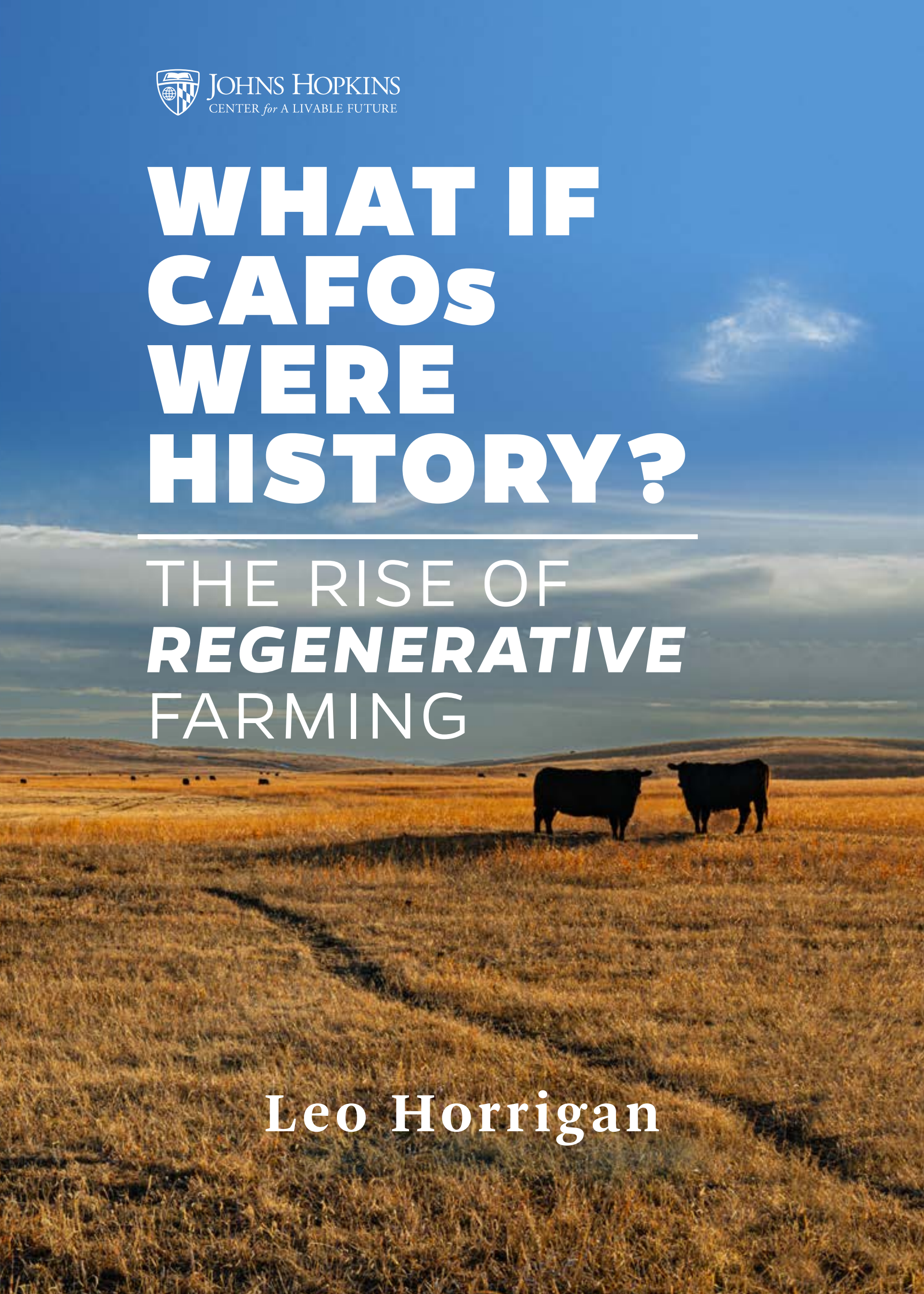

Johns Hopkins
Center *for* A Livable Future

WHAT IF CAFOs WERE HISTORY?

THE RISE OF *REGENERATIVE* FARMING

Leo Horrigan

ABOUT THE AUTHOR

Leo Horrigan is a food system correspondent for the Johns Hopkins Center for a Livable Future. He has written extensively on food system topics over the past 25 years, including sustainable farming methods and improving access to healthy food. He also helped produce a high school food system curriculum called FoodSpan and three documentary films that accompany it. Like this book, his most recent film *(Growing Solutions)* focuses on solutions to farming challenges.

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PREFACE

Since 1996 the Johns Hopkins Center for a Livable Future has been focused on the food system. We have been studying, critiquing and advocating for change on various aspects of the system, especially in relation to addressing its negative impacts on public health, the environment and social equity. CLF has also worked to ascertain the best ways to improve the food system on all of these fronts.

CLF has built a considerable body of work that details the problems with industrial food animal production (IFAP), including those associated with the commodity crops produced to feed IFAP livestock (e.g., an unsustainable use of fossil energy, synthetic fertilizers and toxic pesticides, among other problematic inputs), in addition to the impact of this production model's pollution on the environment and neighboring communities. Our work has also spanned the food supply chain from production to consumption, often highlighting injustices and other unsustainable food production practices and inadequate access to healthy food.

More recently, we have been putting more focus on solutions, shining a light on regenerative agriculture and food security initiatives that offer hope for long-term and broad improvements to our food system. CLF understands that moving away from the IFAP model and toward more sustainable methods for producing animal products would not only help mitigate environmental, health, socioeconomic and animal welfare problems, it would also yield far-reaching and beneficial impacts on the food system as a whole. Such benefits and improvements could include diversifying land use and agricultural production, strengthening regional food systems, and keeping more farming-based profits within local communities.

The Covid-19 pandemic exposed some of the deficiencies of the industrial food supply chain, with food and labor shortages becoming more common under the pressure of the pandemic. Meanwhile, our food production systems often lack the resilience that will be needed in the face of such challenges, including those of increasing climate disruptions.

Despite their deficiencies, it might seem politically unrealistic to suggest that we shift away from industrial agriculture and its companion industrial food system, since they are so dominant and entrenched. However, CLF is striving to be aspirational, presenting a vision of what our agriculture and food system could look like—and, in fact, need to look like if sustainability is to be achieved and a healthy, equitable and sustainable food system is to be created. That vision includes moving away from our reliance on IFAP.

The timing is right to promote an alternative system because regenerative agriculture offers tremendous promise as the centerpiece of a new era for agriculture. It holds up well when evaluated in terms of the "three E's"—ecology, economy and equity—especially when compared with our current industrialized system. Regenerative agriculture is where urgency meets opportunity.

In closing, we want to stress two key points:

- This paper is not an attempt to demonize those who practice or support industrial agriculture, but merely to point out its inherent flaws. The hope is that a different kind of agriculture that flows from a different worldview will eventually become the conventional way of producing our food. We believe all of society would benefit from such a shift, regardless of anyone's current views on our farming and food systems.
- Though we feel qualified and emboldened to write this paper, we also humbly accept that our

vision is imperfect as well as ever-evolving. Far from being the final word on the subject, we hope this paper can ignite a conversation with both our current partners and some organizations we have never partnered with before, all in service of the goals of making our food system more healthy, equitable and sustainable.

INTRODUCTION

This paper lays out a vision and rationale for a more sustainable agriculture, one that regenerates the natural resources essential to farming, and can replace the prevailing industrial model that routinely depletes those resources. We also look at how changing the way we farm and how we market food can make our food system healthier all along the supply chain, and open more opportunities for democratizing the food system.

To underscore the urgency of transforming our farming model, we will spend time critiquing industrial agriculture and its flagship, industrial food animal production (IFAP), as well as the feed grain system that is essential to IFAP's functioning.

We will also describe why a more sustainable approach to agriculture—often framed as "regenerative agriculture"—can help in establishing a better food system, one with multiple benefits to society in terms of public health, the environment, local economies and social equity. For example:

- The slowly emerging alternative food system makes entry into farming feasible for many more people, including systematically marginalized groups.

- Regenerative farmers are more likely to be marketing directly to consumers, and this creates opportunities for consumers to have more input into how their food is grown.
- Regenerative agriculture builds healthy soil, which makes farms more resilient in the face of the extreme weather events that are becoming increasingly common.
- Sustainable agriculture practitioners reduce health risks on the farm and for consumers by reducing or eliminating pesticide use. They also have greater success in building soil fertility, in part because they use little or no synthetic fertilizer, which degrades long-term fertility. Healthier soil can mean healthier food, in terms of nutrient content.
- In sustainable animal production—i.e., raising animals on pasture—manure is an asset that enhances soil fertility. IFAP methods turn manure into a waste problem.
- While industrial agriculture emits large amounts of greenhouse gases and is a large contributor to climate chaos, regenerative ag-

riculture puts significant amounts of carbon back into the soil, and is thus part of a multi-pronged climate solution. It is also much less energy-intensive.

- Rural communities benefit more when farms are diversified and well connected to the local community because those farms buy inputs and sell outputs locally. The concentrated animal feeding operations (CAFOs) at the center of IFAP tend to degrade local economies, and are typically connected to distant markets for their outputs.

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A NEW VISION FOR AGRICULTURE AND OUR FOOD SYSTEM

For too long our agricultural policy has been separate from our health policy—to our great detriment. The nutrients in our food are essential to human health, and our farming methods can have an impact on how much of those nutrients end up in our food. Crop plants must be able to access nutrients in the soil, and that process depends on the symbiotic relationship between plants and soil bacteria and fungi. Many of the methods that are "endemic" to industrial agriculture disrupt or destroy these important plant/microbe relationships.

By contrast, a sustainable agriculture recognizes and nurtures these soil-based relationships, and by creating healthier soil it makes itself more resilient in the face of the extreme weather events that are becoming more common in this era of climate chaos.

Those who are well-versed in the deficiencies of industrial agriculture know we cannot go on with farming as usual. With that in mind, the relevant questions are: 1) What currently marginalized and underused versions of agriculture need public support and policy support to help them become more predominant?; and 2) What collateral benefits to the food system can we expect from such a transition?

Our industrial agriculture system is embedded within an industrial food system.[1] Both are marked by a lack of transparency, an abundance of corporate control, and a concomitant lack of democratic control over decision making. Food consumers do not have an opportunity to be food citizens within the dominant system, as they lack input into how their food is produced. But, alternative marketing models have been taking shape in recent decades and they offer hope for a different kind of food system to take center stage—one that is more inclusive and democratic.

The rise of farmers markets, food hubs, community-supported agriculture, farm-to-school programs, and other democratizing models has made food citizenry more than just an aspiration. By intention, these models have also increased access to healthy food among traditionally underserved populations.[2] The food movement[3] has always sought to combine improvements in our farming systems with improved food access, and the international food sovereignty movement also stresses both goals.[4] Government policies that support these alternative models instead of the industrial model could hasten the transition to a more sustainable food system, which *by definition* means one that is healthy and socially equitable as well as ecologically and economically sound.

This alternative food system that has been developing also makes it easier for new farmers to enter the profession with less financial investment and more direct access to customers. Moreover, it makes better use of our land resources, as it puts more emphasis on growing food for people—in contrast to the industrial system that uses vast amounts of cropland to grow feed for animals as well as "feeding" our vehicles with inefficiently-produced ethanol, and contributing to the production of unhealthy products such as high-fructose corn syrup.

INDUSTRIAL AGRICULTURE IS BUILT UPON A FAULTY WORLDVIEW

> *"Living systems cannot be standardized. They require diversity and some degree of redundancy to adapt to changing environmental conditions."*
>
> ***—Evan Leonard[5]***

Our current era of highly industrialized agriculture—which represents less than one percent of the Agricultural Age in its duration—has been marked by high productivity but also the degradation of resources (soil erosion, water pollution, diminished biodiversity, etc.) as part of the price paid for that productivity. Industrial agriculture is labor-efficient but inefficient in terms of energy use, both predictable results when substituting fossil fuel-driven machinery for people.

To unravel the reasons for its failures, it is important to examine the worldview that animates an industrialized agriculture, and how that worldview has sown the seeds of what seems to be an inevitable, albeit gradual demise for industrial farming.

Key differences in philosophy between industrial agriculture and a more sustainable agriculture are highlighted in the table on the next page.

Take pest control as one example of the contrasting philosophies between industrial and more sustainable models of agriculture. Perhaps the most foundational principle in sustainable agriculture is to work with nature as our model, rather than trying to outsmart or subdue nature with synthetic chemicals, as industrial agriculture does most infamously in the area of pest control. Healthy natural systems are rarely plagued by large-scale pest infestations, because species that prey on pests keep them under control, even if they don't obliterate them.

By contrast, pesticide interventions often have short-term success but lead to bigger problems long term, as targeted pests achieve resistance to these pesticides and bounce back faster than the species that prey on them. Insects and their

DIFFERENT WORLDVIEWS

	Industrial agriculture	**Sustainable agriculture**
Philosophies	▪ Control nature ▪ Technology-intensive	▪ Work with nature as guide ▪ Management-intensive
Scale	▪ Large, consolidating production on fewer farms	▪ More small and mid-size farms, meaning more farmers, more niches
Specialization & Diversification	▪ Fewer crops and animal species; gain efficiencies	▪ Diverse crops and animals; minimizes scale of problems
Fertility	▪ 3 nutrients dominate: N, P & K (N derived from natural gas; P & K mined)	▪ Nurtures soil food web with organic matter; recycles nutrients
Pest control	▪ Uses synthetic chemicals routinely	▪ Uses biological sprays as needed; natural predators, crop rotations
Energy use	▪ High fossil-fuel input; more heavy machinery	▪ Less fossil fuel; more human & animal labor

arthropod relatives have had success in developing resistance to human-made chemicals designed to kill them, as more than 500 species are resistant to insecticides. Each time a new class of insecticides is brought into use, resistance to those chemicals arises in as few as two years, and at most within 20 years.[6]

Weeds display a similar resilience in response to chemical interventions. As of March 2023, there were "518 unique cases of herbicide-resistant weeds globally, [involving] 267 species. Weeds have evolved resistance to 21 of the 31 known herbicide sites of action and to 165 different herbicides. Herbicide-resistant weeds have been reported in 97 crops in 72 countries."[7]

These are just some of the unintended consequences of pesticide interventions, all of which reflect the inherent flaws in applying linear thinking to natural systems. This linear approach seeks to deal with a problem (e.g., a pest) in isolation, without accounting for the natural system in which it exists.

As renowned systems thinker Richard J. Bawden once said:

> *"As what we do in the world is [a] function of the way we see it, there is a drastic need for us to change the way we go about our seeing as a prelude for fundamental shifts in the way we do things ... Unless we, as agriculturists, accept a shift in our thinking and practices ... agriculture and the environments in which it is practiced will be pulled into an ever declining involution with catastrophic effects on the well-being of mankind and of the environments in which we all live."*[8]

Bawden offered those words in 1991, and sadly, they are even more relevant today.

Pesticide use is perhaps the best example we have of the flawed use of linear thinking, as its unintended (read: negative) consequences are enormous. In addition to the environmental damage they cause, pesticides are responsible for a heavy burden of human disease and deaths. Some have estimated that nearly 400 million cases of unintended, acute pesticide poisoning occur among farmers and farmworkers worldwide each year, resulting in 11,000 fatalities.[9]

These kinds of problems are inherent to *industrialized* crop production, because of its dependence on chemical inputs. That kind of agriculture is what supports and enables IFAP, which concentrates food animal production in CAFOs—known as "factory farms" in popular parlance.

In some circles, CAFOs could be considered the crowning achievement of industrial agriculture, in terms of how quickly they produce food animals for meat, milk and eggs; how few workers need to be involved; and how CAFOs break the whole process of producing food animals down to simple tasks, thus reducing production costs. Viewed through a narrow lens, this system can look like a great success—just as it looked like a great idea to those who devised it.

Agricultural economist John Ikerd—one of the designers and early proponents of CAFOs and now a strong critic of them—has written that the goals of industrial agriculture are "to specialize, mechanize, separate, sequence, and control all processes of production—to make farms work like factories and fields and feed lots run like assembly lines."[10]

These goals make more sense in the context of an actual factory, an artificial environment where humans can exercise more control and are not so ruled by the dictates of natural systems. Monocultures (of both plants and animals) are part of the drive for industrial efficiency, but industrial agriculture's attempts to create these standardized environments within natural settings has proven to be a failed experiment. They invariably come up against problems such as pest infestations (weeds and insects), soil degradation and diminished biodiversity.[11]

When industrial farming systems invariably fail ecologically (because they degrade natural systems), they cannot help but fail economically, too, because a healthy agroecosystem is a necessary foundation for any long-term economic success in agriculture.

The good news is that there is a viable alternative in agriculture that already has a track record of success. As a first step, farmers can substitute non-toxic inputs in place of industrial agriculture's synthetic fertilizers and pesticides. But, if they really want to take their operations to a higher level, they can make changes that are more whole-system oriented, as agroecology expert Steve

Gliessman explains:

> *Fundamental changes in overall system design eliminate the root causes of many ... problems. The focus [in agroecology] is on prevention of problems before they occur, rather than trying to control them after they happen. Problems are recognized, adjustments made in internal site- and time-specific design and management approaches, instead of solely by the applications of external inputs. A good example is the reintroduction of diversity in farm structure and management through such actions as ecologically-based rotations, multiple cropping, agroforestry, and the integration of animals with crops.*[12]

This type of holistic approach to farming is precisely what is needed as an antidote to the misapplication of linear thinking that characterizes industrial farming. Linear thinking might see a pest problem, for example, and say "what chemical will destroy this pest?" instead of asking: "How can I redesign my farm in a way that blunts this pest problem?"

SOME SEMANTICS: SUSTAINABLE VS. REGENERATIVE

Before delving more deeply into possible alternatives to the industrial model, it is helpful to first discuss some common terminology related to sustainable agriculture. Many terms have been used to describe movements to make agriculture more environmentally friendly, including organic, conservation agriculture, and agroecology. Recently, "regenerative agriculture" has come to the forefront as an approach to achieving greater sustainability. It has overlaps with those other movements but also distinctive characteristics, and some non-governmental organizations and private-sector partners are working on creating a widely accepted definition.

Regenerative agriculture has been described as "a holistic land management practice that leverages the power of photosynthesis in plants to close the carbon cycle and build soil health, crop resilience and nutrient density." Regenerative agricultural practices are ones that:

> *(i) contribute to generating/building soils and soil fertility and health; (ii) increase water percolation, water retention, and clean and safe water runoff; (iii) increase biodiversity and ecosystem health and resiliency; and (iv) invert the carbon emissions of our current agriculture to one of remarkably significant carbon sequestration, thereby cleansing the atmosphere of legacy levels of CO_2.*[13]

Like organic agriculture, regenerative seeks to minimize external inputs to a farm. Regenerative has much in common with sustainable agriculture but attempts to go beyond the idea of sustaining resources like soil and instead rebuilds—or regenerates—soil health by nurturing the biology in the soil.[14]

"Regenerative agriculture" is not a new term. The Rodale Institute was using the term "regenerative organic agriculture" in the early 1980s[15] and the concept goes back much further (witness the early 20th century ideas of George Washington Carver,[16] or indigenous farming practices that are much older). However, regenerative has gained many new advocates because of the experiences of farmers around the world who have shown what is possible in terms of soil building and other ecological enhancements to their farms.[17]

Practices that are common to regenerative agriculture but not exclusive to it include:

- No-till or minimum tillage, to minimize or eliminate harms to soil organisms that are essential to plant health—particularly fungi and bacteria, which carry minerals to plants in exchange for carbohydrates derived from photosynthesis.[18]
- Soil building through natural amendments such as compost and manure, plus the use of cover crop mixes and complex crop rotations to enhance soil fertility. All of these are biologically-based enhancements, in contrast to industrial agriculture's use of synthetic chemicals as fertilizers.
- Well-managed rotational grazing systems that enhance fertility and promote more plant growth without promoting erosion or the other negative side effects of poor grazing practices.[19]

THE "CULT OF CORN AND SOY"

You could call industrial animal agriculture a success if you focus on its sheer volume of output. In 2020, the production of animals and animal products (meaning primarily meat, milk and eggs) accounted for 45 percent of all US farm income ($165 billion). Feed crops—that essential CAFO companion—pulled in an additional 16 percent of farm income.[20] A majority of the cropland in the US is devoted to corn and soybeans, and a large share of that output is fed to confined animals—just over 70 percent of the soybean harvest[21] and about a third of the corn harvest.[22]

The CAFO system creates demand for commodity feed crops, and this demand is also driven by government programs that incentivize farmers to grow corn and soybeans even when prices are low for these crops, as government payments close the gap between the market price and the price the farmer needs in order to be economically viable.[23]

Industrial agriculture has become so enamored of these two crops that a 2019 *Modern Farmer* magazine headline referred to a "cult of corn and soy."[24] Rather than expand the repertoire beyond corn and soybeans, in some agribusiness circles it is assumed that instead industrial agriculture will just find more uses for these two crops. Witness this quote from *AgFax*, an online newsletter for commercial growers:

> *Recent declines in soybean exports have made worsened returns. The* ***uses of corn and soybeans must grow in the future if corn and soybean returns are to reach higher levels.*** **[emphasis added]** *If uses do not increase, a combination of two items will need to occur:*
>
> 1. *financial aid and intervention from the Federal government will need to continue, or*
> 2. *farmers will need to make financial adjustments as well as lower cash rents.*[25]

As for that federal aid,[26] the US Government Accountability Office says some government subsidies go to "recipients who USDA officials said own farmland that is not economically viable in the absence of these payments."[27] Additionally, the increase in extreme weather events is causing farmers to rely more heavily on crop insurance, with typically about 60 percent of their policy cost covered by taxpayers.[28]

Subsidies flow disproportionately toward the largest farms, toward commodity growers, and often toward non-farmers who are renting their land to a farmer.[29] They also skew heavily toward producers of corn, soybeans and wheat;[30] "and disproportionately [benefit] white farmers over producers of color."[31]

Much of this federal money could be redirected toward supporting farmers who transition to regenerative, as well as new farmers who use these methods—creating a double benefit, as we lose the negative impacts of industrial agriculture and gain the positive impacts from its alternative.

CAFOs AND LAND USE

Because the vast majority of our meat, milk and eggs are produced in CAFOs, and all the feed grain that goes into the CAFOs is produced through an industrial system, moving away from CAFOs and toward more pasture-based operations could have profound effects on land use across our farming system. A University of Iowa report describes CAFOs and their relationship to industrialized crop production:

> *[CAFOs] are defined by US Environmental Protection Agency as animal feeding operations with a large number of animals (1,000-plus animal units—equal to 1,000 beef cows or a [larger] number of other livestock types) ...* ***raised on food that is grown elsewhere and shipped to the operation*** *and who remained confined indoors for 45-plus days at a time. CAFOs now represent the dominant model of livestock production in the United States, particularly in poultry and swine production, where, according to the EPA, land and labor needs to raise animals have been substituted with structures and equipment.* **[emphasis added]**[32]

Land use is still a big part of the system; it just doesn't typically happen in proximity to the animals who consume the feed crops grown on that land. The CAFO system demands concentration and specialization in crop production—that is, larger and larger enterprises, each one producing only a few commodities. This is reflected in the fact that just four percent of US farms control 58 percent of the nation's acreage in production (up from 50 percent in 1997)[33] and just five percent control 75 percent of farm sales.[34] It is also reflected in the fact that about 70 percent of US cropland was devoted to corn and soybeans in 2020 (excluding non-food crops such as cotton).[35]

The vast majority of farmers who grow corn or soybeans for animal feed grow them in rotation, with soybeans restoring some of the nitrogen taken up by corn.[36] However, adding one or two crops to this rotation has been shown to reduce fertilizer and herbicide use without reducing profits.[37]

Note that all of these crop rotation schemes involve annual grains, which typically means the land is plowed (inviting all the negative impacts of plowing), and annual crops have shallow root systems that do not capture as much carbon as perennial plants do. Where do you find perennial plants? For one, you find them in the pastureland that is the basis of a sustainable system for animal agriculture.[38]

REGENERATING LAND: WHAT'S IT GOT TO DO WITH ANIMALS?

> *"Land is not merely soil, it is a fountain of energy flowing through a circuit of soils, plants and animals."*
>
> ***—Ecologist Aldo Leopold[39]***

Wendell Berry once observed that moving animals from farms to confinement facilities took an elegant solution and divided it into two new problems. Instead of having those animals' manure to fertilize their soils, farmers now had a fertility deficit and CAFO operators had a waste problem with the output from those concentrated animal populations.[40]

Not only is animal manure potentially part of any farm's strategy for maintaining fertility, but it also can be one of the key components in any effort to restore degraded land and make it productive again.

Most projections about how much food the world can grow are based on the assumption that we will have the same amount of arable land available as we have now. This is a faulty assumption, and fails to consider that much of what is now degraded land could be restored to usefulness for food production—either as cropland or pastureland, or a mixture of the two—if good regenerative practices were put into action on that land.[41] There are sufficient examples of this phenomenon to warrant scaling up a global effort to restore degraded land for food production.

One such effort has been the restoration of 10 million acres (10 percent) of China's Loess Plateau, an area about the size of the Netherlands. Soil erosion from the Loess has contributed to devastating dust storms that have plagued Beijing for decades. Loess is a mineral-rich soil that was formed when glaciers ground down rock. It can be very rich agricultural soil but is also prone to erosion, particularly by wind, because it is fine and loose.[42]

The successes of the Loess restoration have been summarized thusly:

> *Funding from the World Bank and the Chinese Government helped restore*

4 million [hectares] of land, reportedly more than doubling the incomes of local farmers, reducing erosion by 100 million tons of sediment annually, reducing flood risk and dramatically increasing grain production. Socially, it aimed to strengthen household stability and reduce migration to cities. Environmentally, restoration aimed to improve soil health, reduce erosion, ensure cleaner water and sequester carbon.[43]

The project included the introduction of Kashmiri sheep into the Loess, as well as dairy cattle, but with limitations on where they could graze so that erosion would not result. Through their dung, the sheep helped spread seeds and improve the soil seed bank, which contributed to the regeneration of Loess grasslands.[44]

This success story could be replicated in similarly degraded regions, thus expanding our base of arable land on which to farm. At a minimum, this requires that enough will and enough resources are brought to bear on the project of regenerating degraded land.

Presumaby, if we consumed more animal products from this type of pasture-based regenerative farming—and less from confined operations, as well as less overall—we would be dampening demand for feed crops and mitigating all of the problems attached to them. Much of the cropland in use today is not producing food to feed humans. Globally, one study found that only 55 percent of food calories from cropland feed humans, and only 40 percent of the plant protein produced feeds humans. This statistic is more dramatic in the US, where those numbers are 27 and 14 percent, respectively.[45] To shift some of that cropland over to pastureland would not necessarily diminish our food-producing capacity, and in some cases could even increase it, depending on how crops from that land were being used previously.

Healthy natural systems tend to include large herbivores (e.g., bison on prairies), and when ranchers use grazing plans that mimic nature they improve land rather than degrade it. Grazing animals stimulate new plant growth, whether they be cattle, goats, horses, or other herbivores. The key is to mimic the traditional mob grazing habits of herbivores on natural grasslands. Those herbivores crowded together for safety's sake, to provide some protection from predators.

In managed systems that lack natural predators, ranchers must force this "mob behavior" by using fenced paddocks to crowd animals together on a small piece of land at any one time.[46] It might seem counter-intuitive, but this method helps restore land, as long as the land is given sufficient rest once animals are removed from it. In other words, mob grazing must be combined with a rotational plan that constantly moves animals from one patch of land to another, and this rotational grazing method should somewhat mimic the way bison moved across the prairie, for example.[47] As late as 1800, the bison numbered up to 40 million in North America, and their herding and migration behaviors helped build the prairie's fertility and resilience over millennia.[48]

GATHERING UP OUR ALLIES—IN THE SOIL

> *"It is imperative that an understanding of soil microorganisms and their ecology be developed, so that they may be used to benefit agriculture, especially weed management."*
>
> ***—Soil scientist Ann C. Kennedy[49]***

David Montgomery, a geologist who has written extensively about agriculture's link to the fate of civilizations,[50] says there have been four agricultural revolutions and the world could be on the cusp of a fifth one—this one based on improving and maintaining soil health by nurturing the biological life in the soil.[51] One could describe this as a transition from a Chemical Age of Agriculture to a Biological Age. This prediction is based both on the failings of our chemical approach and the unexplored possibilities for making "alliances" with the organisms in our soil that help crops thrive through the nutrient exchanges that happen in the root zone.[52]

A lot of human capital has been expended for the sake of creating a dizzying array of agricultural chemicals designed to kill the organisms we don't like on and around our crops—weeds, insects, pathogenic fungi, etc.[53] Yet, all of these chemicals have not eliminated the pest problems that plague farmers. At best they fend off pest problems only for a short while. Then, insects and weeds develop resistance to our chemical "solutions."

What if, instead of continuing to trust in chemical interventions that attack pest organisms, we turned our attention to propping up those organisms that are beneficial to crops and are part of their natural defense system?[54] To switch to this approach, we will need a better understanding of the biology that makes up the soil food web, a woefully understudied ecosystem but one that has demonstrated a tremendous ability to increase crop yields without the toxic side effects of pesticides.

One soil scientist described the incipient nature of this area of research:

> *There is clear evidence that plants shape microbiome structures, most probably by root exudates, and also that bacteria have developed various adaptations to thrive in the rhizospheric niche [root zone]. The mechanisms of these interactions and the processes driving the alterations in microbiomes are, however, largely unknown.*[55]

Leonardo da Vinci once said "we know more about the movement of celestial bodies than about the soil underfoot."[56] Sadly, that quote still rings true five centuries later. Soil science has been described as "an uncommon major with only 259 graduations per year" from US colleges.[57] There is plenty of room to improve our store of intellectual capital in this area. Consider, for example, that scientists have only identified an estimated one percent of soil microbial species.[58] Much more soil biology knowledge will be needed if we are to produce the academic underpinnings for a Biological Age of Agriculture.

ENERGY TRADING: "I'LL GIVE YOU A DIME FOR THAT PENNY"

> *"We've got to put a cap on carbon in order to start living with limits. If we do that, I'm quite optimistic as to what beautiful things will happen."*
>
> ***—Evolutionary biologist Wes Jackson***[59]

With climate chaos deepening, there is a desperate need to uplift food and farming systems that are not founded on fossil fuels. By some estimates, our industrial food system uses fossil fuel to the tune of 15 kcal of input (mostly expended after food leaves the farm) for every kcal of food output—in other words, it's like we're paying a dime and a nickel into the system for every penny we get out.[60] Even conservative estimates put the energy-input to energy-output ratio at nearly 10:1.[61]

A good tradeoff? Well, it's one that only makes sense because of the Earth's massive storehouse of fossil energy built up over millennia—one that ideally we would not be using because its use means emitting more greenhouse gases when the greenhouse effect is already wreaking havoc with natural systems.

Instead of continuing on this unsustainable path, we can exploit the energy-production capacity of plants, whose process of photosynthesis creates a sort of pipeline between the sun and the soil—transforming the sun's energy (light energy) into carbohydrates (chemical energy) that feed soil organisms and thus store energy in the soil. The "organic matter" that farmers so value in their soil is merely the sum total of all the organisms that are living or dead in that soil,[62] plus its decaying and decayed plant materials. All this soil life is directly or indirectly dependent on plant photosynthesis and its carbohydrate production for its existence. Since all living things contain carbon, it is not surprising that more than half of soil organic matter is carbon.[63]

Most farmers are happy to build up the organic matter in their soil because of its numerous benefits to their farming operation (improved water retention and water infiltration, greater storage capacity for nutrients and greater nutrient availability, etc.). Meanwhile, they are doing something good for the atmosphere, by taking carbon out of it.

Much of the heat-trapping carbon that is in our atmosphere was once in our soil. By converting so many of our natural landscapes into “built environment” (roads, buildings, parking lots, etc.) and by disturbing land through tillage, we have both released a lot of soil-based carbon into the environment and reduced our capacity to store carbon. Reconnecting our “solar pipeline” could put much—or even all—of that carbon back into the soil where it belongs.[64]

Estimates of how much additional carbon could be sequestered in agricultural soils each year start at 5 percent of current carbon emissions but go up steeply from there.[65] For example, Chambers et al. estimated that US agriculture could halve its greenhouse gas (GHG) emissions by 2050.[66] Some estimates are even more optimistic, especially when they include the potential benefits of replacing annual crops with deep-rooted perennial crops that sequester more carbon.[67]

SOIL HEALTH: A WIN-WIN-WIN FOR CROPS, CLIMATE AND THE BOTTOM LINE

> *"The soil is the 'creative material' of most of the basic needs of life. Creation starts with a handful of dust."*
>
> ***—Soil scientist William A. Albrecht[68]***

Regenerative agriculture benefits the climate from two directions: By reducing agriculture's contribution to greenhouse gas emissions, and by storing large amounts of carbon in the soil. Regenerative agriculture minimizes or eliminates the use of farming methods that are directly or indirectly associated with GHGs, such as synthetic fertilizers that rely on natural gas as a feedstock for their production, and tillage that requires diesel fuel for tractors.

More importantly, though, by reducing soil disturbance and feeding the soil biology that binds up carbon, regenerative farming vastly increases the amount of carbon that is stored in soil—and actually increases the depth of the topsoil. By building new topsoil, regenerative is enlarging the carbon "bank" that soil represents.

On the other hand, tillage increases GHG emissions because the process causes carbon to be released to the environment.[69] It has been estimated that "US soils may have lost between 30 and 50 percent of the [soil organic carbon] that they contained prior to the establishment of agriculture there." This "lost" carbon ends up in our atmosphere, contributing to the warming of the planet. Moving this atmospheric carbon back into the soil, where it belongs, is part of the mission of regenerative agriculture.[70]

Besides the climate benefits of regenerative methods, farmers reap financial rewards from the transition, earning more money per acre after shifting from tillage to no-till and adopting practices like cover crops and nutrient management.[71]

These practices help build topsoil, which is like an investment in the future for a farmer. One example of soil building through regenerative practices:

On his North Dakota ranch, Gabe Brown[72] has seen his soil depth increase from 6 inches to 29 inches on some of his fields. His soils contain 96 tons of carbon per acre in the top 48 inches, which contrasts with the 10 to 30 tons that are typical on conventional farms in his region.[73]

In the past, Brown's soil-building outcome would have been considered impossible in conventional agriculture circles. To put this in context, USDA's Natural Resources Conservation Service (founded in 1935 as the Soil Conservation Service) has long touted its accomplishments in reducing the rate at which topsoil is being *lost* on US farms.[74] Building new topsoil was not even considered as a goal for the Soil Conservation Service. There has been a predominant assumption that topsoil is a mostly nonrenewable resource, but regenerative farmers are disproving that.

As climate chaos deepens, we are seeing more and more extreme weather events such as floods, droughts and heat waves, leading to crop failures and yield decreases along with the corresponding economic damages. In 2020 alone, US farmers suffered an estimated $6.5 billion in damages from extreme weather.[75]

Building topsoil is a crucial intervention for making farmland more resilient, as healthy soil can lessen the effects of both floods and droughts, as well as heat waves. Healthy soil allows for more effective infiltration of rainfall (a defense against floods), and organic matter in a healthy soil acts like a sponge to absorb much of the rainfall that occurs even during deluges.

"Most droughts are manmade," says Brown. "It is not how much rainfall you get, it is how much you can infiltrate into your soil, move throughout the soil profile and hold it there with the organic material in your soil."[76]

The rainfall that ends up stored in soil and available to plants has come to be known as "effective rainfall."[77] The *ineffective* part of any rainfall is that which runs off the land because of soil compaction and hardpan layers caused by conventional tillage.

Because of his regenerative practices that have created a soil with more pore spaces for water to infiltrate and more organic matter to soak up water, Brown's farm fields went from infiltrating only a half-inch of rain per hour in 1991 to infiltrating an inch *in nine seconds* and two inches in 25 seconds when tested in 2015.[78] Now, even the heaviest of North Dakota rains won't carry soil off his fields.

This ability to store water makes healthy soil more resilient when droughts occur, too, as plants can tap into this stored water on an as-needed basis. Regenerative agriculture also stresses keeping soil covered with some type of plant life at all times (whether it be a cash crop, cover crop, or forage crop for livestock), which mitigates the drying effect that hot temperatures can have on topsoil. Not surprisingly, bare soil runs hotter than covered soil, and this is very detrimental to soil biology in the upper layers.[79]

While cover crops have become slightly more popular among industrial growers, they are still planted on just 5 percent of US farm acreage. By contrast, they are a routine part of the toolkit for regenerative growers.[80]

Practices that are routine in industrial agriculture destroy soil biology and reduce or eliminate all of the healthy-soil benefits described above. These practices include tillage and use of synthetic fertilizers and pesticides. Tillage is particularly hard on fungi, whose hyphal strands are cut up by tillage equipment, thus disconnecting the pipeline between plants and fungi that has mutual benefits. Plants send out messages to fungi in their root zone, and the fungi make nutrients such as nitrogen and phosphorus available to the plant that would otherwise be inaccessible. The plant, in turn, provides the fungi with carbohydrates derived from photosynthesis, a process which fungi cannot engage in.[81]

Synthetic fertilization tends to stress nitrogen and phosphorus, which in proper amounts can be a boon to plant growth but when used in excess are destructive of soil life and create downstream problems, too.[82] Their yield benefits also decrease over time with regular use. Moreover, when synthetic fertilizers are readily available to plants they stop seeking out nitrogen and/or phosphorus from soil microbial sources, so this symbiotic relationship between plant and soil microbes is disrupted.[83] Meanwhile, most of the pesticides applied to farm fields do not reach the targeted pest species,[84] and pesticides cause significant collateral damage to the soil biology that is beneficial for plant growth.[85]

When we destroy soil biology we are not only diminishing the prospects for our crops to thrive, but also missing an opportunity to store more carbon in the soil and thus mitigate the impacts of climate chaos. When soil runs off cropland we are shrinking our carbon bank and causing downstream problems as eroded silt builds up in rivers and excess nutrients from synthetic fertilizers contribute to massive dead zones in water bodies such as the Gulf of Mexico.[86]

Keeping moisture in the soil also has a climate benefit, as water vapor is an underappreciated component of the greenhouse effect.[87] "While carbon dioxide may be the primary driver of global warming, there's more water vapor than other greenhouse gases and it traps a lot more heat," says Peter Donovan of the Soil Carbon Coalition.[88]

FOOD DEMOCRACY: OUR BODIES, OUR FOOD

The industrial food system is marked by a lack of transparency all along the supply chain. No better example of this is the fact that genetically engineered (GE) food is ubiquitous on our grocery shelves, yet until very recently there was no federal requirement that they be labeled.[89] Consumers have mostly gotten labels advertising the converse message—that a product does NOT contain GE ingredients. All this non-transparency, despite a public that is overwhelmingly in favor of labeling GE foods.[90]

The food sovereignty movement is a backlash against this lack of transparency, but goes beyond a critique of that deficiency in our food system. More broadly, the movement emphasizes the need to localize and democratize food systems so that consumers (i.e., citizens) play a bigger role in decisions about what food will be produced and how it will be produced. Meanwhile, this movement seeks to diminish the role of undemocratic food corporations while also uplifting small-scale producers globally.[91] This last desire is reflected in

Goal 2.3 of the United Nations' Sustainable Development Goals, which reads:

> *By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.*[92]

As a starting point, many consumers have been keen to shorten the distance between themselves and the people who produce their food. That's why we've seen an explosion in the number of farmers markets, food hubs, community-supported agriculture farms, farm-to-school programs and other economic models that shorten supply chains and put consumers in closer contact with food producers, allowing citizen-consumers to have more influence over what food is produced and how it is produced.

Here are some examples of the increasing ubiquity of direct farm sales models:

- The number of farmers markets in the US increased fivefold between 1994 and 2018.[93]
- Between 2009 and 2013, the number of food hubs in the US increased by 65 percent.[94] Almost all of these food hubs purchased at least half of their food from small and mid-sized farms and ranches.[95]
- CSAs were barely known in the US in the late 1980s, but by 2015 USDA reported there were more than 7,000 farms in the US using this model.[96]
- The farm-to-school movement, which did not get its start until 1997, now encompasses 65% of US schools.[97]

These community-based models still only represent a tiny portion of the food economy, but their steady growth is hard to ignore—especially given that their success has come despite minimal policy support at the federal level. In addition, their success is likely to grow and attract more farmers, given that farmers who have direct-to-consumer (DTC) sales tend to do better financially than farmers who do not. According to USDA's Economic Research Service:

> *Farmers who market food directly to consumers have a greater chance of remaining in business than similarly sized farms who market through traditional channels ... Farmers with DTC sales had a higher survival rate... The differences in survival rates were substantial—ranging from 10 percentage points for the smallest farms to about 6 percentage points for the largest.*[98]

Meanwhile, consumers' desire for more local control over food system decisions has also found expression through food policy councils (FPCs), which have also seen significant growth. The first such council was formed in 1982, and as of 2020 there were nearly 300 FPCs active or developing in the US.[99] These FPCs bring together wide-ranging food system stakeholders to work on issues such as healthy food access, food procurement, and food-based economic development. Their goals often overlap with the goals of the alternative food marketing models mentioned above.

The idea of democratizing the food system comes to the forefront because of the decided *lack* of democracy in a current food system marked by corporate consolidation that negatively impacts farmers, workers, the environment, and the public's health. In a report entitled "The Food System: Consolidation and Its Impacts," a group of food system researchers assert:

> *Because political democracy rests on economic democracy and vice versa, our laser focus in scholarship, praxis and policy must be on democratizing the agrifood system at local, state, regional and national scales. Working together, policy-makers, farmers, workers and communities need to fashion alternatives and policies that can help to curb monopolistic tendencies in the agrifood system, to shine a racial lens in scholarship on agrifood system power and consolidation, to prioritize resilience and redundancy, to rethink core assumptions such as efficiency and property rights, and to encourage the development of alternative production and consumption arrangements.*[100]

Because the food system is a microcosm of the overall political and social environment, efforts to democratize it are likely to succeed or fail based on the success of bigger-picture efforts to strengthen democracy as a whole.

CAFOS DE-SKILL FARMING AND REMOVE FARMER AUTONOMY

CAFOs are part of a policy that stresses keeping food cheap—and they make sense if we only care about this narrow goal and ignore all of their collateral damage to the environment and society. CAFOs have kept the price of animal products low by externalizing many of their costs—in the form of air and water pollution and public nuisances—and de-skilling the role of "producer" in the first stage of the food chain.

The CAFO system de-skills farm operators by taking most of the important decisions about how to run the operation out of their hands and writing them into a corporate contract that is not negotiable for the operator. For example, CAFO operators do not control the animal genetics, choices about animal feed, or decisions about where to market the final products. In fact, they are renting the animals and returning them to the corporate integrator[101] once they have grown them to market size.

Agricultural economist John Ikerd has said that “operating a CAFO is not real farming” and that CAFO operators “end up as little more than corporate hired hands with minimum wage jobs. Their main responsibilities are to keep the feeders, waters, and ventilation fans running and to dispose of the dead animals and tons of manure.” In other words, they are afforded autonomy only in the areas of their operation that include costs and risks but offer little or no reward.[102]

Meanwhile, instead of having an economic relationship with their neighbors because they are marketing products to them, the CAFO operator is often in a contentious relationship with neighbors over quality-of-life issues (odors, lowered property values); environmental health issues caused by manure spraying or manure runoff from their operation; or concerns about human health that include the potential impact of antibiotic-resistant organisms in the local environment because of the rampant use of antimicrobials in CAFO animals.[103]

Thus, the CAFO system sets up operators to be bad neighbors, and also drives a wedge through rural communities as they squabble over whether or not CAFOs should be allowed into their jurisdiction. These conflicts are increasingly ending up in court, leading to avoidable costs for all concerned parties.[104]

In summary, CAFOs are a (narrowly defined) economic success for corporate integrators and consumers who are valuing only low prices, but CAFOs are an *ecological and social failure*. In addition, their economic "success" does not include a true cost accounting of their overall impact, since they have mostly avoided paying the cost of their pollution and their negative effects on the quality of life in rural communities, or broader public health costs such as the diminished effectiveness of antibiotics in medicine because of their routine use in CAFOs.[105]

GETTING BIG OR GETTING (PUSHED) OUT

The other key player in the industrial food animal production model is the commodity crop farmer growing corn and soybeans. Often, these producers are notoriously caught in the squeeze between increasing input costs and prices for their crops that do not keep pace with those rising input costs.[106] At both the input and output ends of the process, they are up against significant concentration whereby a few firms can exercise control over pricing and farmers have much less market power by comparison.

Intentionally or unintentionally, these commodity growers have followed the "get big or get out" trajectory recommended to them by former USDA Secretary Earl Butz. An increasingly large share of our crop harvest happens on farms that are 2,000 acres or more.[107]

Consolidation has been particularly acute in corn and soybeans, where the midpoint acreage tripled during a recent 20-year period (the midpoint acreage means half of all cropland acres are on farms with more cropland than the midpoint, and half are on farms with less).[108]

While increased farm size (consolidation) might suggest greater power in the marketplace for farmers, this farm size phenomenon is no match for the greater concentration in the markets through which farmers buy inputs. Researchers often measure concentration in terms of a ratio called the CR4, which refers to the percentage of a market controlled by the top four firms in that market. At the global level, the CR4 has been measured at between 45 and 65 percent for these four input sectors: farm equipment (45), seeds (50), animal pharmaceuticals (58), and agrochemicals (65). A CR4 of 40 percent is considered the tipping point at which the top firms can control a market.[109]

In the corn seed market, specifically, the four largest biotech companies increased their control from 50.5 to 85 percent between 1988 and 2015. Between 1995 and 2011, corn farmers saw their seed costs more than double while yields increased by only 30 percent. The situation was even worse for soybean farmers, whose seed costs more than tripled while yield rose only 19 percent.[110] Plus, at the output end of corn farmers' operations, they are up against concentration among processors. For example, as of 2012 the CR4 for wet corn milling was 86.[111]

Similar to the situation in commodity crops, CAFOs have become more consolidated, and the market for the CAFOs' output has become more concentrated. In a recent 25-year period (1987-2012), consolidation among meat producers saw the herd or flock size per operation increase by more than 30 times in hogs and eight times in laying hens, while both broilers (chickens raised for meat) and feedlot cattle more than doubled. Meanwhile, in terms of market concentration, the CR4s exceeded the 40 percent tipping point in every major sector of meat processing, as well as in dairy processing.[112]

Each of these commodity farmers, whether they are producing food animals or animal feed, is also producing pretty much the same product as other farmers in their sector, and can only outdo their competitors by being more effective at reducing input costs—by being the "lowest-cost supplier of an undifferentiated product," as organic farmer Fred Kirschenmann would describe it. He says this is one of the two ways to prosper in farming. The other way is to produce a product that *is* differentiated from the rest, based on qualities such as taste or a better "food story," such as a farm that is an especially good steward of the land.[113]

Kirschenmann points out that the undifferentiated products mostly serve the food retail sector (i.e., supermarkets and grocers), while the differentiated products—which mostly come from mid-size farms (the ones most likely to be failing in recent decades)—are more valued in the food service sector (restaurants, schools, and other institutional buyers). In general, large-scale commodity farmers do not have the option to differentiate. That is reserved for farmers who have more flexibility in what they produce, and access to local and regional markets for their outputs, in part because they are right-sized for those markets.[114]

REGENERATING THE FARMING WORKFORCE

> *"We started in the middle of the twentieth century with the doctrine that there were too many farmers, and that's never been called off."*
>
> ***—Writer and farmer Wendell Berry***[115]

As late as 1930 more than 20 percent of the US population was involved in farming, but by the early 1970s that number had fallen below 5 percent.[116] During the same period the number of farms went from a peak of 6.8 million to below 2.5 million.[117] Both numbers continued to decline slowly in subsequent decades.

Somewhat more encouraging is the fact that the USDA identified 27 percent of farmers in the latest census as new or beginning (10 or fewer years of experience).[118] Additionally, USDA has reported that, overall, 36 percent of farm operators are women,[119] but a survey focused on young farmers found that 60 percent of that cohort were women.[120]

A large influx of new farmers—young and otherwise, male and female—is precisely what is needed if agriculture is to transition to a regenerative model. As plant geneticist Wes Jackson explains it: “If we are to attend to the kind of detail that’s necessary to save the soil resource, I think it’s going to need a high eyes-to-acres ratio. That means the small farmer and lots of them watching the land.”[121]

One group of researchers summed it up this way: “Sustainable agriculture is knowledge-intensive work that substitutes experiential knowledge of farm ecosystems for harmful industrial inputs.”[122]

The project of regenerating the farmer workforce can be twinned with the project of making agriculture more sustainable, as Carlisle et al. described:

> *Supporting the next generation of farmers in achieving new levels of environmental stewardship and healthy food provisioning will require investing both in agroecology and in the people who are critical to its success. We have a brief window to decarbonize our food systems, enhance their delivery of ecosystem services, and buffer farmers and farming from the impacts of climate change. … Knowledge-intensive agriculture can reduce the environmental footprint of*

> *fossil fuel-based, chemical-intensive agriculture while providing good jobs in rural places.*[123]

Where will this "next generation of farmers" come from? As with any problem of this scale, there is no silver-bullet solution to the farmer shortage; however, there are numerous sources of new farmers that we, as a society, could further tap into to meet the need.

Young people—The National Young Farmers Coalition (NYFC) surveyed young farmers across the US in 2017 and summarized the characteristics that most distinguish this cohort from the farmer workforce at large:

> *Young farmers today are ... operating smaller farms and growing more diverse crops. They are capitalizing on demand for local food by selling directly to their customers, and they are overwhelmingly committed to sustainable and conservation-minded farming practices. ... They're highly educated, increasingly racially diverse, and, despite significant barriers and relatively low income, they are optimistic about the future.*[124]

In other words, these young farmers embody the kinds of qualities that will be necessary for a transition to a more sustainable farming future, and a more robust and resilient food system.

Debt might be their greatest enemy, though, as under-35 farmers reportedly are carrying more than twice the average rate of debt of farmers ages 55-64, for example. Many young farmers already face heavy debt from student loans before they even try to obtain land, and that existing debt can disqualify them from a mortgage or make it financially out of reach.[125]

Minority farmers—The US population in 2020 was 61.6% white,[126] but 95.6 percent of the farmers recorded in the 2017 Census of Agriculture were white. By contrast, Black farmers were only 1.3 percent of total farmers,[127] while Black people make up 12.4 percent of the nation's overall population.[128]

In the recent census, Asian farmers were only .6 percent of US farmers and Hispanic farmers were three percent,[129] despite representing 6 percent and 18.7 percent, respectively, of the overall population.[130]

Bringing minority and female representation in the farmer workforce more in line with their overall share of the population could be a leading factor in growing the farmer workforce. Two of the most significant barriers to entry into farming are lack of affordable land and lack of access to credit,[131] and lowering that second barrier will mean that USDA must reverse a long history of discriminating against female and minority applicants for loan programs.[132]

Military veterans—This population is well-suited to farming, as veteran and farmer Laron Murrell of Virginia would attest: "I think a lot of the skills that the military gives you ... relates directly to farming," Murrell said. "Getting up early. Keeping a schedule. When something comes up you don't panic. You actually take time and you assess the situation."[133]

Some veterans see farming as a sort of natural extension of their service to their country. "Farming can become their new mission," said Michael O'Gorman, founder of the Farmer Veteran Coalition. "It's heroic. 'We needed you to defend our country, and now we need you to feed it.' "[134]

US military veterans are also a very large cohort, about 18 million strong.[135]

Immigrants and farmworkers—These two groups overlap significantly, as 83 percent of farmworkers self-identify as Hispanic[136] and 75 percent are foreign-born.[137] There is a wealth of agricultural experience and knowledge embodied in this workforce, much of it acquired before immigrating.[138] There is potential for many more of these workers to advance to being farm owners,[139] particularly if they were to receive government and other support to help them overcome both their particular barriers to success and universal barriers such as poor access to land because of prohibitive land prices. The fact that Hispanics are 3 percent of farm owners in the US but 83 percent of farmworkers shows a massive underrepresentation in farm ownership.

In California, the Agriculture and Land-Based Training Association, or ALBA, helps field laborers make the transition to owning their own farms by providing training and low-rent land on which to hone their skills. ALBA's Chris Brown thinks skilled farmworkers are too often overlooked in discussions of where new farmers will come from. "You want new farmers, and you have droves of them already in the field," he said.[140]

CAFO operators and conventional farmers—CAFO operators would be the heaviest lift in terms of achieving the transition to sustainable farming, especially because of these operators' debt burden. But, a federal government bailout could help them pay off their debts and transition to a more sustainable model. There is a long-running precedent for various types of federal bailout (the earliest major one happened in 1792)[141] and this particular type would provide a greater societal benefit than a lot of previous bailouts. The proposed Farm System Reform Act[142] would put up $100 billion to help CAFO operators transition. This is less than a third of what the government shelled out in 2008 to bail out one company, Citigroup (inflation-adjusted).[143]

If CAFOs were phased out entirely, rural communities would be spared the negative externalities (i.e., pollution and cleanups) and instead gain neighbors they can fully integrate into the community instead of seeing them as adversaries.

FROM THE GROUND UP: REVIVING RURAL COMMUNITIES

There has never been widespread community support for CAFOs that would explain their rapid growth, only a top-down rural development strategy and manipulation of local governance by integrators. Plus, recent polls show public opinion trending against their continued growth.[144] As CAFOs have evolved as a rural phenomenon, the companies that promote them have had to become increasingly strategic about where to locate them, so as to minimize public opposition.[145]

In 2006 rural sociologist Curtis Stofferahn did "a systematic review of 56 studies on the topic of industrialized farming and community well-being" and found "largely detrimental impacts in 32, some detrimental impacts in 14, and no evidence of detrimental impacts in 10."[146] Most of these studies did not involve CAFO communities, but CAFOs are the worst-case example of what industrial agriculture can do to a rural community.

As early as 2002, agricultural economist Bill Weida was drawing distinctions between what he called "areas of rural residential concentration" and "areas of rural agricultural activity." He explained that corporate integrators were keenly interested in siting CAFOs in the latter type of rural area, and equally averse to locating in the former, because one would be much more equipped than the other to fight CAFOs.[147] Against this backdrop, Weida spelled out the siting strategy for CAFOs:

> *… A CAFO is structured to view local residents as nuisances instead of assets.* ***CAFOs crave isolation, and they are carefully designed to facilitate an isolated existence.*** *They select areas close to good roads and railroads so they can import those things they need to build their facilities. They use/hire very few people and often import those employees who run their facilities. These people usually live far from the CAFO site. To reduce costs, the CAFO makes every effort to pay as few taxes as possible.*[148] **[emphasis added]**

This contrasts sharply with the characteristics of family farms, which are often passed down from generation to generation and dependent on strong ties to the local community and a well-founded expectation of permanence that benefits both farm and community.[149] These real farms contribute more to the local economy and community than CAFOs because they purchase more inputs locally, sell more outputs locally, hire more people, and pay more taxes while using less of the public infrastructure. In addition, they do not diminish neighbors' property values the way CAFOs do.[150]

Regenerative farms that market directly to the public offer more viable entry points into farming than industrial farms because the startup costs are drastically lower. One accountant ballparked the cost for a novice to start up an industrial grain farm in the US Midwest at over $5 million.[151] By contrast, estimates on the cost of starting a small regenerative farm tend to range between $5,000[152] and $20,000[153] (the higher number was derived from a 1995 estimate that was adjusted for inflation.)

SUMMARY: THE PATH FORWARD FOR AGRICULTURE AND THE FOOD SYSTEM

> *"The problems of CAFOs are systemic—they can't be solved by mitigating symptoms. Animal agriculture needs to abandon CAFOs as a failed system of animal agriculture—if there is to be a future for animal agriculture."*
>
> ***—Agricultural economist John Ikerd[154]***

With the industrial model—and most egregiously with CAFOs—agriculture has taken a wrong turn. A course correction is not only called for, it is the only real option we have because stretching out the status quo over more decades has disastrous implications, especially in the context of climate chaos. Conversely, to not seize upon the promise of regenerative agriculture is to forgo enormous benefits in the realms of ecology, economy and equity.

A large body of scientific evidence shows the negative effects of CAFOs (and industrial agriculture in general) on public health and the environment. CAFOs have been an economic failure for CAFO operators and rural communities. If we replaced industrial with a regenerative style, we would not only shed the negative impacts of industrial, but gain all the benefits of an agriculture that creates healthier soil and healthier agroecosystems—as well as healthier local economies that are less dependent on imports. Sustainable farms also increase resilience to weather shocks and market disruptions because they stress producing a diversity of crops and animals.

We would also be embracing a more transparent farming culture—in stark contrast to the veil of secrecy that shrouds CAFOs. This transparent farming culture pairs well with the citizen-driven marketing models we described here, and would be a launching pad for the more democratic food system that so many people crave. That kind of system views food as a human right, rather than merely as a commodity.

Is it possible that growing public opposition to CAFOs means their days are numbered? We sincerely hope so—and have been working toward that outcome throughout our existence as a Center. However, we're not naïve enough to feel certain that the end of CAFOs is nigh, only that we seem closer to realizing that goal than we have ever been. That's why it seems appropriate to begin imagining what rural communities—and the food system at large—could look like in a post-CAFO world.

If regenerative agriculture fails to supplant industrial agriculture as the dominant agricultural model, it will not be because it cannot measure up against industrial agriculture in terms of the effectiveness of its methods. Research is beginning to validate what regenerative farmers already know: that their methods improve profits[155] and ecological outcomes.[156]

Our federal farm bill should acknowledge the benefits and the urgency of the transition described here, and it should be transformed into a farm *and food* bill that prioritizes food justice and gives greater support to local and regional food and farming systems instead of propping up the status quo in food and farming.

The greatest barriers to the farming transition we have proposed are entrenched economic and political interests that benefit from the status quo in agriculture. They are formidable foes, but not indomitable. The regenerative movement will need strength in numbers and diversity, plus an acute sense of urgency as humanity's converging crises make rapid change an imperative.

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Industrial farming, and especially industrial food animal production, have failed us when judged against three pivotal criteria — ecology, economy and equity. That's the bad news. The good news is that regenerative farming is poised to succeed on all three fronts. Moreover, bringing regenerative farming into the mainstream would open up possibilities for improving our entire food system, including making it healthier, more transparent and more democratic. For decades, industrial farming has been destroying the natural resources that underpin successful farming and degrading our rural communities. Meanwhile, regenerative farming rebuilds natural resources, and it can reinvigorate communities, too.

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