limits has caused widespread damage, including a climate emergency, catastrophic loss of biodiversity, and extensive degradation of soils around the world. Earth abuse is also at the root of the Covid-19 pandemic and the grim possibility that new pathogens will continue to emerge from other animal species to infect humans.

Cultivation, deforestation, mining, livestock raising, and other activities degrade and destroy wildlife habitat, leaving animals no choice but to move closer to humans, potentially bringing pathogens along with them. Suburban sprawl and tourism (especially "eco-tourism") also bring humans and wildlife closer together. Hunting involves the most intimate contact with wild animals; indeed, the hunting of horseshoe bats probably kicked off the chain of events that led to the Covid-19 pandemic.

Humans have lived with domestic animals for millennia, and our bodies may have learned how to deal with the pathogens passed back and forth. But when ecosystems are disturbed or encroached upon, novel zoonotic viruses can move from wildlife into domestic animals and from there into humans. There is strong circumstantial evidence that the 1918-19 influenza pandemic, which killed more than 675,000 Americans and as many as 50 million worldwide, began with the flu virus jumping from swine into humans in Haskell County, Kansas, moving on to what is now Fort Riley with new army recruits, and from there reaching the battlefields of World War 1.

The horrific wildfires that were ignited across Southeast Asia for land-clearing in 1997-98, combined with a regional drought, killed off many fruit-bearing trees in the forests of Malaysia. Fleeing the dead forests, fruit bats found sustenance in domestic orchards, bringing with them the Nipah virus. Swine being raised within the orchards became infected through the bats' virus-laden droppings and passed the virus on to the people who handled them. Nipah brings high mortality among both hogs and human population, killing approximately 50 percent of the people it infects.

We saw during the past year that once the new coronavirus gained a foothold in our species, the modern human propensity for long-distance travel quickly turned local outbreaks into a pandemic. Even short-distance travel such as commuting increased the infection rate. Early spread of the contagion in New York City and nearby

Opposite: Disrupting the ecosphere, with and for fossil fuels, opens the way for pathogens to move from wildlife to humans. "Human Miasma", by Priti Gulati Cox, embroidery and graphite on khadi, a hand-woven fabric.

areas of New York state, New Jersey, and Connecticut was not a product of high population density; rather, it arose from a high degree of mobility and interconnectedness with surrounding areas, primarily by private vehicle.

Air conditioning, another technology with severe climate effects, was also implicated in Covid-19 outbreaks. Summertime, a season in which respiratory viruses typically wane, instead saw dramatic infection peaks throughout the Sun Belt as people escaped the heat and gathered in tightly enclosed, air-conditioned spaces. Vacation cruises, which should have been banned decades ago given their exploitation of workers and heavy effect on the oceans and atmosphere, hosted some of the worst early outbreaks. The industrial meat industry, despoiler of soils and water, prolific emitter of greenhouse gases, also turned out to be an efficient viral incubator.

In some cases, greenhouse warming itself creates conditions for spread of zoonotic infection. In East and North Africa, for example, droughts have become more frequent and intense thanks to climate change. Many pastoralists have responded by replacing their cattle herds with camels, which, famously, can survive for long stretches of time without access to water. As a result, much larger numbers of camels are now in close contact with humans in the region. Worryingly, the coronavirus that causes Middle East respiratory syndrome is circulating in dromedary camel populations in several countries in the region.

MERS originated in bats, has become endemic in camels, and then over the past decade has repeatedly made the jump from camels into humans. It does not spread as readily from person to person as the Covid-19 virus, but it is orders of magnitude more deadly. Of approximately 2,500 people who have been infected by the MERS virus since 2012, one-third have died. As droughts worsen, farmers and herders take their camels on increasingly long journeys in search of forage. Trips often extend for days, and, without fuel for fire building, the herders often must sleep close to the camels for warmth. For want of fire and water, they also may sustain themselves by drinking the camels' milk raw. All of this increases the risk of virus transmission.

We may wriggle out from under the Covid-19 pandemic by year's end, but we won't be in the clear. It is likely that we will continue to encounter novel coronaviruses. Never before the year 2000 were coronaviruses known to emerge from bats into human populations and cause highly lethal disease in humans. In the two decades since, however, there have been three such events, involving SARS-CoV-1, which caused the 2002-2004 "severe acute respiratory syndrome" (SARS) pandemic; MERS-CoV, which causes MERS; and SARS-CoV-2, the cause of Covid-19.

In a 2020 article in the journal Cell, David Morens and Anthony Fauci – yes, *that* Dr. Fauci – wrote that as we continue disrupting the ecosphere, pathogens are finding their way into human populations with increasing frequency: "The Covid-19 pandemic is yet another reminder, added to the rapidly growing archive of historical reminders, that in a human-dominated world, in which our human activities represent aggressive, damaging, and unbalanced interactions with nature, we will increasingly provoke new disease emergences. We remain at risk for the foreseeable future. Covid-19 is among the most vivid wake-up calls in over a century. It should force us to begin to think in earnest and collectively about living in more thoughtful and creative

harmony with nature, even as we plan for nature's inevitable, and always unexpected, surprises."

Our encroachment on the ecosphere has opened a Pandora's box. In addition to the viruses causing SARS, MERS, and Covid-19, some of the other bat coronaviruses studied so far have all the necessary pathogenic tools for attacking humans, and they have been shown to infect and sicken laboratory mice. According to a paper authored by a national group of 10 researchers in the field, there are "enormous groups of bat coronaviruses distributed globally," and many, like SARS-CoV-2, are "functionally preadapted" to infecting humans. That preadaptation may be related to similarities among bats, minks, cats, humans, and some other mammalian species in our lung-cell membranes' susceptibility to entry by this group of viruses.

There's more. Since 2017, another coronavirus – emerging, like the Covid-19 and SARS viruses, from horseshoe bats – has been triggering deadly outbreaks among piglets in China. In the laboratory, the new bug appears to have the genetic potential to infect human airway and intestinal cells. Three different coronaviruses that cause severe disease in cattle, horses, and swine are closely related to another virus that has long been causing the common cold in humans. These livestock viruses may acquire, through genetic exchange, the ability to infect us.

Scientists are becoming increasingly concerned about the propensity of different coronavirus strains to engage in recombination, that is, to swap blocks of genetic code with one another. Reportedly, the code for shaping the "spike" protein that allows the virus to enter host cells is especially prone to recombination, raising concerns that code for versions of the spike that can serve as "keys" for opening human cells to infection could pass from human pathogens like the Covid-19 or common-cold viruses into livestock viruses. The latter might thereby acquire the ability to infect the people who work around them. In researchers' words, "[C]oronaviruses can change rapidly, drastically, and unpredictably via recombination with both known and unknown lineages."

Early in the Covid-19 pandemic, 10 scientists representing a broad range of medical disciplines wrote for a tropical-medicine journal, "Because we have only just begun to sample, sequence, and study bat/mammalian coronaviruses, we can be certain that what we now know is but the tip of a very large iceberg," and that the data "reaffirm what has long been obvious: that future coronavirus transmissions into humans are not only possible, but likely. Scientists knew this years ago and raised appropriate alarm. Our prolonged deafness now exacts a tragic price."

What's good for the ecosphere is good for human health, and we are not helpless victims. Escaping ecological catastrophe and reducing the frequency of pandemics that might be waiting for us in the decades ahead is well within our capability, but it will require assiduous respect for ecological limits and great restraint in our interactions with nature.

The writer and photographer, his refrigerator proxy, and its summertime coolant source.

Frigidare

Keeping food cool without fossil fuels

SCOTT BONTZ

It might have been irritability that led me to start with the refrigerator. I lived in a cottage at The Land Institute's 70-acre farm, and the on-and-off buzzing of the compressor got to me. The place was small but had a mudroom. Feeling crankily inspired, there I pushed the fridge, unplugged. The kitchen became both quieter and more open.

I wouldn't have been at the institute if not already aiming to power down. Energy-rich carbon – coal, oil, gas – has radically changed human life, but now our lives depend on leaving fossil fuels behind. To assure avoiding ecospheric catastrophe from climate change, my co-worker Stan Cox says in "The Green New Deal and Beyond", we need to have quit these fuels within a decade. Not quite cold turkey, but quick. Stan works through what must happen at the top: a leak-proof ratcheting down of extraction by 10 percent every year, which probably means nationalizing the oil companies. Such happened in World War 2, and with everyone aboard, it worked.

But in that time production was *ramped up*. Now we face reversal, reversal of a kind of economic growth that has been made our faith. What will the cap at the wellhead mean for us on the ground? Stan's other books cover rationing and air conditioning, and in "New Deal" he notes countries with much lower carbon footprints than the US achieving comparable comforts. But none has quit high-energy carbon. Neither have I. For more than a decade, however, I've tried to make steps. And I'd like to tell you about them.

At the cottage I designed a 650-square-foot straw-bale house and began building. My plan didn't provide for electricity and didn't leave space for a refrigerator. I had considered a gas-powered fridge. But what does off the grid really mean? I found at the cottage that I could do without. I don't mean that my life doesn't involve refrigerators and freezers, such as at the grocer, but only that I can get by without one in my home. And I don't mean that it's not missed. Sometimes I think that if there were one modern convenience to keep, even before electric lights would be the refrigerator. It's so damned convenient.

What I am using instead is a 1.7-cubic-foot Coleman camp cooler. It's made from petroleum, but beyond that "embodied energy", temperature control is up to me – what I put in the cooler, where I place it, whether and how I cover it to boost insulation. For temperature-stabilizing mass, I try to keep it loaded – as one should a fridge. If there isn't enough food for this, I add bottled water. A bottle can sit outside and cool or freeze overnight, then go in the box for the day. The cooler's placement depends on me reading thermometers inside, outside, and in the box, plus listening to the forecast. The just-right

spot is sometimes the two-door entryway through the straw bale wall. To keep the cooler at fridge temperatures during winter I may need to move it in the middle of the night, but I'm always up at least once anyway.

I write this during two weeks of severe cold, the thermometer never above 20 and wind chill below zero. With temperatures in the house falling as low as 40 overnight, a cooler chilled outside to about freezing can be brought in to stay most of the time, if covered with and blanket and/or sleeping bag. The rest of winter this year in central Kansas has been remarkably mild. The cooler has spent most days on the porch.

Summer sees a reversal: the cooler goes out with night temperature low enough and comes in all day. In summers past, I gave the cooler a rest, made food fresh, used produce fast. But last year, about twice a day I poured in three or four gallons of water straight from the well, at 57 to 58 degrees. This stretched keeping of produce and cheese, and even kept pasteurized milk from our cow fresh for at least a day. When the water warmed, I drained it into a bucket for use at the sink.

One year I tried an idea from Africa: nest one unglazed clay pot in another and separate them with a jacket of sand kept wet for evaporative cooling. I didn't see more than a 10-degree difference between this tiny cooler and the outside temperature, and I didn't bother trying it in a house that can become humid enough to grow mold on books.

If rebuilding the house, I would include a superinsulated, fridge-size box in the straw-bale wall. A door on the box's outside would allow loading and unloading of water or ice. It would also take adjustable layering of insulation to suit the weather. I'll not retrofit, which would mean punching a hole in a wall of plastered straw. But I still might build a bigger, better insulated cooler than the lightweight Coleman, with shelves to save me from having to rummage.

My partner, Emily, and I have considered building an icehouse and filling it with homemade ice blocks. A reprint of an old farm how-to book showed this cottage-size scheme. I suspect these icehouses were in places colder than Kansas, maybe New England. Pictures show teams of men with massive hand saws cutting up frozen ponds and loading horse-drawn sledges. We would have to cast our blocks. Would it be worth hand-pumping that much water and pouring it in molds? Knocking the blocks loose and stacking them safely to avoid a collapse that could crush us or knock down the house? Would an insulated mass of ice 10 x 10 x 8 feet last through summer here? With climate change, will our winters remain cold enough to even build a 24-ton ice cube?

Home refrigerators became common less than a century ago. They are one of those modern luxuries – the early models cost more than a Model T – that came to seem essential but are not. Though the fridge/freezers of today are much more efficient than those 50 years ago, the US Energy Information Administration puts them just below lighting and far above washers and dryers in home energy use. They have also used, both as refrigerant and in their foam insulation, powerful greenhouse gases, most of which will escape unless the defunct fridge gets costly recycling.

Maybe refrigerators will be one thing to keep when our electricity comes only from wind turbines and solar panels. But they could be one thing for some of us to quit when we all quit fossil fuels.

Oil barrel on bare soil where the landowner practices "circle burns" in his pickup south of Smolon, Kansas. Scott Bontz photo.

The dark earth in this field at Thornton, Iowa, has topsoil. That carbon-rich layer has left the higher ground, exposing lighter colored subsoil. Evan A. Thaler photos.

Much of Corn Belt has no topsoil

Satellite pictures show a third of plowed terrain is down to relatively poor subsoil

SCOTT BONTZ

Roughly 35 percent of plowed land in the Corn Belt has lost all of its topsoil, say University of Massachusetts geoscientists who made their estimate by connecting topography with satellite pictures of soil color. The calculation has a broad margin of error, 11 percent either way, but far exceeds previous estimates. Twenty-eight sites from Indiana to North Dakota form the study's basis, and the USDA classifies none as bankrupt of the "A-horizon" soil where most soil organic matter is found. The study also attributed most of the loss not to water and wind erosion after tillage, but simply to the plow and gravity.

The finding, in Proceedings of the National Academy of Sciences, said that the loss included 1.4 billion metric tons of carbon, give or take half a billion. That estimate is based on carbon in native prairie soils. Even harder to discern is how much carbon was released to the atmosphere after plowing and how much stayed in eroded soil, Evan A. Thaler, lead author of the study, said in an interview. What he could say is that eroded soil settling in lowlands might not boost crop yields, because the A-horizon there was already deep enough for annual crop roots.

The study numbers don't include erosion from fields that still have topsoil, however thin it may have become since arrival of the plow 160 years ago. Other researchers have estimated global loss of soil carbon under crop agriculture at 35 to 88 million metric tons.

Previous Corn Belt topsoil loss estimates were based on erosion measured over decades in small plots. Thaler counted only where no topsoil is left, by color contrast between the carbon-rich A-horizon and the B-horizon subsoil with its iron oxides. This showed in 28 satellite pictures including 759 fields and covering 81 square miles. Thaler correlated the loss with how the land sloped, which is well known throughout the Corn Belt by laser measurement from airplanes. Then he extrapolated to cover more than 150,000 square miles of the region.

The other Massachusetts researchers were Isaac J. Larsen and Qian Yu. The study, for Thaler's doctoral dissertation, took him almost three years. He didn't just analyze aerial imagery and numbers but made many trips to the field. "So, I knew I wasn't crazy," he said.

Thaler has had a long interest in erosion, and earned bachelor's and master's degrees in geology. "Despite the societal importance of soil erosion, it is a fairly underappreciated issue in the geosciences community, and that makes it pretty compelling to study", he said.

His estimates of carbon loss used about 8,000 USDA samples from across the nation. He also talked with farmers in the study

area. Some acknowledged the loss, and said they'd seen production fall in their lifetimes. Some denied it.

Other studies have determined that on the convex topography of hilltops and ridges, tillage fluffing up the soil makes for an easy pull by gravity and brings more erosion – soil creep – than do wind or water. Water builds power farther downslope and in concavities, but about 70 percent of the exposed subsoil that Thaler found was on convex terrain. The Massachusetts researchers called for US erosion assessments to include tillage erosion, as have European nations.

No-till farming leaves carbon-rich crop residue, which would throw off satellite imaging, so Thaler looked only at bare, plowed soil. No-till, which relies on herbicides, can greatly reduce soil erosion. It also keeps soil cooler, which delays planting and germination, so less than 15 percent of acreage in the upper Mississippi watershed, the heart of the Corn Belt, is consistently under no-till.

The Massachusetts study estimated that the missing A-horizon costs the economy $2.8 billion annually, give or take $900 million. This does not include the cost of compensation with fertilizer, which Thaler said has been estimated at $500 million to $1 billion.

We can't restore this denuded farmland by hauling back uphill all of the displaced – and disarranged – topsoil. But Thaler and his colleagues conclude by saying that changing how we farm could prevent more soil loss in the Corn Belt, begin regenerating the organic matter that makes soil rich, and turn it into a sink for atmospheric carbon.

The contrast shown directly by a lump of topsoil placed on carbon-poor subsoil.

Extracts

WHEN YOU BEGIN to talk and work with the fertility of the soil and the way it relates to the welfare of humanity, you are talking a common language. It brings people closer together. It will bring nations closer together. – Hugh Bennett

WE INACCURATELY frame climate as a technical problem, when the problem lies in the structure of the economy and society. … We must directly suppress fossil fuels. It will require strong regulation to prevent extraction. – Richard York

THE "ENVIRONMENT" of a gene consists largely of other genes, each of which is itself being selected for *its* ability to cooperate with its environment of other genes. – Richard Dawkins, "The Selfish Gene"

A RESPONSE TO AESTHETICS should guide a sane society and not be an afterthought; a society that forgets to see and love beauty is a hardscrabble place, parched to the bone. – James Balog, "Tree: A New Vision of the American Forest"

LITERARY CULTURE is no remedy for totalitarianism. Ogres gonna ogre. Rhetoric is as liquid and useful for the worst as it is for the best. – Adam Gopnik, in The New Yorker

UNDER THE CURRENT SYSTEM of national accounting, a country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife and fisheries to extinction, but measured income would not be affected as these assets disappeared. … The result can be illusory gains in income and permanent losses in wealth. – Robert Repetto

THEY FELT THE RUSH of sap in spring, they knew the wave which cannot halt, but every year throws forward the seed to begetting, and falling back, leaves the young-born on the earth. – D. H. Lawrence, "The Rainbow"

MAY WE NOT BE of one heart, though we are not of one opinion? – John Wesley, "Catholic Spirit"

OUR INTENSE ENERGY usage is one and the same as modern civilization. – Bill Gates, in Peter Brannen's "The Ends of the World"

OBSERVE CONSTANTLY that all things take place by change, and accustom yourself to consider that the nature of the Universe loves nothing so much as to change the things which are, and to make new things like them. – Marcus Aurelius

ONE MAN'S GIFT must not be another man's capital. – Marcel Mauss

LONG-TERM, HEALTHY PATTERNS of social organization, among all social life forms, hinge on work that maintains the integrity of the community while at the same time granting autonomy to its individuals. What makes a society beautiful and memorable is some combination of autonomy and deference that, together, minimizes strife. – Barry Lopez, in Resurgence & Ecologist

Land Report shorts

Stroer named new president

The Land Institute Board of Directors named Rachel Stroer as the organization's new president, after she had served nine months as acting president. "Rachel is the leader The Land Institute needs right now", board Chairman Kenneth Levy-Church said in an announcement of the decision on March 29. "Her demonstrated acumen for fund raising, management, team building, and external relations are essential to TLI at this moment in its history. She has expressed a strong commitment to TLI's mission and proposed a bold vision for the organization in the coming years."

Stroer

Stroer joined The Land Institute in 2015, and in the next year took the role of chief operating officer. Later she became chief strategy officer. Last July, after President Fred Iutzi's resignation, she took the role of acting president. She lives in Austin, Texas, and every few weeks comes to work at The Land Institute.

Stroer grew up in Salina, where her parents still live. The family restored a tallgrass prairie, which Stroer says ingrained in her an understanding of prairie ecology. For her bachelor's degree, she studied relationships between humans and the ecosphere through performance, ethnography, evolutionary biology, and philosophy. She earned a master's degree in business administration. Before joining us, she advised cities on sustainable development for an architectural firm, and handled communications and investor relations for an energy asset management company.

Levy-Church wrote to Land Institute staff members: "We heard many times over in your feedback that Rachel's energy and enthusiasm are infectious and inspiring, that she's a good listener and solicits advice and ideas widely, that she's decisive when needed, but not afraid to share the work of decision making. We also know that Rachel has a deep understanding of and respect for the unique culture at TLI and is dedicated to fostering an environment where staff can thrive. She is the impresario that we need, a leader who will bring the team together to develop the right people, strategies and organizational infrastructure."

Silphium flourishes up north

Last fall, Land Institute silphium breeder David Van Tassel drove to Fargo, North Dakota, to meet with USDA sunflower geneticist and silphium collaborator Brent Hulke. Hulke showed Van Tassel silphium plots that are four to five years old and have never been irrigated or fertilized yet show extreme vigor and no sign of decline. It appears an excellent location for the new, perennial oilseed crop: soils and groundwater may be loaded with waste nitrogen from years of maize production, and the low humidity

and cold winters may reduce the pests and pathogens that afflict silphium in Kansas. For some of the same reasons, North Dakota is an excellent region for sunflower production. Van Tassel also met with North Dakota farmer Jayne Krabbenhoft, whose family owns a large farm on mostly excellent soils just north of Fargo. Krabbenhoft is qualifying some acres as organic and is interested in alternative crops in general. We rented eight acres from her for breeding plots.

New researcher

Ying Hu has joined us as a postdoctoral researcher using computation and statistics to speed development of intermediate wheatgrass. She is developing technolgies for researchers to use DNA sequences for predicting the traits a new plant will have, which is much faster than growing plants out in traditional breeding. Predictions are based on correlating DNA sequences with how plants have grown and performed. One of Hu's advisers for the work, Jesse Poland at Kansas State University, has been instrumental in helping our lead intermediate wheatgrass researcher, Lee DeHaan, with this genotyping. Hu is helping DeHaan to select from his intermediate wheatgrass populations and improve the crop. For her PhD at K-State, Hu worked to improve drought and cold tolerance in rice and tomato. Now she is with family in Gainesville, Florida, but with access to K-State's Beocat supercomputer.

Hu

New technician

Anna Andersson, a Land Institute intern in 2018, has returned to become our first research technician for civic science. This enlists volunteers across the nation to grow our plants, share their results with us, and help us learn how to organize such a community. Andersson has worked as an educator and project manager for regional agricultural initiatives. She grew up in North Dakota and Sweden, and has a degree combining music and psychology. She also studied physical geography in Sweden.

Andersson

The complexity of shattering

Wild plants tend to drop their seed on the ground, and one of the challenges in their domestication is to stop that loss. Kayla Altendorf, a doctoral student at the University of Minnesota, has collaborated with Lee DeHaan at The Land Institute to understand this "shattering" – among other traits – in intermediate wheatgrass, which produces Kernza®, our registered trademark for the grain and its food products. Altendorf noted that seeds can fall to the ground individually or when whole pieces of the head break off, and she discovered that these two types of shattering are under independent genetic control. So DeHaan has begun scoring the types independently in his work to reduce shattering. Some genes that control the head-breaking trait appear to be those selected against by our ancestors

10 millennia ago when they domesticated barley and wheat. But shattering is not a simple, one-gene affair, and will take generations of more selection.

New Roots International

Over the last 10 years, the foundation has been forming for a global movement of perennial grain research. The Web of Science says scientific papers citing "perennial grains" increased from 15 per year in 2000 to 297 in 2020. The Land Institute collaborates with more than 50 researchers on six continents. The work should involve many more people. We want to build a network of regional hubs to develop perennial grain crops that are ecologically adapted, culturally valued, and economically viable for all grain producing regions of the world. The ecological functions and environmental benefits of perennial grass and forb species are well-documented. Reduced erosion, weed suppression, improved soil structure, and greater carbon sequestration, water infiltration, and nutrient retention: there is extensive evidence that diverse perennials go to the root of agriculture's most damaging ecosystem disservices. We want to see perennial grain agriculture succeed on a global, revolutionary scale. The network of hubs will share data, models, and tools for collaborative research and advocacy. Our initiative for this is called New Roots International. The Land Institute began planning NRI last fall. We surveyed almost 100 researchers around the world on how to best serve the international science community. In December, we were awarded the Food Planet Prize to help launch NRI. (See the next short.) Soon a director will be hired, and we'll continue planning the network with international collaborators.

Mathieu Chevalier amid the roots of intermediate wheatgrass. French researchers are already studying how to grow, use, and market this perennial grain bred at The Land Institute. Our New Roots International initiative will broaden and coordinate collaboration around the globe. The pit shown here allowed researchers to study how intermediate wheatgrass roots change the structure of the soil and affect flow of water and gases. Olivier Duchene photo.

$1 million prize

In December, the Curt Bergfors Foundation in Sweden gave The Land Institute a $1 million Food Planet Prize. This was the first year of the awards, and we were one of five recipients chosen from more than 650 nominees. The money goes to New Roots International, our initiative to greatly enlarge global coordination and promotion of perennial grains and their ecological use. For more about that, see page 24. Bergfors is credited with beginning several companies but is best known for Max, a burger chain that says it offsets more greenhouse gases than it emits. Max has expanded to other Scandinavian countries, and to Poland and the Mideast. Other Food Planet Prize winners were Blue Ventures, a British organization rebuilding tropical fisheries, and FutureFeed, an Australian endeavor using seaweed in cattle feed to cut methane emissions. Sharing a prize were The International Center of Insect Physiology and Ecology, which promotes insects as an alternative to conventional agriculture, and Sanergy, which turns slum waste into feed and fertilizer. Both are based in Kenya. Sanergy was founded by graduates of Massachusetts Institute of Technology.

New board members

The Land Institute Board of Directors added two members, Funlola Otukoya and Eric Schlosser. Schlosser is an investigative reporter best known for "Fast Food Nation". He also wrote "Reefer Madness", about the underground economies of marijuana, migrant labor, and pornography, and "Command and Control", about US nuclear weapons. He lives in Monterey, California. Otukoya is an investment analyst at the philanthropic McKnight Foundation, which is based in Minneapolis. He is also Africa advisor for Concordia, which promotes collaboration for social change. "The future of our planet will require us to do things in ways that are uncomfortable", Otukoya said. "Particularly for the ecological ecosystem, The Land Institute is at the forefront, and I'm excited to see it lead in the changes our society has to make."

Otukoya

Publications and presentations

The new book "What Kind of Ancestor Do You Want to Be?" includes an essay by Aubrey Streit Krug, who directs The Land Institute's ecosphere studies. The book also has an interview with Wes Jackson, our president emeritus. The book is scheduled for release in May. More media are on our website, landinstitute.org. Look under the heading Learn to find videos and audios, scientific publications by our researchers, and past issues of the Land Report. The heading News & Events leads to news coverage.

Smaller seed, but more of it

Domesticated grains share a pattern of changes relative to their wild ancestors. These include larger seeds and flowerheads. It seems obvious that breeding for larger seeds would help increase grain yield. But though the kernels of maize and soybean

are much larger than those of domesticated grain sorghum, wheat, and rice, the latter are still widely grown and highly valued. Many thousands of acres are still planted to even smaller-seeded grains: sesame, teff, canola, flaxseed, pearl millet. This is important, because as lead silphium researcher David Van Tassel selected for larger heads and seeds, that tended to also bring undesirably tall, coarse stalks. Silphium species with attractively short, slender stalks also have small heads and seeds. Van Tassel's team is exploring hybrids, looking for small plants that make up for size with a larger number of heads. Silphium already has larger seeds than canola and flax. The projected yields of some exceptional, individual plants are higher than canola, flax, and safflower, and in the ballpark of oat and barley. There

Civic science for a legume

Research resident Abbi Han gathers sainfoin plants to photograph them at various growth stages for The Land Institute's civic science, in which volunteers around the nation grow our plants, take notes, and send us samples. Sainfoin is our prime perennial legume to develop as a grain crop. Scott Bontz photo.

remains much work to take average silphium to its yield potential.

Perennial grain from the sea

Time magazine tells of Spanish seafood chef Angel Leon and his work to develop a perennial grain that grows in the sea. *Zostera marina*, commonly known as eelgrass, pollinates underwater, and is the most wide-ranging marine flowering plant in the Northern Hemisphere. Eelgrass is not in the same order as the terrestrial grasses from which humans have derived their grain crops, but its leaves are long, slender blades. The Time story refers to it as sea rice, but writer Matt Goulding says the grain looks more like amaranth or chia. After Leon boils some of it and offers a spoonful, Goulding gives this review: "The first thing you notice is the texture: taut-skinned and compact, each grain pops on your tongue like an orb of caviar. It tasted like the love child of rice and quinoa with a gentle saline undertow." Seri, hunters and gatherers of Sonora, Mexico, ate eelgrass seed. Leon's team aims at domestication. They are transplanting whole eelgrass plants from around Spain to Leon's home waters, the Bay of Cadiz. He hopes to harvest 12 acres this summer and use about 48,000 pounds for expanding eelgrass fields next year. He'll keep about 6,000 pounds to cook with at his restaurant, Aponiente, and to experiment with in the lab.

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Every gift matters to us, thank you for being part of this journey. As we work toward best practices as a team, we are moving toward only publishing your name if you have given us permission to do so. If you see your name listed & wish for it not to be published in the future, please contact Amanda at 785-823-5376 or info@landinstitute.org. Thank you again for your generosity. This list is for contributions made from October 1 through December 31.

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Mothballed pumping jacks in Canton, Kansas. Wes Jackson and Robert Jensen (page 4) and Stan Cox (page 10) argue for retiring all of the world's oil rigs to avoid ecological catastrophe. Scott Bontz photo.