Carbon180

Agricultural Soil Carbon

Carbon is naturally stored in soil over time, nourishing plants and crops. Soil has the capacity to store large amounts of carbon and is therefore a powerful tool for addressing climate change.[1] Agricultural soil carbon storage is a land-based carbon removal solution that involves capturing carbon dioxide from the atmosphere and storing a portion of this carbon in the soil. There are several land management practices that can increase the amount of carbon stored in soil, including conservation tillage, planting perennial crops and cover crops, agroforestry, managed grazing, and more.

Increasing soil carbon can be a win-win for farmers and ranchers ("producers") and for climate. US agricultural soils alone can potentially store up to 10% of domestic greenhouse gas emissions per year.[2] Carbon-rich agricultural soils also provide economic and ecological co-benefits by enhancing land and water resources, and building resilience to climate impacts.[3]

GLOSSARY

Conservation tillage
Minimize soil disturbance

Perennial crops
Develop and grow perennial crops, which reduce the need to till

Cover cropping
Grow crops during the off-season to maintain plant cover and reduce erosion

Agroforestry
Trees or shrubs are grown among crops or pastureland

Managed grazing
Rotate grazing of livestock between pastures to stimulate plant regrowth

Considerations

LAND USE AND OWNERSHIP

With slightly more than 50% of US land under agriculture management, there is significant potential for increasing soil carbon storage.[4] As of 2014, white farmers own 98% and operate 97% of all farmland; farmers of color are more likely to be tenants rather than owners, own less land, and generate less farm-related wealth.[5] Despite having expertise and a working history of their land, tenants face a number of barriers in involvement in decision-making, practice implementation, and plans for the transfer of land.

Practices that improve soil health also improve the resilience of supply chains and promote long-term productivity, allowing producers to meet growing demand for food and fiber without having to convert additional non-agricultural land.[6] Regulations will be important in ensuring agricultural soil carbon storage does not result in substantial land use changes, which could drive deforestation, reduce biodiversity, and release stored carbon back into the atmosphere.

ECOSYSTEM IMPACTS

Increased soil carbon can improve soil structure and increase water filtration.[7] Healthier soils also increase ecosystem resilience to climate impacts, biodiversity, and resistance to disease.[8] Additionally, many of these practices reduce producers' reliance on fertilizers, which can improve water and air quality.[9]

Despite these ecosystem benefits, there are ecological limits to how much carbon can be stored in soil.[10] The carbon stored in soil can be released back into the atmosphere if agricultural practices change or if the soil is disturbed.[11] This makes maintaining soil carbon as important as increasing it.

SOCIAL COHESION

Producers place a high value on community and often look to their neighbors when it comes to new practice implementation.[12] Producers have developed strong support networks as many work together to shift the agricultural system towards regenerative practices.[13] The positive impacts soil carbon management can provide, like increased ecosystem resilience and long-term productivity, often result in producers feeling more deeply connected to the land.[14] Producers value the sustainable longevity of their systems resulting from soil carbon practices because it means their successors will be able to benefit from a healthy and resilient environment.[15]

JOB CREATION AND ECONOMIC IMPACTS

There may be an increased demand for technical assistance providers to guide practice implementation.[16] There is significant opportunity for local Natural Resources Conservation Service (NRCS)[17] offices, university extensions, non-profit organizations, and private companies to expand their capacity and provide more training to staff and producers on soil health and carbon storage.[18]

Agricultural soil carbon practices can also improve producers' bottom lines by reducing the need for external inputs, like fertilizer. In some systems, soil carbon practices can lead to greater crop yields, which helps increase profit margins.[19]

COSTS

Soil carbon sequestration in agricultural systems can cost as little as $10 per ton of carbon dioxide sequestered, but may have additional transaction costs and long waiting periods for benefits to accrue.[20] Practice implementation often poses upfront financial challenges for farmers and ranchers, such as purchasing new equipment.[21] These costs become even more prohibitive for first-time farmers and farmers of color looking to enter the sector — an important consideration given that one-third of US producers are over the age of 65.[22] There is also a time investment as farmers learn how to transition their operations. Cost estimates for certain soil carbon storage practices are available from the United States Department of Agriculture (USDA) Economic Research Service, but current financial incentives are not enough to motivate farmers and ranchers to implement these practices.[23,24]

Deployment

Agricultural practices that increase soil carbon storage are not new and most are ready to be widely implemented across the US.[25] No-till practices are already implemented on 37% of croplands and reduced tillage on 35%, while more frontier approaches, such as perennial grain crops, are starting to be deployed on a small scale.[26,27] With additional incentives, these practices will continue to expand and bring agricultural resilience and climate benefits.

Agricultural systems vary from farm to farm, or ranch to ranch, depending on the land use history and biogeographical context of each system. These factors are important for understanding which practices will best promote soil carbon storage in different contexts. Robust monitoring, reporting, and verification (MRV) will be important to accurately measure how much carbon is being sequestered in soils. This is incredibly important given the growing interest in monetizing soil carbon storage.

Government Engagement

The USDA is the primary federal agency involved in soil carbon storage, leading research, development, demonstration, and deployment (RDD&D) efforts. The National Institute of Food and Agriculture (NIFA), the Agricultural Research Service (ARS), and the Economic Research Service (ERS) support agricultural soil carbon research and development. The USDA also administers conservation programs that help farmers fund conservation practices on their lands, such as Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP), and provides technical assistance through the Conservation Technical Assistance (CTA) program.

Congress has signaled growing interest in soil carbon storage through legislative action, and recent bills and funding decisions highlight the importance of soil carbon. Through federal appropriations, USDA programs like CTA and the Agriculture Food and Research Initiative that could support soil carbon storage have received increasing funding in FY2021. Despite this momentum, continued support is needed to help increase adoption of these soil carbon practices. The federal government can help address uncertainties regarding the costs and effectiveness of soil carbon practices across geographies, as well as identify and solve barriers to adoption, especially for underrepresented and first-generation farmers. Lastly, engagement at the local, state, and international level will be necessary to scale agricultural soil carbon in an equitable, transparent, and inclusive manner.

Soil Carbon Sequestration

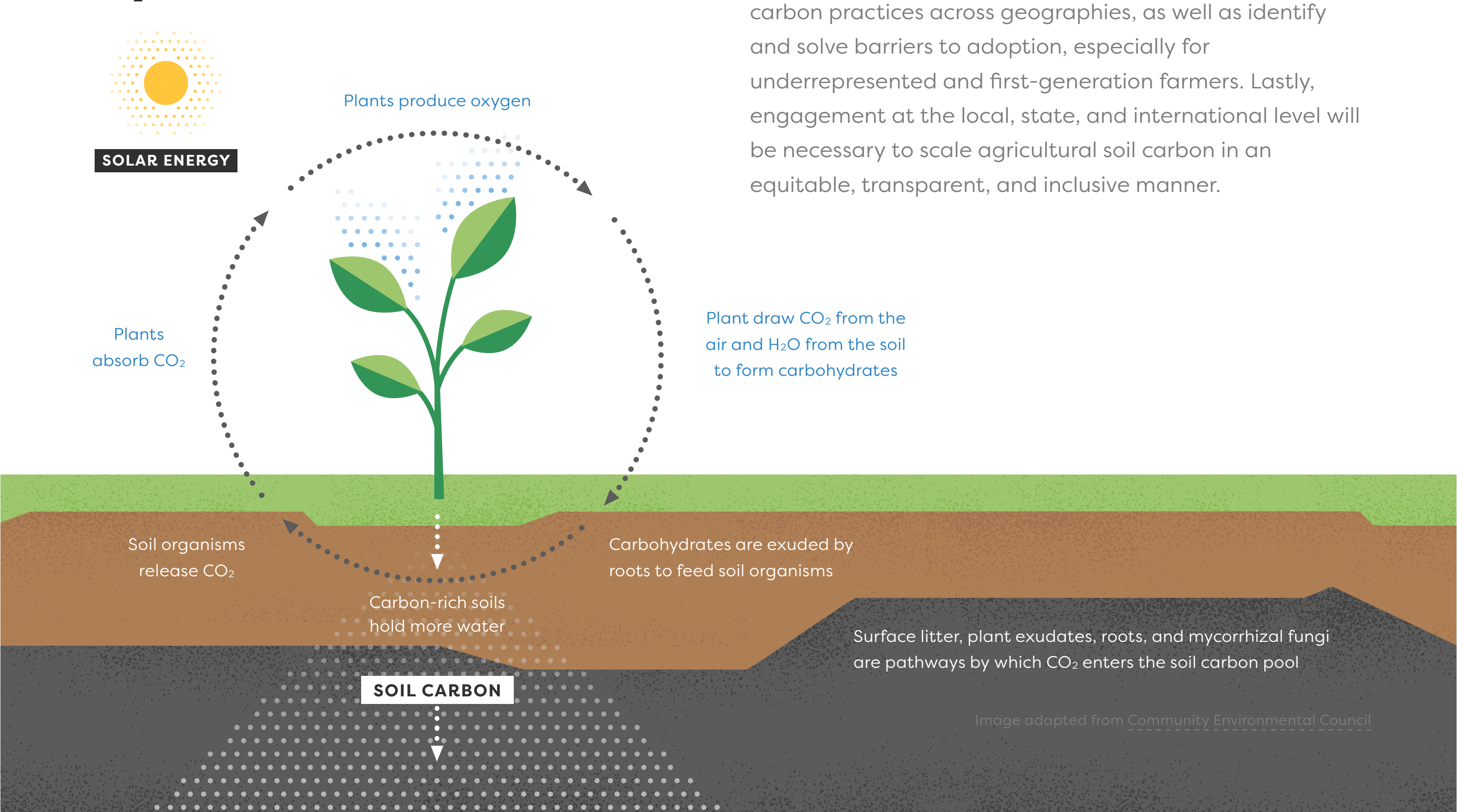

Image adapted from Community Environmental Council

Endnotes

Agricultural Soil Carbon

1 Leading with Soil, Carbon180

2 Building a New Carbon Economy: An Innovation Plan, Carbon180

3 Leading with Soil, Carbon180

4 Building a New Carbon Economy: An Innovation Plan, Carbon180

5 Racial, ethnic and gender inequities in farmland ownership and farming in the U.S., Megan Horst and Amy Marion

6 Negative Emissions Technologies and Reliable Sequestration: A Research Agenda, The National Academies of Sciences

7 Leading with Soil, Carbon180

8 Soil Carbon Sequestration Fact Sheet, American University

9 Soil Carbon Storage Fact Sheet, Carbon180

10 Soil carbon saturation: concept, evidence and evaluation, Catherine E. Stewart, Keith Paustian, Richard T. Conant, Alain F. Plante and Johan Six

11 Carbon Removal in Forests and Farms in the United States, World Resource Institute

12 Leading with Soil, Carbon180

13 Climate Change Mitigation as a Co-benefit of Regenerative Ranching: Insights from Australia and the United States, Hannah Gosnell, Susan Charnley and Paige Stanley

14 Ibid.

15 Ibid.

16 Sustainable Agriculture and Its Implementation Gap—Overcoming Obstacles to Implementation, Norman Siebrecht

17 The Natural Resources Conservation Service (NRCS) is an agency within the USDA that provides technical assistance to farmers and land owners.

18 Leading with Soil, Carbon180

19 Ibid.

20 Soil Carbon Storage Fact Sheet, Carbon180

21 Leading with Soil, Carbon180

22 Farm Producers 2017 Census Highlights, National Agricultural Statistics Service

23 Negative Emissions Technologies and Reliable Sequestration: A Research Agenda, The National Academies of Sciences

24 Leading with Soil, Carbon180

25 Soil Carbon Sequestration Fact Sheet, American University

26 2017 Census of Agriculture: United States Summary and State Data, National Agricultural Statistics Service

27 Soil Tillage and Crop Rotation, United States Department of Agriculture

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