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INTRODUCTION

Can Soil Really Save Us?

In January 2021, Raphael Warnock became Georgia's first Black senator, gaining a seat formerly held by a Confederate general who allegedly led the Georgia branch of the Ku Klux Klan. A month later, he proposed a $5 billion fund for farmers of color, a step toward correcting, if not reversing, a long history of racism at the United States Department of Agriculture (USDA). The legislation, which eventually became part of a broader pandemic relief stimulus package, was covered in media outlets from the *New York Times* to *Modern Farmer*. Yet few reporters connected this debt relief to another headline-grabbing agricultural story that had been making the rounds six months earlier, back when odds of a Warnock victory still felt slim. That story was also one about righting wrongs—specifically, reversing decades of emissions by agribusiness. The world's preeminent group of climate scientists was suggesting that the answer to global warming might just be under our feet, in farm fields.

In early August 2019, journalists gained access to a leaked draft of a new special report crafted by the Intergovernmental Panel on Climate Change, or IPCC. The scientists argued that while a swift and sweeping global transition to renewable energy was necessary, it would be

too little too late. In order to keep warming below catastrophic levels, it would now be necessary not only to sharply curtail greenhouse gas emissions but to actually remove some of the previously emitted carbon from the atmosphere.

The report, which was eventually released on August 8, spurred widespread discussion of previously unfamiliar "negative emissions" technologies, whose enthusiasts basked in the sudden spotlight. One strategy that received significant attention was "bioenergy with carbon capture and sequestration," a geoengineering technology that involved burning plants or biowaste, then capturing the CO_2 and burying it. Another tactic, mineralization, proposed storing atmospheric CO_2 in carbon-rich minerals, including toxic waste from mines. A third approach, termed "direct air capture," used massive arrays of industrial fans to push air through a filter, where a solvent could be used to extract and capture the carbon dioxide. Since the biogeochemical flow of the process mimicked what might happen in a forest, the media took to calling these direct air capture plants "artificial trees."

Or, of course, you could use real trees.

The IPCC special report contained over three hundred mentions of "afforestation"—planting trees—and discussed several scenarios for slowing or halting deforestation. Significant emissions reductions and even negative emissions could be achieved in this way, the report's authors suggested. Planting trees and stopping clear-cuts of the Amazon rainforest had been central goals of the environmental movement for decades, so in a sense, this was nothing new. But what caught the attention of many journalists poring over the leaked draft was the way in which trees now figured in a larger discussion of the relationship between climate and the stuff trees grow in: soil.

As researchers have now known for decades, the majority of the carbon stored in forests around the world isn't sequestered in the trees, but in the soil below. Globally, soils constitute a carbon repository some

three times as large as the amount of carbon stored in all the plants on Earth. This soil "carbon sink" is also three times larger than the amount of carbon currently in the atmosphere. And there's good reason to think that, with the help of plants, our soils could be holding even more carbon. A lot more.

The main reason soils aren't already holding more carbon is agriculture, or, more precisely, industrially farmed monocultures. Over thousands of years (and especially the last two hundred or so), carbon once stored in soils has been released to the atmosphere through overgrazing, plowing, and loss of soil fertility, as soils have been mined for their nutrients and left bare between plantings, prone to erosion. Researchers estimate that some 133 gigatons of carbon have been released as a result—approximately 8 percent of total global soil carbon stocks. The IPCC report and many of its readers started asking whether a different kind of agriculture might be able to repay the debt and put some of that carbon back.

In order to appreciate how carbon might be reinfused into soil, you first have to understand that soil is not an inert medium, but a diverse community teeming with life. Mediating the raucous nutrient exchanges belowground are billions upon billions of microbes, which can essentially digest carbon and store it beneath the soil surface. To do this, of course, they need a steady diet of carbon-rich materials—stuff like compost, mulch, crop residue, and, their favorite, plant roots. All this organic matter—microorganisms like bacteria, macroorganisms like earthworms, and the decaying life forms they like to eat—makes up the most ecologically significant portion of the soil.

Unlike geoengineering or direct air capture, sequestering carbon in the ground by adopting soil-friendly farming methods is relatively inexpensive and comes with multiple benefits. Carbon-rich lands are more fertile and hold more water, which improves resilience to droughts and floods. Practices that enhance soil carbon—like planting soil-building

cover crops—also provide other "ecosystem services," suppressing weeds, reducing runoff, and providing habitat for pollinators and beneficial insects.

The prospect of a win-win solution for farmers and the planet rapidly attracted the attention of both media and industry onlookers, who began exuberantly promoting such practices as "regenerative" agriculture. The French government challenged nations around the world to commit to increasing soil carbon by four-tenths of a percent per year, based on a scientific analysis showing that such an effort could offset 20 to 35 percent of greenhouse gas emissions caused by human activity. In conservative states like South Dakota and Mississippi, no-till farmers and holistic management ranchers—who rotate their animals in ways that mimic native herbivores—began proudly calling themselves "carbon cowboys," spurring large-scale investments from General Mills and other major companies. The Rodale Institute, home to a forty-year-old experiment comparing organic and conventional agriculture, circulated a report claiming that more than 100 percent of current emissions could be offset through a global transition to regenerative organic farming. It seemed the world was poised to turn the carbon story of our food system on its head, transforming agriculture from a carbon source to a carbon sink.

But not everyone was convinced. The viability of the French initiative was widely questioned, as was the Rodale report. Concerns were raised that corporate carbon farming programs and agricultural carbon credit schemes might amount to little more than greenwashing. Scientists flooded academic journals with commentaries like "Managing for Soil Carbon Sequestration: Let's Get Realistic." The authors of this particular article pegged regenerative agriculture's carbon offset potential at no more than 5 percent—not even a quarter of the French team's *low-end* estimate.

But the real kicker came with a blog published by the World Resources Institute in May 2020, alongside the environmental think tank's new

Creating a Sustainable Food Future report. The blog, which immediately elicited detailed rebuttals from scientists and other regenerative agriculture advocates, was entitled "Regenerative Agriculture: Good for Soil Health but Limited Potential to Mitigate Climate Change."

I was no stranger to heated debates over the future of agriculture. I had, at this point, been researching the connection between agriculture and climate change for over a decade, and I was well-acquainted with the battle between organic farming proponents and those who argued that industrial agriculture was more efficient. In truth, I had already taken a side on this one. Both my reading of the evidence and my personal experiences in rural communities convinced me that well-managed organic farms were not only more efficient (expending far fewer resources to produce food) but also more environmentally sound. Yet this debate about regenerative agriculture and its carbon sequestration potential puzzled me, because even people in "my community"—the organic proponents—seemed to have widely divergent viewpoints. How could a climate solution that appeared so promising to one group of scientists be dismissed by another group of otherwise like-minded scientists as mere hype?

Hoping to have something more coherent to say about all of this to my ever-inquisitive students, I started asking friends who specialize in soil ecology for help. Was it true that regenerative organic farming methods could sequester carbon in the soil? How much? Would it stay there? After months of talking to colleagues, attending soil science conferences, and perusing journal articles with scintillating titles like "The Microbial Efficiency-Matrix Stabilization (MEMS) Framework Integrates Plant Litter Decomposition with Soil Organic Matter Stabilization," I came to an unexpected conclusion. Both groups of scientists were right.

As the critics warned, the somewhat simplistic approach to regenerative agriculture being aggressively promoted through carbon credit schemes was, for the most part, highly unlikely to alter the trajectory of

climate change. For example, simply ditching the plow without making other changes might increase carbon levels near the soil surface but simultaneously decrease them at greater depth. Similarly, applying compost might just mean moving organic matter from one place to another—not actually building it up. But when I took a few steps away from Silicon Valley (where I had recently moved for a teaching job) and the investment community, I found deeper versions of regenerative agriculture under discussion, visions that were truly revolutionary. In these discussions, the math started to add up. Maybe we could actually make a dent in climate change if we tweaked more than just individual agricultural practices, if we reoriented the logic underpinning our entire food system.

I finally started to grasp the nuances of soil carbon sequestration in a conversation with Francesca Cotrufo, a soil ecologist at Colorado State University (and the author of the article on microbial efficiency-matrix stabilization). Soil organic carbon, Cotrufo explained, isn't all the same. At a minimum, we should understand this heterogenous substance as composed of two separate pools, or "fractions." Think of these two fractions, Cotrufo told me, like a checking account and a savings account, with plants making the deposits. One fraction is available for meeting day-to-day needs—after all, microbes need to eat too. The other fraction is stashed away in association with mineral compounds underground. Building up the savings account of soil carbon, Cotrufo stressed, involves a different set of processes than building up the checking account. Aboveground biomass—stuff like compost, mulch, and crop residue—is perfectly adequate for building up the checking account and creating fertility that farmers can immediately use. But if you want to build up a savings account too, you need roots. Carbon exuded by plant roots is nutritious and easy for microbes to digest. As a result, carbon from plant roots is five times more likely than aboveground carbon to be stabilized as organic matter in soil—the

microbes gobble it right up and ultimately deposit much of it to their mineral-associated savings account.

So how does agriculture become more deeply (and continuously) rooted? Cotrufo had a few concrete suggestions. For one, farming systems ought to keep living roots in the ground all year long, by rotating diverse crops and using cover crops in the offseason. Perennial crops (like trees, alfalfa, or perennial grains) are a particularly elegant strategy, Cotrufo added, since they remain in the soil for multiple years and develop extensive root systems. In order to retain that stored carbon, plowing needs to be reduced or eliminated. And farmers might want to choose crops that allocate more of their energy to developing carbon belowground, rather than just pumping out the highest possible grain yields. But Cotrufo warned against oversimplifying this strategy, continually referring back to the forests and grasslands where she conducted most of her research before she started studying agriculture. Concerned by suggestions that fields be covered with monocultures of plants that store the most carbon, she cautioned that soil microbes don't respond well to such schemes. A healthy community of microbes needs a diverse diet, and if they can't get it from plants, they'll break open the soil carbon savings account to get at the nutrients inside, releasing stored carbon back into the atmosphere. For this reason, Cotrufo advocates mixtures of grasses (which produce a lot of carbon) and legumes (which produce a lot of nitrogen). "Basically, a healthy, diverse ecosystem," she said.

Speaking to Cotrufo left me wondering about the kind of agriculture she was promoting and whether it was being widely practiced—or if it had thrived in the past. Might there be a precedent for regenerative agriculture that could help people trying to create such farming systems now? I had an inkling of such a history, having studied the organic movement, but it was the kind of situation where I knew just enough to realize that there was a lot I didn't know.

I began conducting literature searches on the history of cover crops and the use of perennial plants in farming systems. Again, I called on colleagues, asking them for bread crumbs that might help me trace the origins of regenerative agriculture. To my amazement, I found that practices commonly promoted within regenerative circles as new innovations had been used for many hundreds and, in some cases, thousands of years—not just in far-away ancient civilizations but *continuously* and right here on the North American continent. Accompanying these practices were sophisticated analyses of soil health, as well as guidelines for stewarding it. Some of these regenerative farmers—though I came to understand them by other terms that they themselves used—were indigenous to these lands. Others had migrated here, bringing knowledge and seeds with them. But once I began learning to recognize the signature of their influence on the North American landscape, I started seeing it everywhere. Some of the most profoundly influential and knowledgeable land stewards in this country had no formal education in soil science, and many were not even counted as farmers by the USDA's Census of Agriculture. But in places that few of my fellow agricultural researchers ventured to look—vacant lots, immigrant neighborhoods, Native American reservations—regenerative agriculture kept periodically popping up, like a desert super bloom after a spring rain.

This left me with a pointed, haunting question. Why weren't these regenerative farmers more securely established? If putting down roots was the key to a climate-friendly food system, what was preventing these people with regenerative farming know-how from doing so? Or had they been uprooted?

What I eventually learned was neither simple nor comfortable, and it took time to sink in. It didn't hit me in a single revelatory epiphany, but one layer at a time, until my entire understanding of the food system had shifted. For years, I had been studying the dilemma of food as a relatively recent phenomenon, a conflict that arose in the wake of

World War II with the glut of chemicals and machinery. When corporations pushed wealthier farmers to use new industrial tools to grow large monocultures, small farmers were forced off the land and out of the market. In response, a coalition of rural communities and environmentalists fought back with the organic model, a more ecologically friendly way of farming that allowed farmers to get paid for the quality of their produce, rather than on quantity alone. As the decades wore on, the power struggle between "Big Ag" and small organic farms continued, each promoting their strategy as the best path to food security.

As I struggled alongside my fellow organic advocates, I began wondering if I'd failed to fully understand the problem. Had it really begun just a half century ago? And was it really just about the power of a handful of corporate meatpackers, chemical pushers, and grain dealers? I began looking further back in time. Before anybody referred to Iowa and Nebraska as farm states. Before Idaho became famous for its potatoes. Before Wyoming put a cowboy on its license plates. Before these lands were homesteaded, before the perfectly square sections could be seen from an airplane. When I no longer took these landscapes for granted, I could begin to see how they were created. And why they were doomed to fail from the very start. As I looked more carefully at the vast monocultures of corn and soy, I started to see not only the chemicals needed to produce them, the multimillion-dollar combines needed to harvest them, and the sprawling feedlots where they would eventually fatten confined animals. Increasingly, I also saw the full five-hundred-year effort required to create American agriculture as we now know it, an effort I would come to understand as one of the most significant events in history. And one of the most horrific.

It doesn't take a historian to recognize that the brutalization of Indigenous people was a fundamental part of US "settlement." But we tend to mentally separate that legacy from what is currently happening on the land. That disconnect allows us to denounce racial oppression while

simultaneously supporting agricultural systems that were built on it. In fact, both human atrocities and environmental destruction stemmed from European societies' effort to remake the world in their image. The ships of military conquest sailed to the Americas on this idea, as did the ships of slave captains and settlers that followed. Indigenous people and their food systems were destroyed, replaced with European people and their plants. African people, themselves stewards of long-standing Indigenous food systems on their own continent, were kidnapped and enslaved, forced to grow agricultural commodities for White landowners. Waves of immigrants would face similar conditions—economically vital to a society that refused to admit them as full members. In this way, the American heartland had been broken. By the moldboard plows of settlers, yes, but simultaneously by the larger forces of which those plows were part and parcel—genocide, colonization, agriculture as domination. This story of climate and agriculture was, fundamentally, a story about racial violence.

As the aggregates in those prairie soils burst open, releasing hundreds of gigatons of stored carbon into the atmosphere, they bore witness to ruptures of life and limb, people and place, marking this violence in the biogeochemical record. The seeds of climate catastrophe were planted in this broken ground, I came to see, and only a full reckoning with that history could offer any hope of getting our planet back in balance.

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At this point, I realized that I needed to examine the story of US agriculture—a story I thought I knew—through a lens other than my own. I needed to speak to people whose ancestors had experienced the slaughter of their bison herds, the enslavement of their entire family, the brutal exploitation of migratory farm work, or incarceration at the hands of their own government while their crops were left to rot. Aware that many people with such family histories were sitting right next to me at sustainable agriculture conferences, I became intensely curious about

what farmers and communities of color might teach me about how to work toward healing on the land. When I asked the question this way, a rich landscape of regenerative agriculture began to come into view.

I spoke with Indigenous Montanans working to restore native prairie and bring home their bison relatives. I talked to "returning generation" Black farmers reaching back to their African heritage to inform new agroforestry initiatives. A Chicana soil ecologist—herself the child of farmworkers—showed me the results of her research with immigrant Mexican and Hmong farmers in California's Central Valley, whose highly diverse small farms were teeming with beneficial fungi. The more I learned, the more I came to see that regenerative agriculture was neither a relic nor a fantasy. It had always been here, but on the margins. Pushed to the edges of industrial agriculture, these practices had been sustained by people pushed to the edges of society. This was not just a story about regeneration but also one about liberation—and the two were powerfully intertwined.

In organic farming circles in my home state of Montana, I had been introduced to an agrarian philosophy descended from Thomas Jefferson, who famously waxed poetic about the virtues of those who worked the land. Small family farmers, Jefferson believed, were good stewards, good neighbors, and the ideal subjects to guide a democratic nation. "Those who labour in the earth are the chosen people of God," Jefferson wrote in his *Notes on the State of Virginia*, "whose breasts he has made his peculiar deposit for substantial and genuine virtue."

But what Jefferson could not quite bring himself to admit was that the majority of the people actually laboring in the earth of the nascent United States were enslaved. Following emancipation, the nation's agricultural labor would be passed on to slave descendants, then immigrants whose legal status was carefully manipulated to approximate a similarly oppressive social condition. Outnumbering by far the European American settlers whose homesteads became the rhetorical centerpiece of our

national agrarian mythology, these people of color were in direct relationship with the landscapes of this continent during the most transformative and consequential time in their history. Like the Indigenous people who preceded them on the land, they knew all about soil getting worn down and broken open. The story of the earth and its wounding was their own story, their own wounding.

And yet, not everything was broken. As I learned from farmers, scholars, and advocates who had spent lifetimes digging into these buried stories—some of them looking into their own families' pasts—the regenerative farming traditions of their ancestors had been suppressed but never fully snuffed out. Carefully tended in the gardens of the enslaved and the murals of the landless, these traditions had provided both material subsistence and another form of sustenance that was difficult to put into words. There had been centuries of this survival work. Seeds braided into hair and smuggled across borders, passed down generation to generation. Bison and their human relatives, confined to reserves, dreaming of reunion on their ancestral lands. *Milpas* on the edges of farm fields. New Year's meals of black-eyed peas. Networks for sharing harvest labor. All these practices had persisted, despite the confines of structural racism. Might this moment of climate crisis be their time to blossom?

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Nikiko Masumoto is optimistic. The third generation to farm her family's certified organic orchard in California's Central Valley, the thirty-six-year-old queer feminist performance artist–peach grower is well aware that hers isn't the face that people typically imagine when they conjure up an image of a farmer. But she is working to change that, to build an agrarian culture that fully embraces diversity both on the land and in the community. Part of that work involves situating herself in her own family legacy on the land.

"Whenever I begin conversations about myself and my relationship to the land, it's always through my grandparents and great-grandparents who touched this same soil," Masumoto says. "There is a gift of that, which is thinking of my life in a lineage that is much more important than my own individual life." This sense of connecting across generations is central to regenerative agriculture, Masumoto believes. "So many of the methods that develop soil take time—the horizon is long. When you're wanting to leave a farm to several generations in the future you have a vested interest in taking up those practices."

But digging into her family's history is also a painful and complicated process. Discriminated against as immigrants, Masumoto's great-grandparents never owned the land they worked. What little savings they had built up was lost during Japanese American internment, when some 120,000 people—most of them US citizens—were incarcerated for years simply for the crime of their Japanese descent. So Masumoto's grandparents had to start from scratch, eking out a living on marginal land as they gradually built up the soil.

"We are the ones that the world needs in this climate crisis," Masumoto says, referring not just to Japanese Americans but to other communities of color who have experienced oppression. "Because we have those stories, we have that sense of fighting against the impossible."

As I continued my research, I heard Masumoto's sentiments echoed dozens of times. From Hawai'i to New York, Montana to Puerto Rico, young farmers and scientists of color were reviving ancestral regenerative farming traditions in a self-conscious effort to respond to climate change and racial injustice in tandem. These farmers and scientists understood regenerative agriculture not as a menu of discrete, isolated practices from which one could pick and choose and then tally up into a sustainability score. Rather, they saw regenerative agriculture as their ancestors had—as a way of life.

"For me agroforestry is not just about figuring out how to minimize your impact and still grow food within that system," says Olivia

Watkins, who is farming mushrooms in the understory of forested land in North Carolina that has been in her family for more than 130 years. "There are so many pieces involved in growing food that don't just have to do with the crop itself. The fungi in the soil. The wildlife in the area. How does water fall on the land? All those things are intertwined, so for me, the question is always, how can I be mindful of all those things?"

Watkins is equally mindful that she's conserving not only forest but also Black-owned land, which her family resolutely held on to over the course of a century when 98 percent of Black landowners were dispossessed. "With the history of oppression around land, the fact that we are stewarding the land and taking care of it is revolutionary," Watkins says.

On Watkins's and Masumoto's farms, what's being regenerated is not just soil but a complex web of relationships. As both women described to me, this form of regenerative agriculture can only be fully realized when the entire web is repaired so that the interconnected parts can function as a whole. This means attending to a component of the farm often left out of scientific discussions: people.

"I get pissed sometimes at ecologists," says University of California, Irvine researcher Aidee Guzman, "because they forget that people are involved in stewarding these systems." Guzman is herself an ecologist—she studies soil microbial activity and pollination on farms—but she's also the child of farmworkers who left their small farm in Mexico to immigrate to the US. When she looks at California's Central Valley, she sees thousands of people like her parents—people who have both the knowledge and the desire to steward regenerative farms, if only they had the opportunity. "We have to stop and think about the fact that farmworkers here in the US, people who were brought over from Africa and enslaved, they left *their* farms, probably extremely biodiverse farms," Guzman says.

Masumoto, who grew up just an hour away from Guzman, agrees. "Structured inequality in farmworker lives infringes on people's right

to think about the future," Masumoto laments. "The very people who have the skills right now [to implement regenerative agriculture] are the very people who we have marginalized the most in this country."

In short, truly regenerating the web of relationships that support both our food system and our planet is going to take more than compost. We're going to have to question the very concept of *agriculture*, and the bundle of assumptions that travel with the English word *farm*. What is the objective of this activity? To convert plants into money? Or to foster the health of all beings?

We also need to think hard about who farms and why. Will agricultural labor continue to be structured as a punishment for the oppressed and a means of marking and fortifying class hierarchies? Or might it be woven into the fabric of social life for all of us, in ways that are regenerative for the human spirit and sustainable for the human body?

As we rethink farming, we'll likewise need to reconsider our relationship with land and whether we can or should own it. Decolonizing agriculture will require big changes in our economic system. But it will also require daily rituals, coming together for meals that connect us to the land and sustain our bodies as well as our ties to the sacred. "I think what we are learning, or perhaps relearning," says Masumoto, "is how to belong to a place. That philosophy is embedded in the practices you use to feed yourselves."

Building this kind of regenerative agriculture will require a much deeper understanding of what happened on these lands that we in the United States now call home. It's a complicated story and, in many ways, a painful one. But facing it squarely offers an irresistible promise: by coming together to rebuild these farmlands, we can not only heal our planet and its carbon cycle, we can heal ourselves and our communities too.

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