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Carbon180

Soil carbon storage

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]

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 13% 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]

Land use and ownership considerations

With slightly more than 50% of US land under agriculture management, there is significant potential for increasing soil carbon storage.[4] As of 2017, agricultural producers are 95% white, and farmers who are Black, Indigenous, and other people 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.

KEY TERMS

Conservation tillage
Preparation of land for growing crops using systems that minimize soil disturbance.

Perennial crops
Crops that don't need to be planted each year, which reduces the need to till soil.

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

Agroforestry
Integrating trees and shrubs into productive agricultural systems.

Managed grazing
Rotating grazing livestock among pastures to stimulate plant regrowth.

Ecosytem 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 CO_2 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

USDA is the primary federal agency involved in soil carbon storage, leading research, development, demonstration, and deployment (RDD&D) efforts across the National Institute of Food and Agriculture (NIFA), Agricultural Research Service (ARS), and Economic Research Service (ERS). USDA also administers conservation programs authorized through the farm bill that provide technical and financial assistance to farmers implementing conservation practices, including those that sequester more carbon, on their lands. These programs include the Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), and Conservation Technical Assistance (CTA) program.

Congress and USDA have highlighted the importance of soil carbon through a number of recent bills and funding decisions. The Agriculture Resilience Act and the Climate Stewardship Act of 2021 aim to accelerate adoption of soil health practices by expanding a variety of existing conservation programs while also bolstering funding for agriculture science research through soil health demonstration trials and regional Climate Hubs.

Through the federal appropriations process, Congress increased overall funding for programs related to soil carbon in fiscal year 2022, including CTA, ARS, and the Agriculture and Food Research Initiative (AFRI). On the administrative side, USDA announced in February 2022 a new Partnerships for Climate-Smart Commodities program, which will provide up to $1 billion to pilot projects that expand markets for goods grown using climate-smart practices, including those that sequester more carbon. In October of the same year, USDA also launched a new $10 million soil carbon monitoring program under the Conservation Reserve Program to quantify the program's carbon outcomes.

The federal government can continue to support soil carbon goals by addressing uncertainties around costs and effectiveness of soil carbon practices across geographies, as well as identifying and alleviating barriers to adoption, especially for underrepresented and first-generation farmers. Lastly, engagement at the local, state, and international levels will be necessary to scale agricultural soil carbon in an equitable, transparent, and inclusive manner.

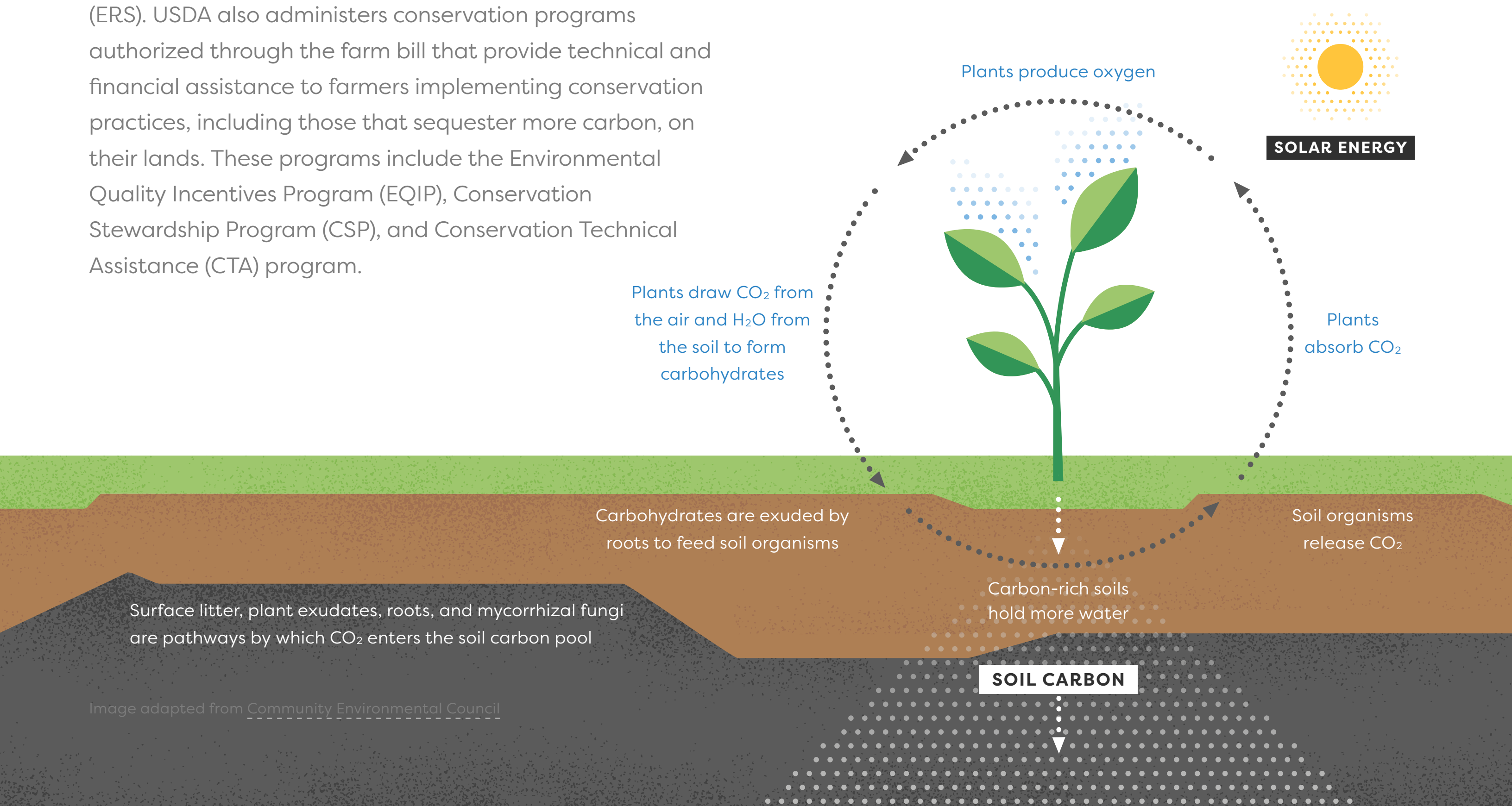

Image adapted from Community Environmental Council

Endnotes

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

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

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