Natural Climate Solutions: Opportunities for Storing Additional Carbon in America's Forests and Farms

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Key Findings

Beyond simply reducing greenhouse gas emissions, removing carbon dioxide from the atmosphere is vital for comprehensive emissions reductions.[1] Fortunately, Mother Nature has perfected high-efficiency, low-cost carbon removal, creating opportunities to manage ecosystems and enhance natural carbon storage across the U.S. and the globe.

Natural climate solutions—defined as agriculture and active land management practices that increase carbon storage and avoid greenhouse gas emissions—are a necessary part of the strategy needed to reduce global emissions. Many of these practices will also increase disaster resilience.

In 2020, American forests and farms reduce, or offset, net total U.S. greenhouse gas emissions by nearly 14 percent each year.

Managed lands—including forests, rangelands, and wetlands—are a net sink for carbon. In 2020, the most recent year for which estimates are available, managed lands in the U.S. removed 812 million metric tons of carbon dioxide from the atmosphere, resulting in a net increase in carbon sequestered on land. In other words, American forests and farms reduce, or offset, net total U.S. greenhouse gas emissions by nearly 14 percent each year.[2]

While implementing natural climate solutions is typically inexpensive, there can be costs associated with changing practices. Advancing natural climate solutions in the U.S. will require good stewardship, not just of the land, but of the financial investment made by taxpayers to support and provide technical assistance to private foresters and farmers.

Applied appropriately, innovative natural climate solutions can raise overall land productivity and play a vital role in tackling climate change. Policies that leverage private sector investment can also be a source of supplemental income for farmers, ranchers, foresters, and other Americans working the land. But such policies should be careful not to incentivize taking fertile American agriculture land out of production. Doing so may not only increase food poverty, but also remove the most efficiently produced agricultural products from the global market, resulting in increased global emissions.

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[1] Rogelj, J., D. Shindell, K. Jiang, S. Fifita, P. Forster, V. Ginzburg, C. Handa, H. Kheshgi, S. Kobayashi, E. Kriegler, L. Mundaca, R. Séférian, and M.V.Vilariño, "2018: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development." *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter2_Low_Res.pdf.

[2] Environmental Protection Agency, "Executive Summary." *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020*, 15 February 2022. https://www.epa.gov/ghgemissions/draft-inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020.

Enhancing nature's role in reducing greenhouse gas emissions

Better land management can increase carbon sequestration

Land-use change occurs when human activities modify a natural landscape, either for agricultural, residential, industrial, mining, or recreational purposes.[3] It can impact watershed function, air and water quality, and wildlife habitats.[4] Greenhouse gases may be released both by the land-use change itself—ecosystems that are natural carbon sinks[5] are modified and the carbon that they stored is released into the atmosphere—and as the human activities carried out on these lands create emissions. In the United States, one of the greatest changes in land use since 2001 has been in forest lands,[6] with a 15 percent decrease in tree cover.[7] With improved conservation, restoration, and management, the carbon sequestration potential of American forests and farmlands can be preserved or improved.

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Managing carbon has important co-benefits

Investments in ecosystem health have numerous benefits beyond carbon sequestration, which occurs when carbon is absorbed and stored in plants and soils. **Ecosystem services** are the many benefits derived from the natural environment. They have varying degrees of value and capacity to be monetized either directly or in terms of increased property values.

Beneficial services provided by healthy ecosystems include, but are not limited to:[8]

- **Erosion control.** Erosion occurs as fertile topsoil is transported from one location to another by wind or water. It is a natural process, but can be accelerated by practices such as overgrazing, soil tillage, land clearing, or clearcutting. It can drastically affect soil quality and may threaten the continuity of human activity on the land in question. Methods such as planting cover crops can reduce erosion by keeping soil in place when wind sweeps over it and reducing the speed of water moving over the soil, thereby decreasing runoff and increasing water infiltration.
- **Water flow and purification.** Ecosystems such as forests improve water quality by limiting runoff, thereby reducing sediment, and trapping other pollutants that would otherwise speedily make it into groundwater or nearby surface waters.

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[3] Environmental Protection Agency. "What are the trends in land use and their effects on human health and the environment?"7 September 2021. https://www.epa.gov/report-environment/land-use.
[4] *Ibid.*
[5] Natural carbon sinks are ecosystems that store more carbon than they emit for an indefinite period of time.
[6] United States Geological Service. "New Land Cover Maps Depict 15 Years of Change across America." 20 May 2019. https://www.usgs.gov/news/national-news-release/new-land-cover-maps-depict-15-years-change-across-america.
[7] Global Forest Watch. "United States deforestation rates and statistics." Accessed July 2022. https://gfw.global/3r6hWMU.
[8] Millennium Ecosystem Assessment. *Ecosystems and Human Well-being: Opportunities and Challenges for Business and Industry*, 2005. http://www.millenniumassessment.org/documents/document.353.aspx.pdf.

- **Pollination.** Pollination by insects, birds, and bats is vital for food production, with around 35 percent of global crop production dependent on pollinators.[9] Estimates for the monetary value of pollination worldwide vary widely, but range between $195 and $387 billion.[10]
- **Natural hazard**. Ecosystems such as wetlands and coral reefs serve as buffers that reduce wave intensity and storm surge during extreme weather events.
- **Air quality**. Forests contribute to improved air quality by filtering pollutants out of the air, as well as trapping particulate matter. In urban settings, tree cover also helps regulate air temperature, helping prevent the formation of pollutants like ground-level ozone, which accelerates in higher temperatures.
- **Food**. Maintaining healthy ecosystems is crucial to preserving our ability to obtain food from them. Maintaining soil health, minimizing erosion, and ensuring adequate water infiltration in agricultural soil increases land productivity. In oceans, phenomena such as marine pollution, overfishing, and illegal fishing threaten fisheries and their ability to supply food. Wild foods, dependent on the preservation of the ecosystems that supply them, also form part of the diets of approximately one billion people across the globe, contributing to food security.[11]
- **Fiber.** Another provisioning ecosystem service is the supply of fiber for human materials and activities: timber for construction, paper, furniture, and fuel; cotton, hemp, and silk for textiles, clothing, and other products.

Different ecosystems like forests, grasslands, and urban areas provide combinations of services to society. The successful generation of these ecosystem services depends on the health, extent of land area, and biodiversity contained by the ecosystem.

Emissions reductions from managed lands could be even more substantial

Natural climate solutions are sustainable land management, conservation, or restoration actions that increase carbon storage and avoid greenhouse gas emissions and can be implemented across a variety of ecosystems.[12] They include forest management to increase carbon stores in forests, increases in tree carbon stocks in cities, wetland restoration, conversion of unproductive agricultural land to forests (afforestation), and crop management practices that increase carbon in agricultural soils.[13]

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[9] Guimarães Porto, Fernandes de Almeida, R., Cruz-Neto, O., Tabarelli, M., Felipe Viana, B., Peres, C.A., Valentina Lopes, A. "Pollination ecosystem services: A comprehensive review of economic values, research funding and policy actions." *Food Security*. 19 May 2020. https://www.researchgate.net/profile/Marcelo-Tabarelli/publication/341500493_Pollination_ecosystem_services_A_comprehensive_review_of_economic_values_research_funding_and_policy_actions/links/5fe488ec92851c13feb5d8a0/Pollination-ecosystem-services-A-comprehensive-review-of-economic-values-research-funding-and-policy-actions.pdf.

[10] *Ibid*.

[11] Bharucha Z. and Pretty, J. "The roles and values of wild foods in agricultural systems." *Philosophical Transactions of the Royal Society B: Biological Sciences.* September 2010. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2935111/#.

[12] Griscom, B., Adams, J., Ellis, P. and Fargione, J. "Natural climate solutions." *Proceedings of the National Academy of Sciences (PNAS),* Vol. 114, No. 44, 16 October 2017. https://www.pnas.org/doi/10.1073/pnas.1710465114.

[13] Economic Research Service, Department of Agriculture, "Climate change," op. cit.

Natural climate solutions could deliver up to 37 percent of the "cost-effective" mitigation of global carbon emissions through 2030 needed to help keep warming below 2 °C. In the U.S., a combination of 21 natural climate solutions could potentially prevent or sequester 1.2 gigatons of carbon by 2025. This is more than one-fifth of our current annual greenhouse gas emissions.

A 2017 study of 20 natural climate solutions showed that they could deliver up to 37 percent of the "cost-effective" mitigation of global carbon emissions through 2030 needed to help keep warming below 2 °C.[14] The research also found that natural climate solutions could often be more cost-effective than many emerging technological solutions.[15] In the U.S., a combination of 21 natural climate solutions (listed in the chart below) could potentially prevent or sequester 1.2 gigatons of carbon by 2025 (Figure 1).[16] This is more than one-fifth of our current annual greenhouse gas emissions.

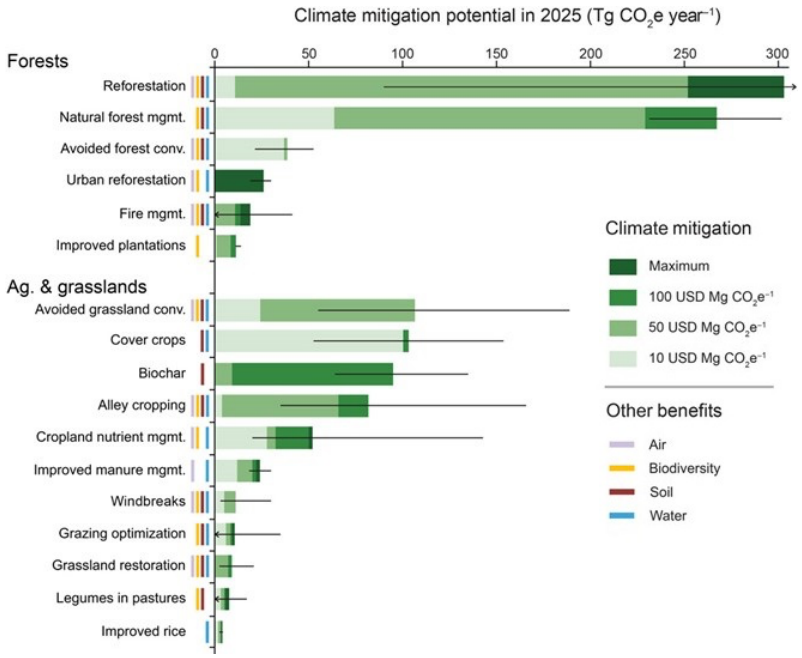

Figure 1: Natural Climate Solutions for the United States

Source: J. E. Fargione et al., "Natural climate solutions for the United States," Science Advances, Vol. 4, Issue 11, 14 November 2018, https://www.science.org/doi/10.1126/sciadv.aat1869. Illustrated above are 21 different types of natural climate solutions in the U.S, which increases with the amount invested in the solution in question ($10, $50, or $100). Colored bars on the left side indicate the ecosystem service benefits of each solution: air (filtration), biodiversity (habitat protection or restoration), soil (enrichment), and water (filtration and flood control).

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[14] Griscom, B., Adams, J., Ellis, P. and Fargione, J. "Natural climate solutions." *Proceedings of the National Academy of Sciences (PNAS),* Vol. 114, No. 44, 16 October 2017. https://www.pnas.org/doi/10.1073/pnas.1710465114.

[15] Ibid.

[16] Fargione, J., Bassett, S., Boucher, T., Bridgham, S., Conant, S., Cook-Patton, S., Ellis, P., Falcucci, A., Fourqurean, J., Gopalakrishna, T., Gu, H., Henderson, B., Hurteau, M., Kroeger, K., Kroeger, T., Lark, T., Leavitt, S., Lomax, G., McDonald, R., Megonigal, J., Miteva, D., Richardson, C., Sanderman, J., Shoch, D., Spawn, S., Veldman, J., Williams, C., Woodbury, P., Zganjar, C., Baranski, M., Elias, P., Houghton, R., Landis, E., McGlynn, E., Schlesinger, W., Siikamaki, J., Sutton-Grier, A., Griscom, B. "Natural climate solutions for the United States," *Science Advances*, Vol. 4, Issue 11, 14 November 2018. https://www.science.org/doi/10.1126/sciadv.aat1869.

Forests

Forests play a vital role in the carbon cycle. Trees sequester carbon from the atmosphere and store it in their biomass. Carbon in forests is also transferred to soil when trees die and decompose. While forests emit carbon when photosynthesis stops at night, during times of stress, or if burned in a fire, they function as a net carbon sink, absorbing twice as much carbon as they emit yearly.[17] Globally, forests capture 1.5 times more carbon every year than annual U.S. carbon emissions.[18] Restoration and effective management of our forested lands offer a significant opportunity for climate mitigation. All of these practices carry commercial potential, including the production of timber and other forest products, while also helping to reduce emissions.

Afforestation and reforestation

Afforestation is the establishment of a forest in an area where the preceding vegetation or land use was not a forest. Reforestation is the re-establishment of forest cover, either naturally or artificially, that usually maintains the same forest type and is done promptly after the previous forest was removed. Both practices can reduce atmospheric carbon dioxide levels by sequestering carbon in tree biomass. Effective land management not only increases carbon sequestration but is essential in reducing wildfire risks. In 2021, wildfires broke emissions records when regions such as North America, Siberia, and the Mediterranean experienced intense and prolonged wildfires.[19]

Proper management of forests would have reduced the severity of these wildfires, thus reducing damage and emissions. Carbon removal from these practices can come at relatively low cost. Generally, the costs for forestry projects can be influenced by several factors, including the tree species involved, type of forestry practice used, the value of using the land for alternative uses (i.e., the opportunity cost), and anticipated changes in forest and agricultural product prices.[20]

Public and private initiatives are emerging to scale up these solutions. A notable project is the One Trillion Trees Initiative, which aims to conserve, restore, and grow one trillion trees worldwide.[21] Studies show that restoring one trillion new trees globally would sequester 205 gigatons of carbon, an amount equivalent to two-thirds of all human emissions in the atmosphere today.[22]

The U.S. Forest Service has been active in reforestation and the management of national forest resources since the agency's inception, with a particular focus on restocking lands deforested as the result of natural catastrophes, excessive cutting, fire, insects, or farming practices of the late 19th and early 20th centuries.[23]

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[17] Harris, N. and Gibbs, D. "Forests Absorb Twice As Much Carbon As They Emit Each Year," World Resources Institute. 21 January 2021. https://www.wri.org/insights/forests-absorb-twice-much-carbon-they-emit-each-year.

[18] *Ibid*.

[19] European Commission. "Copernicus: 2021 saw widespread wildfire devastation and new regional emission records broken," The Copernicus Program. 6 December 2021, https://atmosphere.copernicus.eu/.

[20] Stavins, R.N. and K.R. Richards. 5. The cost of U.S. forest-based carbon sequestration. Pew Center on Global Climate Change

[21] World Economic Forum. "Conserving, restoring and growing 1 trillion trees by 2030." Accessed July 2022. https://www.1t.org/.

[22] Bastin, J., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., Zohner, C.and Crowther, T. "The global tree restoration potential," *Science.* July 2019. https://www.science.org/doi/full/10.1126/science.aax0848.

[23] U.S. Forest Service, U.S. Department of Agriculture. "Reforestation overview." Accessed July 2022.https://www.fs.fed.us/restoration/reforestation/overview.shtml.

Better forest management

A key principle in maximizing carbon storage in large or small forests is restoring the forest ecosystem and allowing, managing, or mimicking natural processes. For example, natural forest management is achieved by extending harvest cycles, or reducing the impact of logging and improved silvicultural practices that release suppressed forest growth. Forest managers can improve plantation carbon sequestration in above- and below-ground tree biomass by extending rotation lengths for a limited time. Some business models for carbon offsets (defined below) focus on extending the current economic optimal rotation length—even by just one year—so it is closer to the biologically optimal rotation length in which harvest occurs when stands reach their maximum annual growth. Additionally, fire management restores frequent, low-intensity, understory fires in fire-prone forest ecosystems where trees have evolved to withstand small fires, to reduce the potential for high-severity wildfires that kill the trees and release the otherwise naturally stored carbon.

Expanding urban forests

Urban forests are important sources of carbon sequestration. Over 141 million acres of America's forests are located in our cities and towns. They include urban parks, street trees, landscaped boulevards, gardens, river and coastal promenades, greenways, river corridors, wetlands, nature preserves, shelter belts of trees, and working trees at former industrial sites. Urban forests, through planned connections of green spaces, are sometimes referred to as "green infrastructure" on which communities depend to help filter air and water, control storm water, conserve energy, and provide animal habitat and shade.[24] Urban forests have important resiliency co-benefits, especially related to water flow, temperature, and erosion control.

Farms

Improving soil health means more carbon storage

U.S. farmers have long recognized the benefits of managing soil health and plant productivity, and many have adopted practices to do so. Soil carbon sequestration increases carbon in the soil and soil organic matter, which is about 60 percent carbon,[25] resulting in healthier soils that produce higher yields. Soil carbon functions as a nutrient sink to trap mineral nutrients that slowly become available to plants. Carbon-rich soils also support a larger population of soil microorganisms, which, in turn, support many processes beneficial to plant growth, such as water retention, soil resilience, and pathogen resistance.[26]

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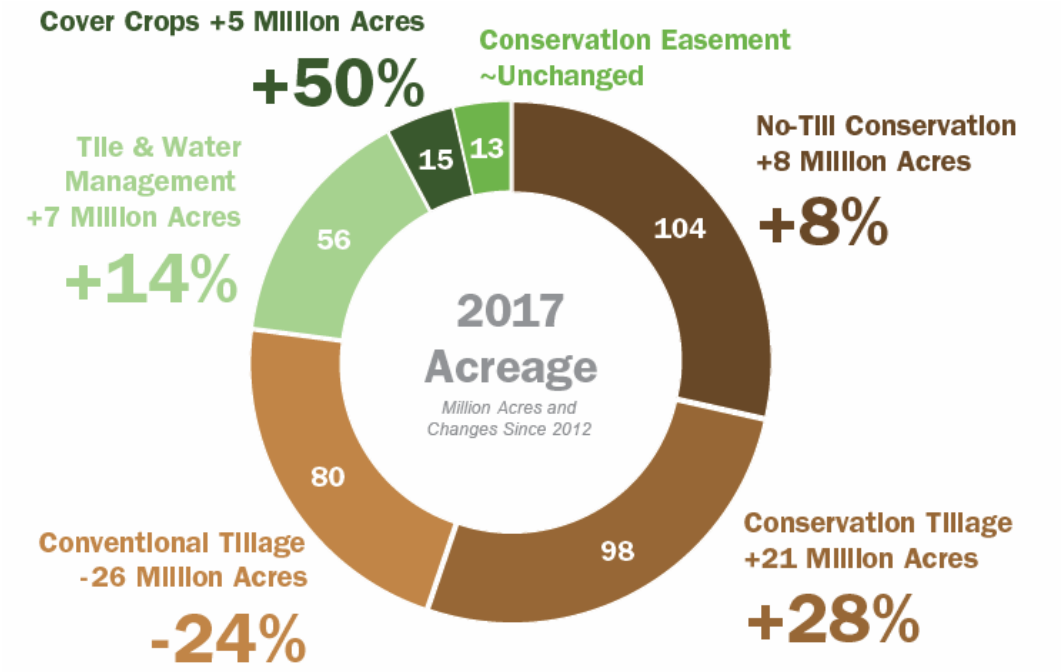
[24] U.S. Forest Service, U.S. Department of Agriculture. "Urban forests." Accessed July 2022. https://www.fs.usda.gov/managing-land/urban-forests.

[25] Food and Agriculture Organization of the United Nations. *Soil Organic Carbon: the hidden potential.* Rome, Italy, 2017.http://www.fao.org/3/a-i6937e.pdf

[26] *Ibid*.



Source: Farmers for a Sustainable Future, June 2019. The figure shows how U.S. farmland changed over the seven-year period from 2021 to 2019. Substantial acreage shifted from conventional tillage to conservation tillage, and cover crops increased by 50 percent, all resulting in better soil health and soil carbon sequestration.

Practices that increase soil carbon pay dividends for the farmers through other ecosystem services like erosion control and water control that may improve on- or near-farm fisheries and animal habitat.

Practices that increase soil carbon pay dividends for the farmers through other ecosystem services like erosion control and water control that may improve on- or near-farm fisheries and animal habitat. Different pathways to increasing soil carbon sequestration include implementing no-till farming, conservation tillage, or planting cover crops. Since 2012, sustainable soil use and resource conservation efforts increased by 34 million acres, or 17 percent.[27]

Tillage is the mechanical manipulation of soil by overturning and stirring to kill weeds and prepare land for cultivation. It makes soil vulnerable to erosion and compaction, however, and increases surface runoff. Conservation tillage reduces the amount of tillage performed and retains some crop residue as soil cover to reduce erosion, which has the added benefit of increased carbon sequestration. No-till farming maximizes soil health and involves seeding without previously disturbing the soil and using techniques such as applying hay or herbicides to prevent weed growth. The use of cover crops can be a companion to conservation tillage or no-till farming and involves planting crops that are not harvested but left on the field to help manage weeds, fixing nutrients in the soil, supporting pollination, reducing erosion and compaction, and increasing soil carbon sequestration.[28]

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[27] See American Farm Bureau Federation. "Farmers for a Sustainable Future." https://www.fb.org/land/fsf

[28] U.S. Department of Agriculture. "Cover cropping to improve climate resilience." Fact Sheet of the U.S. Department of Agriculture Northeast Climate Hub. February 2019. https://www.climatehubs.usda.gov/sites/default/files/CoverCropsFactsheet_Feb2019_web508.pdf.

Investment in technological innovation can also yield promising results for the development of soil-based climate solutions with the potential for near-term widespread deployment. Biochar, for example, is an emerging carbon sequestration tool that can sequester carbon for hundreds of years. It is produced by burning biomass in the absence of oxygen, and its use can produce environmental benefits ranging from improved forest health and resiliency, agricultural productivity, environmental remediation, water quality improvement and retention, and improved soil health.[29]

Financing natural carbon storage

Examples of federal support for private foresters and farmers

The federal government has various forest management and protection programs that support efforts in private and nonfederal public forestland.[30] Most are managed by the U.S. Department of Agriculture (USDA) Forest Service, often in partnership with state agencies. They serve a variety of goals, such as forest conservation and management; protecting forests from threats such as wildfire and pests; and enhancing ecosystem services provided by forests, such as protecting water quality, providing recreation opportunities, and preserving wildlife habitats.[31] These programs provide either technical assistance (such as training in wildfire control or survey methods) or financial assistance (such as support for restoration projects or the purchase of lands at risk of conversion to other uses—usually in the form of grants), or both.[32]

To the benefit of America's farmers, total annual mandatory budget authority for conservation programs has grown from a total of $3.9 billion in FY 2008 to over $6.7 billion in FY 2019.[33] The 2018 Farm Bill reauthorized and amended the major conservation programs and created a number of new pilot programs and initiatives.[34] It provided $62.6 billion in budget authority for dedicated funding over ten years to be used for conservation and energy efficiency programs. The most notable include the Environmental Quality Incentives Program (EQIP), Agricultural Conservation Easement Program (ACEP), Conservation Reserve Program (CRP), and Conservation Stewardship Program (CSP). These programs include environmental co-benefits that protect and improve water quality, soil health, habitat preservation, and air quality.[35] In addition, cover crops that are planted in the 2020 crop year and later can be covered in the crop insurance program.[36]

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[29] U.S. Department of Agriculture. "Biochar." The U.S. Department of Agriculture Northwest Climate Hub. https://www.climatehubs.usda.gov/hubs/northwest/topic/biochar. See also Singh, H., Jatav, Rajput, V., Minkina, T., Singh, S., Chejara, S., Gorovtsov, A., Barakhov, A., Bauer, T., Sushkova, S., Mandzhieva, S., Burachevskaya, M. and Kalinitchenko, V. "Sustainable Approach and Safe Use of Biochar and Its Possible Consequences," *Sustainability.* 13 September 2021. https://www.researchgate.net/publication/354630292_Sustainable_Approach_and_Safe_Use_of_Biochar_and_Its_Possible_Consequences .

[30] Most forestland in the U.S. is privately owned, with 58 percent in the hands of individuals, corporations, families, Native American tribes, and nongovernmental organizations. See *Forest Service Assistance Programs*, Congressional Research Service, 6 January 2022, https://crsreports.congress.gov/product/pdf/R/R45219/7.

[31] *Ibid.*

[32] *Ibid*.

[33] Congressional Research Service, R40763, Agricultural Conservation: A Guide to Programs

[34] Congressional Research Service, R45698, Agricultural Conservation in the 2018 Farm Bill

[35] Economic Research Service, U.S. Department of Agriculture. "Agriculture Improvement Act of 2018: Highlights and Implications."https://www.ers.usda.gov/agriculture-improvement-act-of-2018-highlights-and-implications/conservation/

[36] U.S. Department of Agriculture "Cover crops and federal crop insurance." Risk Management Agency Fact Sheet, Department of Agriculture. June 2019. https://www.rma.usda.gov/en/Fact-Sheets/National-Fact-Sheets/Cover-Crops-and-Crop-Insurance.

The 2018 Farm Bill also contained a new pilot program that promotes and rewards carbon performance on farms. The Soil Health and Income Protection Pilot (SHIPP) program under CRP is designed to incentivize farmers to remove less productive farmland from production and instead receive annual rental payments for planting affordable perennial cover crops.[37] SHIPP gives farmers a flexible option for enhancing the health of their soil and sequestering carbon at the same time.

Opportunities to leverage the private sector

Public-private partnership

Large businesses are becoming more interested in partnering with foresters and farmers to help meet corporate sustainability commitments. This may be particularly beneficial as land managers look to ensure their land's ongoing profitability by adding carbon sequestration as a service they can monetize beyond traditional crops, livestock, timber, or other products.

To this end, Congress should consider authorizing the U.S. Department of Agriculture (USDA) to receive contributions for private-sector partnership to increase the total funds available for conservation programs, including conservation programs offered by the Natural Resources Conservation Service (NRCS), a USDA agency that helps farmers, ranchers, and forest landowners to maintain the health and sustainability of working lands. This would provide the opportunity for voluntary private-sector dollars to leverage existing federal programs and further utilize natural climate solutions and conservation efforts.

Voluntary offset credits

As private-sector commitments to climate action gain momentum, many companies are increasingly adopting strategies that include purchasing certified emission reduction credits—or carbon offsets—as part of the effort. Based on current net-zero goals from more than 700 of the world's largest companies, there have already been commitments of carbon credits of around 0.2 gigatons (Gt) of carbon by 2030. As a core component of corporate climate mitigation, natural climate solutions are thus becoming mainstream, if not yet commonplace. Natural climate solutions now account for around 40 percent of retired carbon credits in voluntary carbon markets, up from only five percent in 2010.[38] Leaders are also investing directly in nature through protecting and restoring large expanses of land and ocean.[39]

Natural climate solutions now account for around 40 percent of retired carbon credits in voluntary carbon markets, up from only five percent in 2010.

Carbon offsets are created by farmers or land managers that undertake projects or activities that reduce, avoid, or sequester carbon. These credits can be purchased to compensate for or cancel carbon emissions that occur elsewhere.

As demand for offsets has grown, so has the number of entities that generate offsets, and a patchwork

[37] Congressional Research Service, R45698, Agricultural Conservation in the 2018 Farm Bill
[38] McKinsey & Company. "Why investing in nature is key to climate mitigation." McKinsey Sustainability. 25 January 2021. https://www.mckinsey.com/business-functions/sustainability/our-insights/why-investing-in-nature-is-key-to-climate-mitigation.
[39] McKinsey & Company and World Economic Forum . "Why investing in nature is key to climate mitigation." 25 January 2021. https://www.mckinsey.com/business-functions/sustainability/our-insights/why-investing-in-nature-is-key-to-climate-mitigation.

of standards and systems has emerged around the country to match market demand for carbon emissions reductions with a supply of carbon credits. Companies developing or brokering offsets often use registries to track buying and selling of certified or verified offsets, to make sure that a credit is used only once (by retiring the offset once it has been claimed). There are multiple registries in the U.S. and around the world. While some are linked, there is no universal carbon offset registry.

There are also numerous standards and protocols for assessing and certifying offsets. Assessing the validity of projects, and the level of emissions reduction or avoidance that the project is estimated to achieve, is a challenging process, and each trading system approaches it differently. This heterogeneity means that the credit corresponding to a particular emissions-reducing action might be measured in different ways, with different results, by different systems.

Furthermore, no single coordinating entity exists to certify protocols and assure that quality accounting methodologies are being used or provide the necessary confidence to potential market participants. This has created challenges for farmers, ranchers, and land managers who otherwise would have an interest in participating in these markets.

As a result, the quality of offsets is a significant concern. For example, voluntary carbon offsets from forestry projects can be complex and controversial given concerns about permanence.[40] The rapid growth of the offset market has made it increasingly difficult for buyers and regulators to evaluate the emissions reduction or abatement that a project will purportedly achieve, monitor project status and outcomes, and ensure that the offset is appropriately retired. As systems become increasingly linked, the need for more rigid standards and transparency is even greater.

Finally, offsets require some validation of project design and verification of the reductions in emissions achieved by the project. Verification can be especially complex, given that for some projects, emissions reductions may occur over a long period of time, and will not be consistent from year to year. Emissions reductions can also be impacted by unanticipated and uncontrollable variables, such as weather or natural disasters.

In an effort to apply more rigorous quality-assurance practices to the market, numerous voluntary standards have been developed for projects and for offset retailers, most of which include three key components:

- First, accounting standards can include methodologies for assessing baselines and additionality, validating project activities, and determining project eligibility, among other things.
- Second, monitoring, validation, and certification standards ensure that projects deliver the results anticipated and quantify carbon savings.
- Finally, registration and enforcement systems address offset credit ownership issues (which facilitates trading) and retirement of offsets.[41]

However, many foresters and farmers may not have the technical expertise to engage with existing voluntary carbon markets.

In order for American farmers and ranchers to have adequate knowledge of and confidence in these

[40] Ramseur, J. "Voluntary Carbon Offsets: Overview and Assessment." Congressional Research Service. Order Code RL34241. 2007.
[41] Kollmuss, A., M. Lazarus, C. Lee, and C. Polycarp. "A review of offset programs: trading systems, funds, protocols, standards, and retailers" (Version 1.0). Prepared for USEPA by The Stockholm Environmental Institute under contract number: 68-W-06-010.

voluntary offset markets, the USDA should provide technical assistance to land managers who want to seek out opportunities to monetize their stewardship. Congress should also consider authorizing a USDA program to validate methodologies and a rigorous certification of third-party validators to give American farmers and ranchers both information and confidence in engaging in these voluntary markets.

The Growing Climate Solutions Act embraces a voluntary approach to addressing climate change and empowers farmers, ranchers, and private forest landowners to engage in voluntary carbon credit markets to monetize conservation practices that will reduce emissions and improve land productivity.

An example of legislation that embodies these types of policies is the Growing Climate Solutions Act, which passed the U.S. Senate in 2021. It embraces a voluntary approach to addressing climate change and empowers farmers, ranchers, and private forest landowners to engage in voluntary carbon credit markets to monetize conservation practices that will reduce emissions and improve land productivity. The legislation seeks to provide reliable information to farmers, foresters, and ranchers on voluntary carbon markets and potential economic benefit that comes from using natural climate solutions to generate carbon credits.[42]

Conclusion

There is no substitute for the efficiency and low-cost opportunity associated with natural climate solutions on managed lands. Farmers and foresters can maximize harvests and the productivity of their lands and maximize carbon benefits at the same time.

Natural ecosystems currently are an important carbon sink, offsetting and reducing overall U.S. greenhouse gas emissions. Ecosystem restoration and on-farm technological improvements offer important pathways to further reduce greenhouse gas emissions. Doing so will also increase the natural resiliency of local communities. Healthy ecosystems help reduce flood risks, reduce fire risk, reduce erosion, increase local pollinator populations, and are important spaces for recreation.

To these ends, opportunities for public-private partnership, or direct private investment, should not be overlooked to incentivize land managers to implement natural climate solutions.

Private-sector investment through the voluntary development and sale of carbon offsets may be a useful tool for some farmers to diversify and add new revenue streams without reducing productivity. Limited-government, principled policies should be utilized to empower farmers, ranchers, and private forest landowners to implement best practices that will sequester emissions while also improving land productivity.

[42] "Growing Climate Solutions Act reintroduced," U.S. Senate Committee on Agriculture, Nutrition and Forestry, 20 April 2021. https://www.agriculture.senate.gov/newsroom/dem/press/release/growing-climate-solutions-act-reintroduced.