Land Report

Number 130, *Summer* 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

A drawing of earth after a prescribed burn of vegetation. Charcoal on paper, 48 x 45 inches, by Erin Wiersma, who will show at The Land Institute's Prairie Festival, September 24-26. See page 26.

On the bridge

The Land Institute's new leader deals with two worlds to save the one that matters

SCOTT BONTZ

When Rachel Stroer was a girl, she would drive north with her father and mother from home in Salina to help coax 320 acres in the country back to prairiehood. Some of the half-square-mile of land was hilly and unplowed, but much of it had been in row crops or grazed. The family took out invasive trees and burned to encourage native grasses and forbs. Rachel visited areas of vigorous tallgrass, collected seed in glass jars, and sowed it on struggling ground. And the place gradually became something nearer native. The Wedel family weren't expert conservationists, but Rachel's father, Alan, a physician, had read indigenous writers, Thoreau, and William Least Heat-Moon's "PrairyErth", and she picked up from him a land ethic. "He had a lot of reverence for the space, and the soil, and the plants, and the animals", she said. As they walked the land, they talked, and they observed. Rachel would follow directly in her father's steps, in part to avoid badger holes, but also thinking of paths taken by the original Americans and the bison. "There was a feeling of quality of movement in that place", she said. "There was a spiritual and philosophical aspect that has grounded me in my life."

Rachel Stroer has worked for an architect, rebuilding a tornado-ravaged town, and earned an MBA, *always with sustainability in mind. Here she speaks at a conference on seeing Earth as ecosphere. Scott Seirer photo.*

That quality of movement might have played in her interest in dance. There was also her artist mother, Sandy, who studied printmaking and Greek mythology in college, and who paints and sculpts. Rachel did well in Salina's public schools and enjoyed the academics. But for college she wanted to eat her cake and have it too, and so combined dance with sciences and the great books, including Plato, Descartes, and Goethe. "It was a big mashup of my interests," she said. This was at New York University's Gallatin School of Individualized Study, which Rachel also liked because it was outside the status quo, but, she hoped, still useful.

Even so, she graduated without a career goal. First came work in hospitality and exploration of a graduate degree in dance. But she always had in mind sustainability, though at the time she might not have used the word, and she wanted to work with more purpose than making money. She joined a Kansas City architecture firm that aimed for sustainable buildings. Among her work there was a master plan to rebuild after a tornado destroyed 95 percent of Greenburg, Kansas. She also learned about the "triple bottom line" – people, planet, prosperity – and decided that sustainable prosperity could not be reached without more involvement by the power of business. To learn that world's language and "way of being", she went back to school for an MBA.

Rachel Wedel had gone to high school with Pete Stroer. They once had a date for homecoming but that was all. While Rachel went to New York City, Pete went to the University of Texas. He played professional tennis, and then became a financial adviser. The two reconnected after college during Christmas visits to their families in Salina. They developed a friendship, and then a marriage. With an infant, they moved back to their hometown and the boy's grandparents.

Rachel came with no job. "I had no idea what I was going to do." But she had a strong memory of The Land Institute's president at the time, Wes Jackson. The Kansas City architect had asked her to call Wes about something, and after she told him her name and that she had grown up in Salina, he drew her family tree with astonishing thoroughness. "He knew more about my genealogy than I do", she said. And this was comforting. Wes showed her the importance of connection to place through connection with one another.

Back home, Rachel stayed in touch with Wes, though feeling no sense of being needed at The Land Institute. When it began a $22.5 million, 15-year project with the Malone Family Land Preservation Foundation, however, "All of the sudden my MBA had some relevance." She was hired on in 2015 as director of strategic operations. Her title changed to chief operating officer, then chief strategy officer, and, last summer, to acting president. Nine months later, the Board of Directors decided she would lead The Land Institute to spread its collaboration around the world and speed development of perennial grains for a more ecologically sound agriculture.

Rachel had long wanted purposeful work, but in terms of a career had never considered herself aspirational. She joined The Land Institute with no idea that six years later she would be president. Three months on, the job feels quite different than when she served as a stopgap. "That was a nice little training-wheel realm", she said. Now there is a greater sense of responsibility, and greater stress. "I hope it hasn't changed much for staff. I think it's mostly changed in my mind." Some of the stress

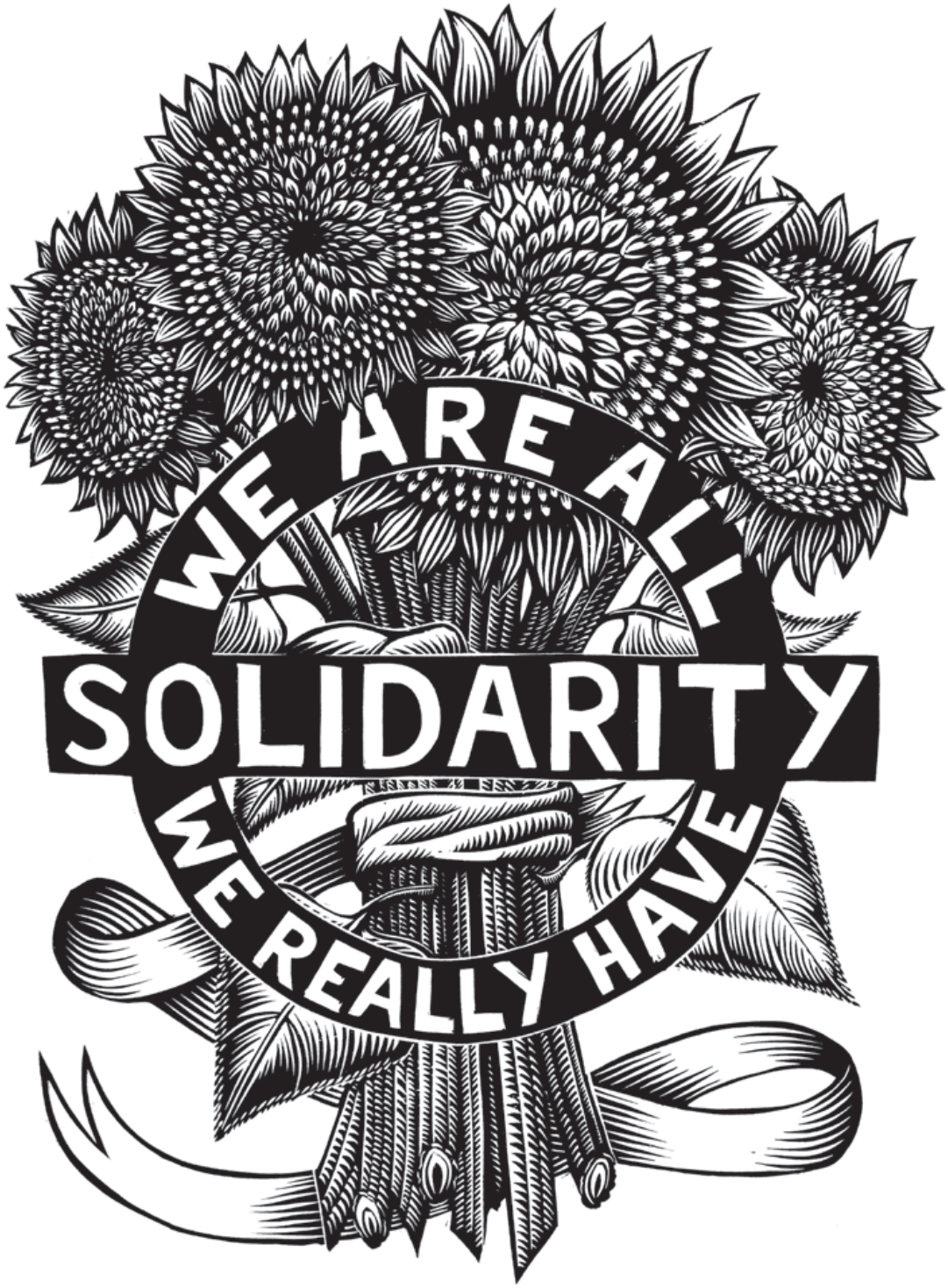
comes from searching for people to fill new jobs as the institute grows, including a human resources manager, a communications director, and a director of the global project called New Roots International. She's also involved in fund raising, contracts, and trying to improve work culture through such things as a less hierarchical structure, with a "team of teams", and classes in diversity, equity, and inclusion. And working out what the institute is to become. "How are we going to live into this long-term vision of perennial grains in polycultures on a majority of grain-producing acres on the planet? How do we grow when we also know endless growth is not possible?" She hoped that by the end of this year she might finally be able to describe a typical day as president.

Three years ago, the Stroer family moved back to where Pete went to college, Austin. They took two boys, who Rachel said are opposite in every way. Nine-year-old Isaac is cautious, shy, contemplative, and, like his mother, brown-eyed. Five-year-old Ethan is boisterous, confident, funny, and, like his father, blue-eyed. Rachel herself is the oldest of three children, with five years between each.

Every three to four weeks, she drives the 630 miles to Salina, sometimes with the boys, stays with her parents, and spends a work week at The Land Institute. In June, she led The Land Institute's first in-person monthly staff meeting in more than a year. The setting was a shaded breezeway between the research building and the threshing building. The temperature was 100, but everyone was face to face, not mediated as Zoom thumbnails, muted and appearing to look at one another's foreheads. Rachel told the group that it can be draining work to get the attention of the agricultural complex, hard to hold the line for what she called the courageous, long view. But she said, "I'm invigorated by this meeting."

Her commute is long, but it bridges a gap between two worlds needed by the institute. There is Salina, ingrained with a sense of place, and tending toward the insular. Rachel grew up here and knows the place deeply. And there is Austin, with more than a million people, a state capital, the flagship university, and wealth – masses "accustomed to having resources". Such accommodating comforts can limit creativity, Rachel said, and people in places like Austin and New York don't really understand agriculture. "You just get a different set of questions. These are the minds that we have to change." Urban, consumer culture can discourage her, but she said, "I am optimistic that there is a pathway for humanity. If I wasn't optimistic, I wouldn't be doing this work."

She also keeps in mind the world lost by those who originally lived, sustainably, in the place that she helped restore to native flora more than a century later. "Today I'm acutely aware of the privilege that this experience represents", she said. "I am a white woman whose family immigrated to the US and to Kansas in 1874. I got to walk on this land that was stolen from the very communities and tribes from which my family was learning, through reading, about how to interact with it. I grieve this and am on a journey to understand how I can use and distribute this privilege in a meaningful way in my work at The Land Institute and my personal life."



If a place is welcoming to new members they'll want to stay. Linocut by Roger Peet, an artist in Portland, Oregon.

Judge not, lest ye lose people from your state

EMILY RUDE

Romance is a survival strategy. Romanticizing things helps us cope with ugliness in our everyday lives. If we're very good at it, we can feel quite complacent in the most absurd conditions. I often wonder if this is why images of sunflowers and wheat are absolutely everywhere you look in Kansas. They call to mind the real beauty of the prairie, and the true satisfaction of a solid harvest. Beauty and bounty – that's what Kansans want Kansas to be about. The Land Institute is what brought me to Kansas; the land is one reason why I stayed. But the tallgrass prairie is less than 4 percent of what it once was, continent-wide. Only about 3 percent of Kansans actually farm. Even if you aren't from the Midwest, you're probably aware that few young people are excited to live there. For many of us, rural or in town, Kansas is desolate. It's fast food, weedy lots, and judgement. True, fast food can be excellent sometimes, and weedy lots have their own morose poetry. But the judgement – that's what's truly wearying. It comes in small doses, but it adds up.

It comes from the minimum wage being $7.25 an hour for over a decade – less if you're a student or a tipped employee. This might put you over the poverty line if you work long hours, but it won't pay your bills – especially if you have kids or health problems. To people thinking of making a life here, this says: We only think people are worth something if they have a college degree or good connections. If you're young and new in town, good luck.

It comes from not being able to get healthcare if you're able-bodied and your jobs don't get you over the poverty line, which is $12,880 per year. This can easily happen if you are, say, an adjunct professor who also works parttime for a small nonprofit. This says: If you don't make enough money, we're okay with you being sick. This also says: If you're poor, we want you to stay poor.

It comes from the Kansas sales tax being more than double – in most counties triple – the base Kansas income tax rate of 3.1 percent for taxable income up to $15,000. (Any income after $15,000 is taxed at 5.2 percent, and after $30,000 it's taxed at 5.7 percent.) The sales tax is 9.5 percent at my closest grocery store. This says: We think people who make less money should bear more of the burden of paying for state services. In other words, we think people who make less money are more responsible for the mess we're all in.

The insidious ambiance of judgement also comes from more personal interactions, which nonetheless are often a result of policy and not necessarily personality. While not unique to Kansas, this sort of judgement comes with disappointing frequency here.

It comes from the sharpness in the voice of the hospital staff member as she charges you a fine for not keeping your appointment – even if the reason might be germane to her mission of care. This says: You are not as important to us as your money is.

It comes from the refusal of the police to believe that their buddy could have abused his girlfriend – the reason my friend refuses to set foot in Junction City ever again. This says: We protect and serve who we like, and who we like looks like us.

It comes from the police being the only option when you're worried that someone will harm themselves – and if you've ever seen this play out, you probably know how scary it can get. This says: If you are suicidal, you are the same in our eyes as a criminal.

And then there is the sort of judgement that is cultural, inherited from generations of schism and prejudice. I'm talking about racism, of course. Bleeding Kansas has always had its fair share of racial struggle. Nowadays, it shows up as a coolly suspicious – and oddly persistent – stare at the only Black person in the grocery store. Or, it appears as the 911 call in response to a Black couple walking up a friend's driveway for their weekly game night. Or, it appears as a Kansas National Guardsman writing "Make Lindsborg White Again" in chalk on Bethany College's campus, which has lately enjoyed an increase in Black and Latinx students. None of these situations are hypothetical. And I haven't even got to the unwelcoming flavor of religious judgement. I don't think I need to. Whether you're religious or not, you already know, don't you?

None of these Kansans – not the secretary of state, the hospital staff, the police, or even those folks in the grocery store – would judge you to your face. Not if they knew you, up close, as a human being. But they don't know you. How would they? They're just playing their roles, as they've been told to. At some point, though, the ugliness is too much. The romance of wild sunflowers and waves of amber grain just can't compete with the grim prospects that face someone starting out in Kansas, especially if young, especially if not white like 86 percent of the state.

Being part of a church can help. This is how many young people who stay are encouraged to do so, it seems. Church provides sorely needed community, purpose, support, and even a little glory. And, of course, romance. These churches, many of them quite new, with smart branding that give a flavor of athletic wear, do the work of retaining young people that the state is incapable of.

But this only works for people already here, already part of the church culture. It does not attract those for whom – for one reason or another – Christianity has always meant unfair judgement. And, unless you work for the church, it does not absolve you of the sin of being poor in Kansas. Not in the eyes of employers and the state, anyhow.

I don't blame people if they get defensive when I talk about all this. I don't even blame those folks who have told me to move if I hated it so much – although this is one of my least favorite comebacks, because it comes off as very – well – judgmental. But I respect pride of place. It's adjacent to unconditional love, which is a beautiful thing. I say "adjacent to", because true unconditional love is not blind. True love of Kansas sees the ugliness as well as the beauty. It sees opportunity for the beautiful parts – the people, the land – to thrive. Not just in our romantic fantasy, but really. Changing policy is one way to do it. I think we're capable of it. In the meantime, we can follow the example of the many churches of Kansas and

build community wherever we are, with or without the help of the state.

One interesting idea for building community in a tangible way that became somewhat popular during the pandemic, although it isn't new by any means, is mutual aid. Everyone practices mutual aid to some degree already, if only by doing household chores, helping a friend move, or bringing a casserole to a potluck. It's sharing your time, skill, and energy, without strings attached, knowing that your work will build the relationships that you need to survive and thrive for the long haul. The only trick is to organize that sort of thing on a larger scale, and between people who may not know each other well, or at all. Unlike charity, it requires seeing others as equal to you in social standing. In other words, not judging them.

A community that's capable of mutual aid at scale is capable of welcoming new members. A community that is welcoming to new members will attract new members, the kind that will want to stay.

There are mutual aid groups all over the nation, even in other red states, but few in Kansas. I'd like to understand why that is.

For my part, I'm learning a heck of a lot about community, judgement, and mutual aid. A lot of this learning happens in the classroom, where I teach undergraduate biology at a small-town college. I feel like I've learned more in four years of teaching than I learned in eight years of secondary education in agronomy and plant genetics. Young adults are fascinating, and more intelligent than they often get credit for. They're also very frustrated, and disappointed. They had expected more of us.

I'm not going to leave Kansas. It's home, and I love it. Not just for wild sunflowers, although I'm grateful to live among many of them. Not just for our state's farming heritage, although I'm surrounded by it. But also, for the unappreciated beauty and value of the people we lose for want of better judgement – and the people we could gain, if only we welcome them.

The writer teaches at Bethany College. You can reach her, including for a list of sources, by writing to rudeea@bethanylb.edu.

Hand Threshing

AUBREY STREIT KRUG

The sunflowers reseeded themselves into a forest to sway in the wind.
I had to look up to see the bees.
After petals fell each head bent with weight into a shepherd's crook.
What I harvested was a secret even to me.
The dry heads held their yield tight against thump and crumble.
Facts like songs only sometimes come free easy.
The wind teased help and skittered light chaff from grackle black seeds.
At last I could see every necessary sort of thing.

Priti Gulati Cox created a flame on an ash stump by arranging seeds from wheat, cowpea, buckwheat, and perennial sorghum. Wood-fired powerplants are terribly far from a net-zero solution to greenhouse gases.

“Net zero”, smoke, and mirrors

STAN COX

With 137 nations, including the United States, now having set targets for achieving net zero greenhouse emissions by 2050 or so under the Paris Agreement, hope is bubbling through the climate movement. But “net zero” is not zero, and these pledges are not as ambitious as they seem.

According to the world’s climate experts, to keep global warming below the 1.5 degrees Celsius called for in Paris will now require reducing greenhouse emissions by 8 percent per year, every year, until they are fully eliminated. A reduction that steep cannot be achieved without a precipitous phase-out of fossil fuels, which account for more than three-fourths of global emissions.

Zeroing out oil, gas, and coal on such an ambitious schedule would hamper and almost certainly reverse economic growth. Therefore, in their recent climate pledges, governments have set as their target a more palatable variation on the theme of “zero”.

Confident that their growing economies will deeply depend on fossil fuels through 2050 and beyond, national leaders, including President Biden, are pledging to, in theory, cancel out carbon emissions from oil, gas, and coal by extracting an equivalent quantity of carbon out of the atmosphere and keeping it out. We will still be pumping out greenhouse gases, but net emissions will be zero – on paper anyway.

“Net zero” is an illusionist’s stunt. Molecules of carbon dioxide can be made to vanish the moment they are emitted, by invoking the prospect of “negative emissions technologies”. However, the industrial and biological mechanisms by which the negative emissions will be conjured up tend to be ecologically destructive, wholly impractical, ineffective, or even purely speculative.

The dream of extending the fossil-fuel era well beyond its sell-by date has long been exemplified by the quest for “clean coal” or “clean gas” powerplants. These facilities would be made ostensibly carbon-free by capturing exhaust from the smokestack, extracting almost all the carbon dioxide, and injecting it belowground, where it is supposed to remain forever. Industrial carbon sequestration of this sort is energy-intensive, expensive, and therefore not done in practice – except to extend the profitable flow of crude from depleted oil wells, thereby leading to more emissions.

A wider search for ways of generating “carbon-free” electricity has led to the use of wood pellets as fuel in power plants. This process is not emissions-free; in fact, wood-fired power plants produce more pollution per kilowatt-hour of electricity than coal-fired plants. But no worries – there’s a net-zero solution. Newly planted trees can be relied upon to eventually capture as much carbon dioxide as was released by pelletizing and burning their predecessors.

The European Union classifies bioenergy as “renewable”, so over the past

decade, plant matter, mostly in the form of wood pellets, has come to account for well over half of the union's ostensibly carbon-free electricity supply. Voracious demand for wood pellets has led to deforestation in Eastern Europe. The EU nations are also importing pellets from as far away as the pinelands of the southeastern United States.

Wood-powered electricity has a fatal flaw: its climate account is perpetually overdrawn. A power plant can release a tree's worth of carbon into the atmosphere within minutes, but decades will be required for a replacement tree to recapture that quantity of emitted carbon. Then that tree will be burned, canceling out the savings until another tree can grow to maturity. Electric grids would be on this carbon treadmill through the very decades in which emissions must be eliminated completely.

In Estonia, the land-use sector, which includes forestry, is traditionally a net accumulator of carbon from the atmosphere. Now, with extensive clearcutting under way to feed Europe's power plants, Estonia's forest lands are on course to become a net carbon emitter by 2030.

As it has become increasingly clear that neither smokestack carbon capture nor electricity from biomass alone will be sufficient to achieve net-zero emissions, attention has turned toward a technology called "bioenergy with carbon capture and storage". This process, typically referred to as BECCS, is not in use beyond the research stage. It would start with burning pelletized biomass to generate electricity, as today's wood-fired power plants do. But then the carbon dioxide emitted from the power plant would be captured from the smokestack and buried.

Employing trees, grasses, and other biomass crops to remove carbon from the air while its power plants avoid releasing that carbon back into the air, BECCS would aspire to immediate net-zero emissions. But the process's many steps – producing and harvesting biomass crops, hauling the biomass to the processing factory, grinding and pelletizing, hauling pellets to the power plant, sucking carbon dioxide out of the smokestack, liquefying the carbon dioxide, hauling the liquid to the injection field, and shooting it into the earth under high pressure – would, in sum, eat up large quantities of energy. Researchers at Imperial College London and other analysts estimate that after accounting for those processes, a BECCS power plant would produce far too little net energy to make the enterprise worthwhile. And if the energy consumed in the process were to come from fossil fuels – as would be the case well into the future – a large portion of the carbon-capture benefits of BECCS also would be canceled out.

The harm caused by BECCS would not stop there. Growing biomass plantations to feed powerplants would do the kind of ecological and social damage to the entire Earth that Europe's pellet-burning is doing to Estonia. To pull less than one-third of human-produced carbon dioxide emissions out of the atmosphere would require that bioenergy crops be grown on as much land as is already used to produce the world's food, feed, and fiber. Replacing grasslands and forests with vast acreages of biomass crops and monoculture plantations of fast-growing tree species, with cycles of clear-cutting and replanting, would also break down organic matter in soils, releasing carbon dioxide into the atmosphere and canceling out a big portion of what's being captured. We could lose half of native forests, grasslands, and savannahs, wiping out more biodiversity than would die off with a global temperature rise of 2+ degrees above pre-industrial levels – the very scale of disaster that carbon sequestration is aimed at preventing. It's

not surprising that there are no full-scale BECCS facilities in operation; nevertheless, its broad deployment is being assumed in many climate models and national climate pledges that project the theoretical possibility of net-zero emissions by 2050.

As it becomes clearer that neither "clean" coal and gas plants nor burning biomass for energy on a world scale are feasible routes to net-zero emissions, attention has turned to the idea of pulling carbon dioxide straight out of thin air, in an industrial process known as "direct-air capture". But carbon dioxide makes up only 0.03 percent of the Earth's atmosphere. Sorting every three- or four-thousandth molecule out of the air for sequestration would require impossibly large expenditures of energy.

The energy numbers for direct-air capture are numbing. Capturing and storing a ton of carbon dioxide from the air requires more energy than a coal-fired power plant generates in the process of emitting a ton of carbon dioxide into the air. Conceptually, therefore, as many power plants would be needed to provide energy for capturing carbon dioxide from the air as were responsible for putting it into the air in the first place. Patrick Moriarty of Monash University in Australia, who has studied net-zero technologies told me, "Everybody talks about direct-air capture, but nobody is going to do it, because of the energy requirements."

James Dyke, Robert Watson, and Wolfgang Knorr of the University of Exeter, the University of East Anglia, and Lund University, respectively, have been researching climate change for decades. On this year's Earth Day, they wrote an article published by The Conversation in which they recanted their longtime support for net-zero technologies, telling readers that "the premise of net zero is deceptively simple – and we admit that it deceived us." Their conclusion: "We have arrived at the painful realization that the idea of net zero has licensed a recklessly cavalier 'burn now, pay later' approach which has seen carbon emissions continue to soar. It has also hastened the destruction of the natural world by increasing deforestation today, and greatly increases the risk of further devastation in the future."

No technology can relieve us of the necessity to phase out the extraction and burning of fossil fuels within the next decade or two. The purge of oil, gas, and coal must be done directly, by law. Economic nudges from market competition, carbon taxes, cap-and-trade schemes, and carbon capture all are too indirect and weak. Disinvestment from the petroleum giants and repeal of fossil-fuel subsidies are needed, but they are not enough.

Achieving an 8 percent annual decrease in fossil fuel use through the 2020's and well beyond is a daunting goal, but it's achievable – if the fossil fuel industries are nationalized and a mandatory, fast-falling cap is imposed on the barrels of oil, cubic feet of gas, and tons of coal coming out of the ground and into the economy each year. The hole left by the departure of fossil fuels can be filled only partially by wind and solar power, and not quickly. A conversion to a low-energy, downsized, equitable economy will be necessary.

I realize that such policies would be non-starters in the current White House and Congress, but the urgent need for them must be kept continuously before the government and the public. To instead delude ourselves into believing that catastrophic heating of the ecosphere can be averted through smoke-and-mirrors carbon accounting would be simply to give up and wait for the worst.

The writer and photographer's house at dusk, illuminated using 2 watts from a solar panel and battery.

Light switch

Finding a way through artificial illumination, from candle to LED

SCOTT BONTZ

As part of my early exploration of living without electricity, I bought a lantern of the kind common before power lines reached rural America. My motive was at least somewhat romantic – illumination directly from a flame, in an apparatus like that my grandfather must have used when as a boy he rose to milk the cows. But these antique-store oil burners are still made in China for everyday use, and millions of people in the developing world still rely on them. Before oil wells transformed transportation and the world itself, they gave us kerosene and revolutionized rural lighting.

You carry the lantern with a wire bale. The body is an ingenious arrangement of hollow, lightweight steel and a glass globe to maintain the flame even outside in wind. An assembly of steel wire holding the globe also lifts it for you to reach in with a match to light a flat wick, which trails into a tank of kerosene. My lantern was advertised to make about four times as much light as a candle, and the light was far cheaper – at least if the fuel was kerosene and the candle was beeswax. I could read and even cook with my Dietz lantern, and I naively loved it.

But in reckoning lumens and cents I consulted co-worker Marty Bender, who had spent much of his career at The Land Institute making energy calculations. And the answer I recall from him was not a number. It was a sarcastic appraisal of kerosene lanterns lighting the way to *emphysema*. I had assumed that with the wick properly trimmed and adjusted, and no apparent smoke, all was fine. In later reading about the history of artificial lighting, I learned that fires from tipped lanterns have destroyed a lot of property – well beyond Chicago in 1871 – and killed a lot of people. They still do. The particulates and fumes alone are blamed for more than a million lives lost each year. Lanterns with glass globes, like mine, release far fewer particulates, according to a study by California university researchers in the journal Indoor Air. But millions use simple lamps with exposed wicks. Their burning of kerosene and other fuels to directly make light released greenhouse gases at the rate of 30 million cars, according to an estimate by the same researchers 16 years ago.

Evan Mills was with Lawrence Berkeley National Laboratory when he led the studies as founder of The Lumina Project. In an interview, he said there has not since been the same kind of research to revise the numbers, but he was confident that they have come down, despite population growth. This is because of the number of people in the world without connection to powerlines has fallen from about 2 billion to less than 800 million, and because of adoption of affordable solar-charged LED's. Here the developing world has leapfrogged over rich nations, Mills said.

This is a little ahead of my story, which began about the time of the Berkeley studies. Still without electricity, I went to beeswax candles. These are claimed to burn more cleanly than candles made of paraffin, another petroleum derivative. But all candles release volatile organic compounds. So do plants, to attract pollinators, and so do perfumes and fossil fuels. Some voc's are hazards to human health. In high numbers, also harmful are microscopic, lung-penetrating particles from fossil fuels and candles – and perhaps any incomplete combustion. A study review by the web service Healthline last year said that breathing any kind of smoke can be unhealthy, but there's no definitive research showing that candles, with their tiny wicks and slow fuel use, pose a risk. You can reduce any risk by burning the candle in a room that is well-ventilated but without drafts that cause uneven burning as well as an annoying flicker. Keep the wick trimmed, and instead of blowing out the flame and making a lot more smoke, dip the wick into the molten wax. Or carefully slide a small pair of scissors up a short wick and pinch out the flame. I couldn't get a snuffer to not make smoke. Healthline says that candles made from beeswax, soy wax, or other vegetable waxes might produce less soot than paraffin. But paraffin is more refined than kerosene and should burn cleaner.

So, a beeswax candle is safer than a kerosene lantern. But part of the reason a candle is better – or less bad – for the air is simply that it burns less fuel. This means it also makes a fraction of the light. I can get around a room by one candle's light with no problem. But for finding things, and for reading or handwork, the flame must be within a couple of feet. Not so long ago, before kerosene lanterns but after stoves replaced the enchanting though inefficient open hearth, families were closer in at least in one way: bunched around a costly candle or oil lamp. The candle also demands more attention. I trimmed the lantern wick only after a few to several days. The candle wick demands trimming every several minutes for optimum combustion. Carrying the candle also takes care to avoid spilling molten wax. It's best to place the candle where you want it before lighting. There is one way that a candle is less trouble than a lantern: no glass globe to keep clean.

I had adapted to living by candlelight when my brother gave me a solar powered camp lantern with light emitting diodes. This was not on my wish list for back-to-basics living, but there it conveniently was, and my partner, Emily, and I used it. The light was cold and harsh, not like the warmth of candle glow, or even of an incandescent bulb. But it was free and easy – just put the lamp out during the day, bring it in and turn it on for the night – if the day had been sunny. Carry it around without worry about flame or hot wax. We liked it enough that when it was damaged through my neglect, I bought another. I think it cost no more than two 12-inch beeswax candlesticks.

When Emily began teaching at Bethany College, she researched and bought a portable solar panel. Folded, it's like a large but thin suitcase. The panel keeps her laptop charged for work at home. This was crucial during the pandemic, when Emily taught from the kitchen table. The panel feeds a battery package about the size of a car battery, with USB and 110-volt outlets. There are also outlets for powering LED's. Emily bought a pair of these lights, and to our straw-bale, earth-floor, unwired home came 21st century rural electrification.

One light hangs over the table, and one over the wood-burning stove. The lights have two brightness levels. We set them

on low. This way, the manual says, each light uses one watt to produce 100 lumens. A 60-watt incandescent bulb throws out 800 lumens. That makes 100 lumens sound dim, but it's about eight times the light of a candle. In the main room that is half of our 650-square foot house, 200 lumens total do not leave us wanting. I can read without strain anywhere at the seven-foot-long table. As a child of the profligate 20th century, I don't call the light brilliant. But it's more than enough.

I say that partly from reading of how artificial light throws off our circadian rhythm, the daily cycle of change in things like hormone levels, heart rate, and times when we wake and go to sleep. Jane Brox devotes a chapter to this in her book "Brilliant: The Evolution of Artificial Light". She tells of French geologist Michel Siffre spending almost two months in a cavern with one incandescent light and telephone communication to the surface but allowed no way to know the time. Scientists aboveground monitored Siffre's waking and sleeping, and found his internal clock hardly affected, with a cycle of about 24½ hours. But on the last day of the experiment, Siffre believed it to be August 20, when it was in fact September 14. His sense of time was shot. He also suffered anxiety, confusion, and physical stress, emerging from the cave "a half-crazed marionette."

An unusual case. But everyday life with artificial light is enough to throw us off. Brox cites research by Harvard's Charles Czeisler, who found that even long periods of lower-level artificial light can skew us, so "most people in the United States are actually on Hawaii time", experiencing peak drive for sleep at 4 to 5 a.m. instead of midnight to 1 a.m., and forced to wake earlier than they would like, which contributes to feeling tired. "Every time we turn on a light we are inadvertently taking a drug that affects how we will sleep and how we will be awake the next day", Czeisler said.

The eight hours of uninterrupted sleep now recommended for our health might be just another of industrial life's impositions. Brox relates historian A. Roger Ekirch's study of medieval villagers, who went to bed soon after sundown. They woke around midnight for an hour or two, time which might be occupied by work, if they could afford the light, or by talk or sex. Then until dawn came a lighter sleep, the sleep of dreams. Thomas Wehr at the National Institute of Mental Health replicated this. He gave men daylight time of 10 hours – a midlatitude winter day. They slept only about an hour more than normal, but spread it over about 12 hours, divided by middle-night time of "quiet, distinctly nonanxious wakefulness", with brain waves resembling those of meditation. I write this during the longest days of the year, when I can live almost entirely by sunlight, going to bed at dusk, early in the 9 o'clock hour. But six months ago, when the sun was setting three hours earlier, Emily and I read a lot before lights out and sleep.

Have we humans let the combination of our diurnal and technical natures get the better of us? Few might admit fear of the dark, but whenever we could afford it, we have added yet more light to our lives. Men killed most of the world's sperm whales for lamp oil better than beef and sheep tallow. Cities tapped former waste gas from coal to light streets, homes, and businesses, which brought us urban night life and graveyard shifts. The "gasometer" production systems also ruined neighboring soil and sometimes exploded. And then there was the revolutionary lightbulb, which outsourced soot and gases to powerplants, and brought so much light to Chicago's 1893 Columbian

Exposition that a rural visitor accustomed to kerosene lamps said it was like "a sudden vision of heaven". Each of these steps began as too costly for all but the rich, but gas and electric lighting eventually became far cheaper than what came before. Historians Roger Fouquet and Peter Pearson studied lighting in the United Kingdom from the 14th century to the 21st and found that the cost of lumen-hours, adjusted for inflation, fell 12,000-fold. But between 1800 – little in lighting changed until then – and today, the per-capita consumption of lumen hours rose nearly the same amount, 11,800-fold. Britain's population took off half a century earlier. Counting from then, total lighting has increased 100,000-fold. The industrial world churns out so much night light that in a city you can't see the stars, but from space you can see the cities – even, on a picture of the nation, Salina, Kansas, population 48,000.

This change concerns not just the health and esthetic experience of human beings. Artificial light affects the circadian rhythms of other animals and the flowering time of plants. It makes hiding harder, and navigation and hunting harder for those who depend on good night vision. Birds are confused and drawn to illuminated windows of tall buildings and to communication tower lights. These are a few of Brox's examples of how light affects chances of survival and the course of evolution. Emily and I have no lights outside, and I like to think that signals from fireflies around our house show that the insects are successful despite the light escaping out windows. But we diurnal creatures can see it from 400 yards.

And though LED's don't make fumes in the house, I still worry. Artificial lights take energy to make, and unless that energy all comes from renewables begotten by renewables, we'll burn fuel and make fumes somewhere before even flipping the switch. Modern lights also demand mining for metals, plastic, and sometimes glass. LED's can contain nickel, arsenic, and copper, which some sources consider hazardous, though neither the US government nor the city of Salina bars them from the trash. They reportedly are 95 percent recyclable, but I couldn't find a place here to take them. There are mail-in services. That all said, LED's are far more efficient and longer lived than incandescent bulbs and even compact fluorescents, and their manufacture has evolved to use less material and energy. Mills, the researcher, is a wholehearted advocate. One can't get out of bed today without some ecological effect, but he said these small lights, especially with their own solar panel, are a godsend for people who have relied on more costly and hazardous – to humans and to climate – kerosene, candles, and other fuels.

Emily and I have chosen to bring LED's to our once darker though no less cozy home, and I hope that their light, which is pleasingly warmer than the old camp lantern's harsh blue, will last us at least a decade. An LED shouldn't fail suddenly like an incandescent when the filament breaks, but instead slowly fade. A typical claim is for the light to reach 70 percent of original brightness after 10,000 hours. I think that 140 lumens – 10 candles worth – will still be far more than enough.

The efficiency that gets that much light from 2 watts and the declining cost of LED's furthers the change noted in the UK study, published nine years ago in Economics of Energy and Environmental Policy. Artificial light is vastly cheaper than centuries ago, or even a century ago, and is getting cheaper yet. And with that comes illustration of the Jevons paradox: increased efficiency lowers prices, which leads to increasing consump-

tion. Will LED's make those night photos from the International Space Station even brighter, and our night skies even more starless?

I take hope from the story of electric arc-lights. This 19th-century innovation was a continuous spark between two electrodes, which added to the light with their own incandescence. The result was exponentially brighter than anything before and shone with the color of the sun. The light reportedly woke birds to sing, prompted ladies to open their umbrellas, and enabled reading of a newspaper while blocks away. To replace thousands of gas streetlamps, a French architect proposed such lighting atop a 1,200-foot tower at the heart of Paris. This opens Wolfgang Schivelbusch's book about the development of lighting in the 19th century, "Disenchanted Night". (Google translates the original main title, "Lichtblicke", as "Bright Spots", quite a different connotation, and more fitting Schivelbusch's objective history.) The committee for the city's 1889 exposition instead chose a tower by bridge engineer Gustave Eiffel. But Cleveland, Denver, Minneapolis, Detroit, and other American cities erected arc-light towers. Flint, Michigan, touted its own as the "poor man's light" because it penetrated everywhere for everyone. Not everyone wanted it. Robert Louis Stevenson, who witnessed arc-lights in London and even the City of Lights, called the illumination quality obnoxious, "a lamp for a nightmare". There also were the towers. San Jose's 200-foot colossus over a major intersection looked like it belonged at the perimeter of a prison yard, Brox said. And cities that had thrown up the towers eventually came back to something more modest and traditional, streetlamps. "Lighting that would maintain hours distinct from day", Brox says. Our work to remake our world can indeed be limited for reasons other than economic.

But modern electric streetlamps remain far brighter than the candle and gas lamps that lit city streets before the 20th century. Modern homes – even mine – and offices are far brighter than much of rural America before Roosevelt's New Deal just one lifetime ago, and far brighter than homes in vast areas of poorer parts of the world even today.

I sometimes still read by candlelight. We more often read in bed with a little LED headlamp that Emily bought when she thought of a life on the road. Even in our home it's seductively convenient, far less trouble than carrying a candle when we want something away from the main room and its two fixed lights, and especially for leaving the house to collect chicken eggs. We would miss it. I usually read with the headlamp's dimmer, red light rather than with its brighter white beam. I hope this uses less energy and so delays having to remove and solar-charge the three AAA batteries. I can hope it's less disconcerting to my circadian rhythm. I also propose that there is an awareness had in using just enough light. The red headlamp leaves the room fairly dark but brings out the page and its type – all that matters at that moment. Even the candle, when I've got it right, is enough. And its flame brings something that no lightbulb can. You may call it romantic. Or a kind of independence, a lighting with wires neither attached nor in the guts. It is close to part of what first made us human, what illuminated the way for the painters of the caves at Lascaux and Altamira, and which demands us to take care with how we see the world.

Five years into his work to develop a perennial legume as a grain crop, Brandon Schlautman is concentrating on sainfoin, an old-world genus already used for forage. Here sainfoin grows in The Land Institute greenhouse last February. The box in the foreground is home base for a pollinator, bumblebees. Scott Bontz photo.

The legume field is narrowed

A nitrogen-fixing perennial grain crop candidate rivals soybean in protein

SCOTT BONTZ

A masked man gallops over verdant England with a great bag of loot taken from the rich for the poor. This is "Monty Python's Flying Circus", and the do-gooder unloads not coin, but flowering lupines. And when swamped with the pretty legume, the cottagers turn on him. What if he had waited until the plants made seed to eat? Actually, lupine seeds have been eaten for millennia, but more as snack, not a staple. And they have been annual plants. What if they were perennial, and so were also a boon for soil? Brandon Schlautman explored this and found lupines don't do well in Kansas. But after five years at The Land Institute, also evaluating alfalfa as a grain crop for humans, he is developing perennials from another, promising genus with flowers as lovely as the lupine's.

The genus is *Onobrychis*, which according to Wikipedia means "devoured by donkeys", and the popular name is sainfoin, which derives from the Old French for "healthy hay". You can see it's already been used as a good forage crop. The genus has 71 species. Schlautman has acquired 15, and now favors four. Sainfoin has enjoyed some forage breeding and use by farmers, including in the American West. So Schlautman has more previous research to draw on than does David Van Tassel, who started from scratch with the sunflower family oilseed can-

didate called silphium. But you'll still find little about *Onobrychis* on the web, and much of what's there is written in Cyrillic letters. Scientists do not even know yet the number of chromosome sets in all of the species.

Beyond having seen *Onobrychis* grow well in Kansas, Schlautman has learned that its seed is high in protein, at 35 percent close to that of soybeans. He still has lots to learn about the characteristics and functionality of sainfoin proteins, and how they will affect what foods the seed can make. But tests of one of his favorites, *O. viciifolia*, found no heavy metals or toxins. Sainfoin seed has been fed to pigs, chickens, and mice with no problems. This research in Italy was to find cheaper alternatives to organic soybeans. The University of Wyoming also studied sainfoin as a grain crop. As with other cases of exploring novel perennial grains, neither of these earlier sainfoin program sustained funding for a job that will take decades. "Which is one of the beautiful things about The Land Institute", Schlautman said: commitment to the long haul. In addition to high protein, Schlautman said, sainfoin has respectable amounts of oil.

Among US sainfoin forage growers are two in Montana who will each let Schlautman use two acres for trialing his grain crop prospects in a setting distinct from Kansas. He'll take a crew and a tractor northwest to plant in August. The fields are in the western half of the state but east of the Continental Divide, one near Conrad, in the north, the other near Twin Bridges, in the south.

Sainfoin flower stems grow from about six inches long up to two feet. The florets, which blossom in ascent, are easily the largest among The Land Institute's crops. Like silphium, they are pollinated by insects. Schlautman and his technician, Spencer Barriball, have employed bumblebees in the greenhouse. This year in one field they are trying alfalfa leaf-cutter bees. At another field are hives of honeybees managed by Ebony Murrell, the institute's lead researcher in crop protection ecology. Her team is also studying whether there are native bees to do the job. Like sainfoin, alfalfa and the two noted bee species are from the Old World.

Sainfoin appears to have originated in what is now Turkey. Schlautman is collaborating with breeders there and in Mexico. Another colleague, Omar Tesdell, has collected *O. caput-galli* in Palestine. This species is a diploid, with one paired set of chromosomes, which would make breeding simpler. *O. viciifolia* is an autotetraploid, meaning it has two pairs. Schlautman isn't ready to attempt hybrids. But he has been selecting for traits such as seed count, erect growth for combine harvesting, and retention of seed on the stalk but with easy removal from pods.

Most of Schlautman's seed came from the USDA. He has about 100 accessions, or varieties, of *O. viciifolia*, which provides great genetic variety to tap. He has just one accession of *O. vassilczenkoi*, the sainfoin with the stack of flowers up two feet long. But no seed has come from these plants, because sainfoin is self-incompatible and usually can't reproduce with a plant too closely related. Perhaps more international collaboration will bring Schlautman more germplasm. His other favored species are *O. transcaucasica*, which grows in Iran, *O. arenaria*, and *O. altissima*.

Perennial lupines are not without hope in a different clime. Schlautman and Barriball said they did well in a Wisconsin plot managed by another colleague, a former Land Institute graduate fellow, Valentin Picasso. But developing them as a grain crop will take a richer budget.

Land Report shorts

Perennial rice in US

Ebony Murrell visited Yunnan University to see progress by Chinese colleagues with perennial rice. Her job at The Land Institute is crop protection ecology and especially insect ecology, and she noticed that skimming over the rice fields were lots of dragonflies. This led her to wonder if perennial rice might help reduce malaria. "The disturbance of rice paddies through tillage and replanting creates an environment that is well-suited for *Anopheles* mosquitoes, the genus that transmits malaria in developing countries, and suppresses insect predator populations," she said. "Perennial rice fields, with their lower disturbance, have the potential to increase predators, such as dragonflies, and decrease larval mosquito populations, which could lower the incidence of malaria infections on people in rice-growing communities. Both economic savings and human health benefits of perennial rice, if demonstrated, could be major incentives for promoting the international adoption of perennial rice." Rice is not The Land Institute's forte, but it is at Louisiana State University, where Murrell knows Michael Stout, a rice entomologist and ecologist, and Jong Ham, a plant pathologist. And after a year of the three working together, Ham obtained a USDA permit to import rice from Yunnan to LSU. The seed arrived in March and has cleared customs. Ham and Stout will screen the rice for pathogens in a quarantined greenhouse for up to two generations. Then the rice will grow at a research station in southern Louisiana, isolated from other research plots of rice to prevent accidental crossing of the perennial rice with annual rice in other research plots. Ham and Stout want to see if the perennial rice has resistance to rice diseases and pests of North America. They also want to compare perennial rice with annual rice in ecological benefits, how it would work in a dual-crop system with crayfish, and how it would affect mosquitoes and their insect predators. Funding from a program administered by The Land Institute will support a graduate student for the project.

A study published by The Lancet modeled how climate change might affect malaria and dengue fever, both transmitted by mosquitoes. They predicted that longer seasons for the insects and the diseases, spread of suitable climate to higher elevation and temperate latitudes, and human population growth will increase risk in parts of Africa, southeast Asia, and the Americas.

Fengyi Hu and his team at Yunnan, also Land Institute collaborators, have made great strides with perennial rice. The Chinese government has approved three varieties for commercial release, thousands of hectares have been planted in 10 provinces, and research partners are working on the agronomics and breeding of perennial rice in Myanmar, Laos, Bangladesh, Uganda, Vietnam, Thailand, Cambodia, Indonesia, Ivory Coast, Iran, India, Ethiopia, and Nepal. "It was a leap of faith for Fengyi to ship perennial rice to the US, and particularly to scientists who he hasn't yet met", Murrell said. "I am very grateful to him for doing this."

Prairie Festival returns

The Land Institute's Prairie Festival is on for this year, September 24-26, after the pandemic prevented its staging in 2020. There is no cap yet on attendance, but attendees will be asked to take precautions. Masks are strongly encouraged for the unvaccinated. Participants should use hand sanitizer stations before entering communal areas such as concessions, the bookstore, and the Big Barn, where talks are held. The barn itself seats several hundred. There also are bleachers by the barn, and surrounding lawn if you

Erin Wiersma creates drawings of the land by placement of paper after prescribed burns. For an example, see the magazine's cover. Wiersma, an associate professor at Kansas State University, will show her work at The Land Institute's Prairie Festival, September 24-26. David Mayes photo.

want more space. These are guidelines as of late July, and subject to change. If you are unsure about attending the event, know that livestreaming and recordings will also be available.

At press time the slate of speakers was not set. As usual, the festival begins with a barn dance Friday night. Pancakes made with Kernza®, our trademarked name for grain from intermediate wheatgrass, will be served Saturday morning. There will be food trucks for Saturday lunch and supper. Also as usual, there will be on-site camping, a bookstore, and plot tours led by researchers. Artist Erin Wiersma will show her work. On Sunday morning, Rachel Bieker will lead yoga, Aubrey Streit Krug will lead a prairie walk, and Ann Zimmerman will sing. Festival tickets are $40 for Land Institute donors, $60 for others. You can register at our website, landinstitute.org, by calling 785-823-5376, or by mail.

31 acres and buildings

In 1986, the Krehbiel family sold nine of their 40 acres to The Land Institute. The property abutted Wes Jackson's 29 acres, which already largely served the institute. The Krehbiel place included a 3,300-square-foot house that quickly became our office, plus a shop and other structures. Added since then to the 9 acres: two greenhouses, a research building, and a threshing building. The Krehbiels had sold to move nearer their children. A son and his family remained in a newer house on the remaining 31 acres. Thirty-five years later, those Krehbiels have also moved nearer children. In April we bought their place and reunited the 40 acres. The house we gain was built in 1976, the founding year of The Land Institute. It has four bedrooms and three bathrooms, and might be used by our growing number of visiting researchers and interns. There's also a large shed, two 1,200-square-foot metal barns built in 1986, and two ponds. The acreage is rolling upland and not prime for grain plots. But we couldn't ask for a better place for when our work demands more building space. Use of the property will be part of an upcoming campus masterplan.

New lead sorghum researcher

In June, Pheonah Nabukalu was named The Land Institute's lead perennial sorghum researcher. She had continued to help develop the crop after leaving Salina in 2019 to be a visiting scholar at the University of Georgia's Coastal Plains Experimental Station, at Tifton. This was after six years as a post-doctoral researcher at The Land Institute. Now she is again an institute employee. She will stay in Georgia with her family, but travel between there and Kansas after she has hired a technician. For now she must stick to her fields at Tifton. Stan Cox continues to help maintain the sorghum plots in Kansas, though he left the position of lead sorghum researcher last year to join The Land Institute's ecosphere studies team. See his essay on page 12.

Nabukalu

Machine vision

Last summer, 17-year-old Malachi DeHaan joined a crew processing samples of Kernza®, The Land Institute's registered trademark for grain and food products from

intermediate wheatgrass. His father, Lee, is our lead Kernza researcher. The crew threshed samples, cleaned them, and then went through the lengthy process of collecting data. "The last step is tedious because Kernza samples do not all thresh easily to naked seed, like domestic wheat would", DeHaan said. "Some seeds are stuck in hulls, and others are stuck in pieces of the heads, called spikelets. We visually estimate the fraction of naked seed – which is slow and inaccurate – and then by hand pull out naked seeds to weigh and measure their length and width. After a few days of processing these samples – which takes weeks – my son asked if it wouldn't be possible to use artificial intelligence to process photos of the seeds and automate the data collection. I said I didn't know, but he could try. So, he spent some evenings taking photos of seeds and trying out the latest software available for 'machine vision' or artificial intelligence. He proved that the idea had merit, and soon I had jumped in and started evaluating approaches. Over the winter, I worked out a method and had a computer programmer build a nice image capture and processing pipeline." This involved photographing and manually classifying hundreds of seeds and spikelets, including hulled and de-hulled, sometimes with seeds touching, sometimes not. With this preparation Lee "trained" AI to make the needed distinctions. Data collection became a matter of dumping up to 1,000 seeds from a plant on the photo background, taking the picture, and sweeping the seeds off, followed by the usual analysis with a computer. The Kernza crew should be able to make 400 photos a day. For every seed pictured, they have length, width, area, and circularity. The AI program's error rate is usually less than 1 percent, much better than human estimation. In addition to knowing what percent of seed in a sample is naked, DeHaan can closely predict what the sample would weigh if all its seeds were de-hulled. "I am confident this data will increase the accuracy of our breeding program while requiring less worker time in the frantic harvesting and threshing season."

Brood X

Most of Edy Cheremond's work as crop protection ecology technician at The Land Institute involves insects, both beneficial and detrimental to our crops. Outside of work he rears and studies ants. Having lived in Kansas for three years, he's also familiar with cicadas, neither friend nor foe of grain plants but big and loud. These have been annual cicadas, however, not the periodical cicadas whose emergence by the millions after up to 17 years as nymphs underground makes for a visual and aural spectacle. In early June, Cheremond drove to Hoosier National Forest in southern Indiana for the advent of what is called Brood X, the largest

A long-lived member of the genus Magicicada.

of the staggered 17-year cicada cycles. "There aren't many insects that come out in hordes like that", he said. He missed the peak, but saw the ground pocked with openings, and adults and their left-behind exoskeletons coating trees. Unlike green annual cicadas, these throw camouflage to the wind – black bodies, orange wing veins, red eyes – and win by sheer numbers. "Predators can't possibly eat all of them", he said. A buzzing "chorus" of the male cicadas made a base noise for Cheremond's hikes. The volume reportedly can reach 100 decibles, matching that of a hand drill, and if sustained, enough for hearing loss. For Cheremond it was never too loud to talk over, but in the car his ears faintly rang. He had three days with Brood X and said he would have enjoyed a week. Six weeks later, the adult cicadas would be dead, and their chorus replaced by the sound of rain as millions of nymphs hatched in the trees and fell to ground for the long haul.

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The Land Institute bought 31 acres, a house, and barns just east of its office and research buildings. *See page 27.* *Scott Bontz photo.*