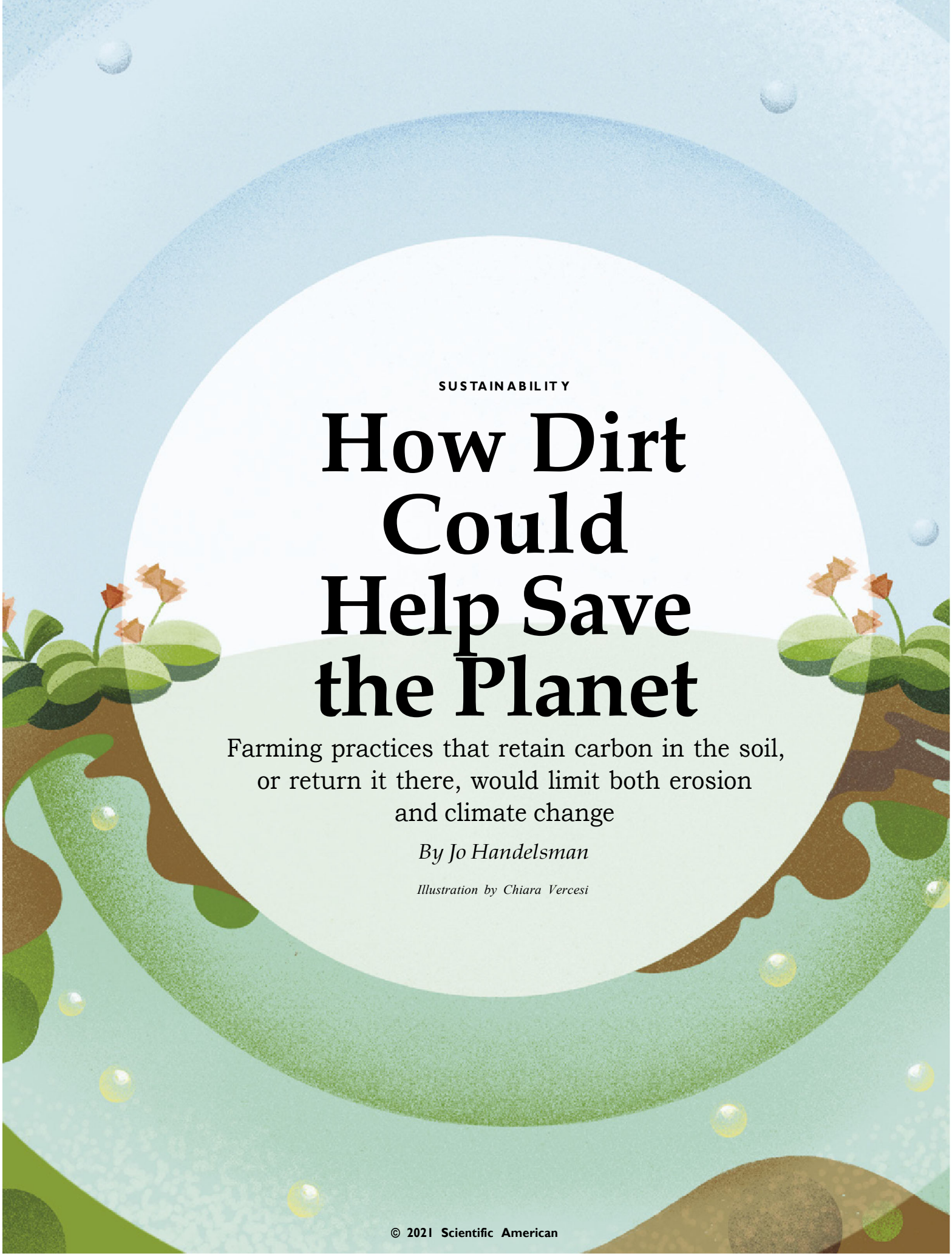

SUSTAINABILITY

How Dirt Could Help Save the Planet

Farming practices that retain carbon in the soil, or return it there, would limit both erosion and climate change

By Jo Handelsman

Illustration by Chiara Vercesi

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The American dust bowl of the 1930s demonstrated the ruinous consequences of soil degradation. Decades of farming practices had stripped the Great Plains of their fertile heritage, making them vulnerable to severe drought. Ravaging winds lifted plumes of soil from the land and left in their wake air choked with dust and a barren landscape. Thousands died of starvation or lung disease; others migrated west in search of food, jobs and clean air.

Today we again face the potential for extreme soil erosion, but this time the threat is intensified by climate change. Together they create an unprecedented dual hazard for the food supply and the health of the planet. Farmers, however, can be key partners in averting the catastrophic consequences. By using readily available practices, both erosion and climate change can be mitigated by incorporating more carbon into soil.

Photosynthetic carbon fixation removes carbon dioxide from the air, anchoring it in plant material that can be sequestered in soil. This process reduces atmospheric greenhouse gases and reduces soil erosion by enriching soil with carbon that feeds hungry microbes that produce sticky substances, which in turn bind soil particles into clumps that are less vulnerable to movement by wind and water. The Biden administration has the opportunity to avert both crises through domestic policy for U.S. agriculture and international policy that would restore U.S. leadership in the battle against climate change. Reducing greenhouse gas emissions is the central feature of most plans to slow the climate emergency at hand. Much less attention has focused on sequestering atmospheric carbon in soil.

Soil, which stores three times more carbon than the entire atmosphere, is the largest terrestrial carbon sink, offering a vast repository with immense, untapped capacity. Since the beginning of agriculture, food production has removed about half, or 133 gigatons, of the carbon once stored in agricultural soil, and the rate of loss has increased dramatically in the past two centuries, creating a large void to be filled. Restoring this carbon stockpile would sequester the equivalent of almost one fifth of atmospheric carbon, bringing greenhouse gas concentrations nearly to pre–industrial revolution levels and making soil less vulnerable to erosion. Realistically, we're not going to restore 133 gigatons of carbon any time soon. But working toward this goal could be a centerpiece of a multifaceted plan to address both erosion and climate change.

Farmers know that soil is no longer a renewable resource. Many farms are simply running out of it. A 2018 inventory from the U.S. Department of Agriculture reports that the U.S. loses soil on average 10 times faster than it is generated; in states such as Iowa, New Mexico and Nevada, erosion is much more rapid. In parts of Africa and Asia, soil erosion outstrips replenishment as much as 100-fold.

And it's getting worse. Heavy rainstorms are a key cause of erosion, driving loosened soil particles into streams and rivers. Many parts of the world, including the U.S. Midwest, have experienced a dramatic rise in the frequency and power of rainstorms, a trend likely to accelerate as climate change worsens. At current rates of erosion, some of the world's most productive farmland will lose most of its topsoil over the next few decades, rendering it worthless for food production just as Earth's population reaches nine billion. In fact, even the well-endowed soil of Iowa has been so ravaged that subsoil is revealed at the land surface at locations across the state. But there is a general principle worthy of attention: erosion is reduced by accumulation of soil carbon.

Carbon sequestration in agricultural soils was the goal of the "4 per 1000" proposal for food security and climate that was introduced by France during the 2015 Paris climate talks. The proposal contended that increasing the carbon content of soils worldwide by 0.4 percent annually would offset future emissions. Only 29 countries signed the agreement, and the U.S. was not among them. The proposal encompassed all soil on Earth, giving it an aspirational and unattainable nature that put off many potential signatories. So 4 per 1000 should be reformulated to pass a reality test, focusing only on agricultural soil for starters. As President Joe Biden reestablishes U.S. leadership in global climate policy, achieving broad ratification of a proposal to increase soil carbon should be high on his agenda.

To meet such soil carbon goals, the U.S. would need to adopt different farming practices. One important step is to reduce plowing, which causes erosion by breaking up large clods and destroying the soil structure that prevents detachment and movement of particles. The alternative—no-till planting—involves drilling seed directly into the stubble of the previous crop rather than plowing the field after harvest and again before planting and dropping seeds into plowed furrows. Although no-till methods were shown to substantially reduce erosion in the 1970s, they have been adopted on only one third of U.S. cropland. Another highly effective practice is growing cover crops—plant species that enrich the soil between fall harvest and spring planting of the main crop. Cover crops anchor soil and prevent winter winds and spring rainstorms from removing fertile topsoil.

Cropland soil can be stabilized by interspersing strips of perennial prairie plants, the very species that generated the expanses of Midwestern soils that have produced abundant food since European-Americans migrated to the center of the country in the 19th century. These perennials have massive root systems that feed the soil. Switchgrass roots, for example, can grow 14 feet deep and account for half of the plant's biomass at the end of the season, a reservoir that enables the plant to resprout in the spring. Corn, in contrast, has shallow roots and by the end of the growing season a negligible amount of root biomass remains after the plant has shuttled its carbon to the seeds. Replacing just 10 percent of a corn crop with strategically placed prairie plants reduces erosion 95 percent! Similarly, reforestation reduces erosion with large tree roots that anchor and enrich soil. All these soil-protective practices accelerate carbon sequestration, reducing greenhouse gas accumulation.

Another way to boost carbon sequestration is a method for pasturing cattle that stimulates plant growth. Intensive regenerative grazing replicates the effects of the herds of bison that once roamed the American plains, contributing to formation of some of Earth's most fertile soils. Regimes involve moving cattle frequently—sometimes several times in a single day—to new pasture, thereby preventing the animals from cropping the vegetation close to the ground. The remaining plants recover and start growing again more quickly than those that have been reduced to nubs, enabling them to be more photosynthetically active over the growing season and accumulate more carbon. Some researchers estimate that regenerative grazing boosts carbon fixation through photosynthesis enough to cancel out most of the greenhouse gases released by beef production.

BRANDING CLIMATE-FRIENDLY SOIL

EvEntually soil will rEach its carbon-holding capacity. But that would be a good problem to confront—it would mean that soil was packed with carbon and was therefore healthy and resistant to erosion. By the time carbon capacity is reached in soils worldwide, strategies to reduce carbon emissions will likely be more advanced.

Critics of 4 per 1000 argue that the benefits of incorporating carbon into soil would be canceled out by the increased needs for nitrogen fertilizers, which are produced by a fossil-fuel-intensive process. But carbon sequestration can be accompanied by retention of nitrogen in plant material, reducing nitrogen needs of future crops. Moreover, nitrogen needs could be satisfied by biological nitrogen fixation, which is conducted by soil bacteria that need no fossil fuels to make nitrogen fertilizer.

We have the means to halt soil loss and mitigate greenhouse gas emissions, but we need policies that enable farmers to adopt new practices. Most farms survive with a fragile profit margin. Although Americans enjoy one of the cheapest, safest and most abundant food supplies in the world, farmers receive only 15 cents of every dollar spent on food, and between 2013 and 2018 net farm income dropped nearly 50 percent. The usda forecast that half of U.S. farms would lose money in 2020. Many farms persist only because a family member provides income from off-farm employment. And financial hardship drives many farms out of business, which is evident in the loss of half of U.S. dairy farms between 2001 and 2019.

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To improve the profitability of farming and reduce both soil erosion and net carbon emissions, the Biden administration could restructure crop insurance to reduce premiums on land that is managed in a carbon-friendly manner. This strategy would pay for itself within a few years because even small increases in soil carbon reduce vulnerability to droughts and floods and, consequently, the likelihood of insurance payouts. The administration could build an alliance of key stakeholders—farmers, food retailers, consumers, Indigenous communities, agribusiness and environmental groups—to design certification and marketing strategies for food sold with a label indicating it had been produced under conditions that sequester carbon.

The label might read "Produced by Carbon Heroes" to recognize the heroism of farmers who make it possible for millions to eat and would now add protecting the planet to their list of contributions. Multinational retailers could demand such practices from their producers as they have already done with other practices friendly to animals and the environment. Current agricultural subsidies could be redirected to pay for both the food and the carbon sequestered during its production.

The U.S. experienced the impacts of extreme soil degradation during the Dust Bowl. We could avert a similar devastation of U.S. farmland by changing farming practices, which would generate ancillary benefits for climate. The stakes are too high to ignore the soil. SA

FROM OUR ARCHIVES

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