How carbon farming could halt climate change

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What Is Regenerative Agriculture?
Part 08

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Soil holds more carbon than the atmosphere and all vegetation combined. But who's going to convince more farmers to farm with carbon levels in mind?

We can't say we weren't warned. For years, scientists have argued that human civilization must prevent the planet's average annual temperature from rising by more than 2 degrees Celsius—or face certain catastrophe. Once we pass that critical threshold, according to the Intergovernmental Panel on Climate Change, life on planet earth is going to be a lot less fun. Think droughts, floods, superstorms, food shortages, and widespread extinctions.

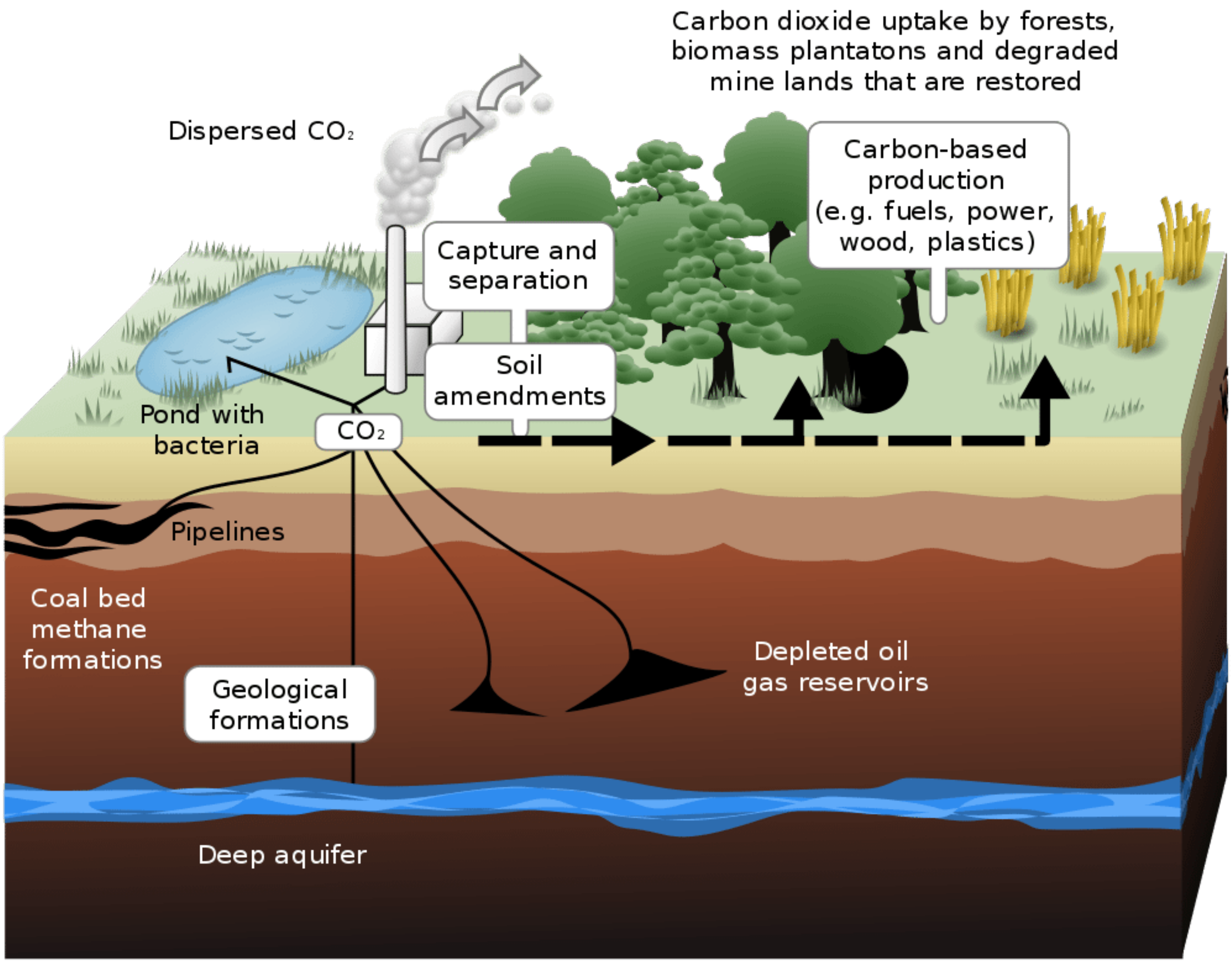
Now, as forest fires rage and Delaware-sized chunks break off from Antarctica, scientists have more grim news: We're *going* to hit the two-degree mark by the end of this century. Even if we manage to cut carbon emissions drastically, it's simply too late—with one big caveat. If we can find some way to suck excess greenhouse gasses out of the atmosphere, we may still avert the very worst catastrophes.

Soil holds more carbon than the atmosphere and all vegetation combined.

What's the best way to do this? That's still up for debate. A Bill Gates-backed startup, for instance, is experimenting with a factory-like facility that pumps CO2 out of the air, creating carbon pellets that can be buried underground or used for fuel. But a time-honored, low-tech solution may prove to be even more viable. It's called "carbon farming," and it's exactly what it sounds like: using farms not only to grow food, but also to sequester carbon safely in the soil.

In some ways, farmers make unlikely climate heroes. Agriculture is a major contributor to global climate change, since the industry drives deforestation, relies heavily on fossil fuel-powered machinery, and raises methane-emitting livestock by the billions. But farms, when they're managed properly, can also be formidable carbon sinks.

Think back to biology class: Plants absorb atmospheric carbon dioxide through photosynthesis, releasing oxygen in exchange. As crops grow, carbon is used to build plant tissues both above and below ground—from stems and leaves to seeds and roots, even root hairs and root exudates. Sequestering more carbon by planting more trees is readily recognized as a strategy for fighting climate change. But what happens underground is just as important: Plant materials that are left to accumulate and slowly decompose in the soil contribute to the formation of soil organic matter, a way of storing carbon in the soil over long periods of time.



LeJean Hardin and Jamie Payne

Carbon sequestration

Given this, you could say that carbon farming is a new perspective on an old idea. Advocates of sustainable agriculture—from backyard organic gardeners to large-scale conventional no-till farmers—have been emphasizing the importance of soil organic matter for decades. Soils high in organic matter tend to be good soils: They are more resistant to drought, less prone to erosion, harbor more beneficial soil organisms, and are generally better at growing healthy crops with fewer synthetic inputs. But soil organic matter is also about 58 percent carbon, which is why the business of building and protecting organic matter in soils has suddenly taken on a whole new level of importance.

If boosting soil organic matter used to just look like a good way to farm, building soil carbon now looks like a key to planetary survival.

From the perspective of global climate change, soils are a major compartment within the planetary carbon cycle, the second-largest pool after the oceans, holding more carbon than the atmosphere and all vegetation combined. Soils aren't necessarily climate neutral, depending on how they're managed: they can release additional carbon into the atmosphere through practices like overgrazing and excessive plowing, or soak up atmospheric carbon through practices like agroforestry and conservation agriculture. But when run properly, farms can be powerful tools in the fight against climate change.

Estimates of the "technical potential" of agricultural soils to absorb carbon range from 3 to 8 gigatons (billion metric tons) of CO_2 equivalent a year for 20 to 30 years, enough to close the gap between what is achievable with emissions reductions and what is necessary to stabilize the climate. If boosting soil organic matter used to just look like a good way to farm, in other words, building soil carbon now looks like a key to planetary survival.

Getting there is complicated, however, for a variety of scientific, political, and economic reasons. Carbon farming is one of those ideas that is simple in broad outline but infinitely complex in detail. While public awareness campaigns like Soil Solutions or Kiss the Ground are eloquent in presenting the overall argument, the success of carbon farming comes down to what happens at the farm level, on hundreds of millions of farms large and small all over the world. Encouraging farmers to implement the right kinds of practices—and providing them with accurate information as to what those practices are—is a multi-faceted challenge, the contours of which depend on the type of farm, the soil type, local climatic conditions, and many other factors, not all of which are perfectly understood.

Still, the urgency of the problem and the significance of the potential solution are mobilizing a wide array of individuals, from scientists and lawmakers to corporate executives and investors—not to mention farmers—to get involved in figuring out how to make it happen.

Flickr/Global Landscapes Forum

Agriculture drives deforestation, which takes carbon-sequestering trees out of the environment

The new idea of carbon farming embraces a wide array of practices to increase soil organic carbon while at the same time continuing to produce food and fiber for people and animals. It is sometimes referred to as climate-smart agriculture because it can function both as a mitigation strategy (a way to suck carbon out of the atmosphere) and as an adaptation strategy (a way to help farmers adapt to climate-change related problems like drought and flooding). As a method of carbon sequestration, carbon farming has a lot to recommend it: Unlike many reforestation projects, carbon farming doesn't remove land from agricultural production—instead it can actually increase yields by improving soil quality. And unlike high-tech proposals to pump carbon deep underground, it relies on relatively inexpensive, proven methods for putting carbon back where it is known to be beneficial.

Agriculture is an "uncapped" sector, but farmers anywhere in North America can generate and sell offsets, provided they follow an approved protocol.

Interest in carbon farming has been around for a while, but the concept has gained substantially in prominence since the COP21 meetings in Paris in November of 2015. Close observers of the international climate change negotiations point out that until recently, agriculture was largely excluded from the discussion, in part because of a lag in the science and in part because countries bristled at being told how to manage their food supply. The shift to a voluntary approach as adopted for the Paris talks—in which each country offers its own proposal for reducing harmful greenhouse gases—has allowed agricultural solutions to come to the fore. The French hosts also helped kick-start the conversation in 2015 by launching a campaign called "Four per Thousand," which proposes that increasing soil carbon by just 0.4 percent per year on agricultural lands worldwide would make a significant contribution to halting global climate change.

But who's going to convince more farmers to farm with carbon levels in mind? Here's a recent example: this year, Microsoft agreed to purchase 600 tons of carbon offset credits from seven rice farmers in Arkansas, California, and Mississippi, the first ever generated that way. Several years in the making, the deal was worked out through the involvement of multiple partners, including Terra Global Capital, the American Carbon Registry, the USDA Natural Resources Conservation Service (NRCS), the California Rice Commission, the White River Irrigation District, and the Environmental Defense Fund.

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To create the carbon credits, the farmers agreed to implement a suite of practices related to water management in their rice fields. Rice fields as commonly managed give off methane, a greenhouse gas several times more potent than carbon dioxide. By flooding their fields for shorter periods of time and making other adjustments, growers can reduce methane emissions while at the same time realizing other savings, like spending less money on fuel to run irrigation pumps.

The research and coordination underlying the project was funded by NRCS and by the Entergy Corporation, a major electricity producer. A key first step was getting the reduced-emissions rice-growing methodology approved by the American Carbon Registry, a nonprofit entity that sets standards for the creation and verification of carbon offsets, and by the California Air Resources Board, the state body that oversees California's cap-and-trade program, which has created the most important carbon market in North America. Agriculture is an "uncapped" sector, but farmers anywhere in North America can generate and sell offsets, provided they follow an approved protocol to produce "verified greenhouse gas emissions reductions or removal enhancements" (in other words, sequestration), as the Air Resources Board puts it.

This example illustrates several of the key dynamics shaping the emerging landscape of carbon farming in the United States. The first is the importance of the California carbon market, in operation since 2013. Regulated entities (mainly energy suppliers and large industrial producers) are allowed to cover up to 8 percent of their "compliance obligation" with so-called carbon credit offsets – commitments to reduce or absorb greenhouse gases elsewhere. For 2013 to 2020, the initial time horizon of the California legislation that created the program (the Global Warming Solutions Act of 2006, which pledged to reduce California's greenhouse gas emissions to 1990 levels by the year 2020), that 8 percent adds up to more than 200 million metric tons of carbon credits , conservatively valued at $2 billion. So far, most carbon credits have been generated through forestry projects or projects to capture and destroy ozone-depleting substances, but the number of livestock and cropland projects coming online is starting to pick up.

If a key challenge of carbon farming at the moment relates to our ability to quantify the exact amount of carbon added to soils, the benefits of increasing soil carbon are clear—and in some cases may provide incentive enough.

The Environmental Defense Fund (EDF) is among a handful of nonprofit groups that have been working to expand this potential—to better connect carbon farming with carbon markets. The key factor is the availability of reliable data: As Robert Parkhurst, EDF's director of agriculture greenhouse gas markets puts it, "You need some equation to calculate the agricultural practice into greenhouse gas emissions reduced. You need ease of use; you need credibility of the science… you have to have a high degree of accuracy. You have to be able to say, if I do *x*, *y* happens." And you need all that at a price that is still going to return some value to the farmer—at the moment, carbon offsets are valued at about $10 per ton, which in most cases is not going to cover the farmer's costs as well as the costs of monitoring and verification. Groups like EDF see their role as helping to develop the systems of quantification so that eventually, carbon markets for carbon farming can function on their own.

"Things in agriculture don't necessarily move at that fast a pace," Parkhurst points out. "In industry, you can change a production line multiple times a year; farmers just get one shot a year. We're trying to provide the market signals to do that more and faster."

The rice-farming example also highlights the fact that the idea of "carbon farming" can relate not just to soil carbon sequestration but also to reductions of the other two principal greenhouse gases, methane (CH_4) and nitrous oxide (N_2O). Paradoxically, documenting and verifying soil carbon sequestration is more challenging than documenting reductions in methane or nitrous oxide emissions. The rice-farming protocol involves reductions in methane emissions; another well-established approach to reducing methane emissions in agriculture is through the installation of covered manure storage facilities on dairy farms to capture and use the methane that escapes from stored manure and use it for energy production. (New York State has a Climate Resilient Farming Program, established in 2015, which has helped fund several such installations.) EDF also recently announced a pilot project to test whether improved nitrogen fertilizer application by corn farmers can be reliably linked to reduced nitrous oxide emissions, and thus qualify for the creation of carbon offset credits. Since fertilizer rigs can be connected to on-board tractor data-collection systems, some of the elements for this already exist.

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Predicting and documenting carbon storage in soils is more difficult, Parkhurst notes. The principal mechanism utilized so far is "avoided conversion," agreements in which farmers or ranchers are compensated for permanently protecting grasslands, which store significant amounts of carbon. An agreement of this type was recently announced between Climate Trust Capital and a ranch in eastern Oregon, securing an estimated 55,000 tons of carbon emissions from being released into the atmosphere. The Marin Carbon Project in Marin County, California, has been pursuing another approach, proposing a protocol of applying compost to northern California rangelands with the goal of boosting their carbon storage capacity. For the moment, however, the costs of this practice are not covered by the potential carbon credits to be created. Rangeland scientists also caution that the additional carbon sequestration potential of grassland soils can vary widely depending on rainfall and soil type.

A third key feature of the emerging carbon farming landscape in the United States is the significant role played by the NRCS. In addition to creating a free, online tool, called COMET-Farm, designed to assist farmers in calculating their greenhouse gas emissions and the impact of potential improvements, the NRCS has made "conservation finance" a priority area within its Conservation Innovation Grants program for the past three grant cycles. Grantees—which include the American Farmland Trust and the Nature Conservancy as well as EDF—have been pursuing a variety of strategies to facilitate private investment in environmental initiatives, carbon farming among them. Some of this work involves the development of quantification metrics, some of it is about bringing different groups together to figure out new approaches to environmental challenges.

Flickr/USDA

Rice fields give off methane, a greenhouse gas several times more potent than carbon dioxide

Advocates of carbon farming agree that carbon markets are only one of several necessary routes to building carbon storage in soils, however—just as carbon sequestration in soils is just one of an array of essential strategies for addressing global climate change. If a key challenge of carbon farming at the moment relates to our ability to quantify the exact amount of carbon added to soils, the benefits of increasing soil carbon are clear—and in some cases may provide incentive enough.

"There's a big opportunity in the co-benefits," says Adam Chambers, an air quality scientist with the NRCS who has worked on the COMET-Farm tool and other climate-change initiatives. "Improving soil carbon sequestration improves water retention, which improves drought resistance—that is what really got the attention of California," he says. California's support for carbon farming is coming not just from the cap-and-trade program but also from a new Healthy Soils Initiative, with $7.5 million allocated in its first year to fund soil carbon storage and the reduction of greenhouse gas emissions in agriculture. Other states are moving in this direction as well. Maryland, for example, recently passed legislation directing its Department of Agriculture to establish a new Healthy Soils Program, with explicit connections drawn between soil health, carbon sequestration, and meeting the state's commitment to reducing greenhouse gases by 40 percent by 2030 (signed into law in 2016).

Agriculture represents a new frontier in the climate-change discussion, one with enormous potential but also unique challenges.

Support for carbon farming is also taking shape within the corporate sector. Walmart recently announced an initiative it calls Project Gigaton, intended to cut greenhouse gas emissions in its supply chain by 1 billion metric tons by 2030; some of those reductions are expected to reach back to the farm level. Ben & Jerry's commissioned a company-wide greenhouse gas audit in 2015, which found that each pint of its ice cream represented two pounds of CO_2 emissions—41 percent of which came from producing the milk and cream. To help fund improvements to its carbon footprint, the company has imposed an internal carbon "tax" of $10/metric ton; it also has a quality-incentive program for its producers that includes greenhouse gas emissions monitoring among other elements.

What unites these disparate efforts is the sense that agriculture represents a new frontier in the climate change discussion, one with enormous potential but also unique challenges. "As a sector, agriculture is very different from other parts of the carbon economy," says Torri Estrada, executive director of the Carbon Cycle Institute and a spokesperson for the Marin Carbon Project. One difference is that—so far—it hasn't received anything like the level of subsidy and incentive payments enjoyed by the green energy or transportation sectors. Another difference is that it relies on biological as well as technological systems and processes, necessitating a different approach.

Eric Toensmeier, author of the book *The Carbon Farming Solution* (Chelsea Green, 2016) and a research fellow with Project Drawdown says he is impressed by the number of new developments in the field since his book came out, from high-level international meetings to interest in conservation finance, to regenerative ingredient sourcing for bioplastics. The elephant in the room—President Trump's announced withdrawal of the United States from the Paris agreement—has made an already urgent situation that much more critical. "We can't get there without the farmers," Toensmeier says. "All the right people are starting to talk to each other, and they weren't five years ago. That's exciting, but we only have ten or fifteen years to straighten this out."