
# Agriculture and Forestry Offsets in Carbon Markets: Background and Selected Issues

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# Agriculture and Forestry Offsets in Carbon Markets: Background and Selected Issues

SUMMARY

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The number of private *carbon market programs* (also known as *carbon market initiatives*) that pay farmers, ranchers, and forest landowners (*participants*) to generate carbon offsets for use in carbon markets has grown in recent years. Such programs promise to financially compensate participants for implementing *climate-smart* practices that reduce greenhouse gas (GHG) emissions associated with agriculture (e.g., carbon dioxide [$CO_2$], methane, nitrous oxide) or sequester carbon in soil and plants (e.g., crops, trees). Through hearings and proposed legislation, Congress has considered what role, if any, the federal government might play with respect to agriculture and forestry offsets and carbon markets.

*Carbon market* generally refers to an economic framework that supports buying and selling of environmental commodities that signify GHG emission reductions or sequestration. Governments and private entities typically create carbon markets to support climate change objectives that include mitigating GHG emissions. Carbon markets can include both carbon-based GHG emissions (e.g., $CO_2$, methane) and non-carbon-based emissions (e.g., nitrous oxide). Carbon markets generally fall into two broad categories: *compliance markets* and *voluntary markets*. Compliance markets—for example, the Regional Greenhouse Gas Initiative (RGGI, a regional cap-and-trade program involving 11 states) and California's cap-and-trade program—typically support a program requiring certain entities to cap or reduce their GHG emissions. Voluntary markets give businesses, organizations, and individuals that are not regulated in terms of GHG emissions the opportunity to purchase carbon offsets to support a range of objectives.

Agriculture and forestry activities are sources and sinks of GHG emissions. Agriculture is a net emitter of GHGs, and forestry results in net sequestration. According to the U.S. Environmental Protection Agency (EPA), agriculture contributed 10% of all U.S. GHG emissions in 2019. EPA also estimates that carbon sequestration through agriculture and forestry reduced gross U.S. GHG emissions by 12% in 2019. Some research estimates that agriculture and forestry have the potential to increase their current levels of carbon sequestration. Collectively, these estimates suggest that the agriculture and forestry sectors could play key roles in meeting U.S. GHG emission reduction goals.

*Carbon offsets* (also known as *carbon credits*) represent an amount of avoided or reduced emissions, or sequestered carbon. Agricultural producers can generate carbon offsets by beginning new practices, such as cover cropping or installing methane digesters to manage livestock waste. Forest landowners can generate offsets through new afforestation or reforestation projects, among others. The quality of carbon offsets may be considered in terms of broad metrics, including *realness*, *additionality*, *leakage*, *permanence*, and *verification*. Offsets viewed as high quality are generated by implementing GHG mitigation *protocols* (or *methodologies*) accounting for each of these metrics. Protocols are specific to individual GHG mitigation practices (e.g., cover cropping, no-till farming, reforestation), and they standardize the measuring, reporting, and verification (MRV) requirements for generating carbon offsets. Protocols generally require that *third-party verifiers* independently confirm the requirements of the protocol were met. Once verified, a carbon offset may be registered with a *carbon registry* and sold to a *purchaser* (e.g., private company, individual) on compliance or voluntary markets.

Currently, the U.S. Department of Agriculture (USDA) is not directly involved in carbon markets. USDA personnel do implement policies, conduct research, and collect data that may be useful to existing or potential carbon markets. Such policies and activities involve USDA's Office of Environmental Markets; Forest Service; Agricultural Research Service; Economic Research Service; Natural Resources Conservation Service; and other agencies and offices.

Certain legislation introduced in the 117th Congress would address agriculture and forestry offsets and carbon markets. The Growing Climate Solutions Act of 2021 (S. 1251/H.R. 2820) would create a USDA certification program for third-party verifiers and technical assistance providers and would require USDA to establish and maintain a list of USDA-backed protocols. The Rural Forest Markets Act of 2021 (S. 1107/H.R. 3790) would direct the Secretary of Agriculture to establish a program within USDA to provide financing to facilitate the sale of forest carbon offsets in carbon markets. These bills would not set a price for carbon, create a federal carbon bank, or create or regulate a carbon market.

Carbon markets and carbon offsets in the agriculture and forestry sectors raise numerous questions for ongoing policy consideration, including questions about

- who benefits financially from such programs;
- the appropriate role, if any, for federal engagement;
- whether or how to reward *early adopters* (e.g., participants who implemented climate-smart practices before financial rewards became available);
- equity and access for potential participants of different financial means and operating circumstances; and
- other approaches to achieving GHG mitigation goals that may not involve agriculture and forestry in voluntary carbon markets.

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# Introduction

Congress has debated what policies, if any, the federal government should adopt to address climate change by reducing greenhouse gas (GHG) concentrations in the atmosphere.[1] Greenhouse gas mitigation includes both reducing GHG emissions and increasing carbon sequestration. Practices that reduce GHG emissions and increase carbon sequestration (storage) in the agriculture[2] and forestry sectors have the potential to play a key role in mitigating U.S. GHG emissions. These sectors are both sources and sinks of GHG emissions. According to estimates published by the U.S. Environmental Protection Agency (EPA), agriculture contributed 10% of U.S. GHG emissions in 2019.[3] The same year, EPA estimates indicate that net sequestration in the land use, land-use change, and forestry (LULUCF) sector—that includes agricultural and forested lands—reduced gross U.S. GHG emissions by 12%.[4]

Various policy tools exist to support GHG mitigation in the agriculture and forestry sectors. This report discusses carbon offsets in the agriculture and forestry sectors and their use in carbon markets. A *carbon offset* is a measurable reduction, avoidance, or sequestration of GHG emissions used to counter (i.e., offset) GHG emissions generated at another location. Carbon offset projects often involve activities in the forestry and agriculture sectors. Carbon offsets can be a valuable commodity in carbon markets. A *carbon market* is an economic framework that supports the buying and selling of environmental commodities that signify GHG emission reductions or sequestration.

Generating and using carbon offsets from agriculture and forestry can be complex, requiring technical expertise and familiarity with how carbon markets operate. In recent years, a number of carbon market programs have arisen to assist farmers, ranchers, and forest landowners (participants) to participate in carbon markets. Carbon market programs can provide participants with technical guidance, and they may be able to reduce costs by providing services to multiple participants and by aggregating their carbon offsets for sale to purchasers.

As described in this report, carbon offsets and carbon markets can be a part of both voluntary and mandatory policy approaches to GHG mitigation. Although the development and use of carbon offsets in carbon markets do not require federal intervention, this report discusses congressional deliberations and potential questions regarding roles the federal government could play in shaping and facilitating the use of carbon offsets from agriculture and forestry in carbon markets. It also discusses stakeholder perspectives and highlights issues for potential congressional consideration. Discussion of other policy tools to achieve GHG mitigation—such as regulation of GHG emissions in agriculture and forestry—is beyond the scope of this report.

[1] Greenhouse gases (GHGs) in the atmosphere trap radiant energy, warming the earth's surface and oceans. The primary GHGs emitted by humans include carbon dioxide ($CO_2$), methane, nitrous oxide, sulfur hexafluoride, chlorofluorocarbons, hydrofluorocarbons, and perfluorocarbons. $CO_2$ emissions account for 80% of total GHG emissions in the United States. See U.S. Environmental Protection Agency (EPA), *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, April 2021. Worldwide, $CO_2$ emissions account for approximately 74% of total GHG emissions, according to the Climate Watch database (https://www.climatewatchdata.org).

[2] Throughout this report, *agriculture* refers to on-farm production of food, feed, or fiber and does not include processing, transportation, or storage of agricultural goods.

[3] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, April 2021.

[4] Ibid.

# Carbon Markets: Overview and Key Elements

A *carbon market* generally refers to an economic framework that supports the buying and selling of environmental commodities that signify GHG emission reductions or sequestration. Governments and private entities typically create carbon markets to support climate change mitigation objectives. These objectives often include the reduction, avoidance, or sequestration of GHG emissions, such as carbon dioxide ($CO_2$), methane, and nitrous oxide, among others. Carbon markets can include both carbon-based GHG emissions, such as $CO_2$ and methane, and non-carbon-based emissions, such as nitrous oxide or certain fluorinated gases. Carbon markets can also support other objectives, such as conservation of forests, soils, or biodiversity.

A carbon market can take several different forms depending on its specific structure and context. The operations of a carbon market may involve a number of entities, groups, or organizations. The following bullets briefly introduce some of the key terms involved in carbon market discussions and subsequent sections of this report.

- **Carbon offsets** represent a measurable reduction, avoidance, or sequestration of GHG emissions. Farmers, ranchers, and forest landowners can create carbon offsets by implementing eligible projects or activities. Carbon offsets have monetary value and may be tradeable instruments in both compliance and voluntary carbon markets.
- **Compliance carbon markets** support a regulatory program that requires GHG emission reductions from particular emission sources. A traditional example of such a mandatory program is a GHG emission cap-and-trade system, which creates a cap on GHG emissions for covered entities while providing flexibility in how these entities comply. In some cases, covered entities may be able to use carbon offsets as a compliance option.
- **Voluntary carbon markets** encompass the voluntary buying and selling of carbon offsets outside of a regulatory framework. There is no single voluntary carbon market or authoritative marketplace. Carbon offset transactions can occur directly between participants and buyers, or they can be mediated by other parties or programs.
- **Participants** in carbon markets include farmers, ranchers, and forest landowners who implement certain agriculture and forestry practices that have been shown to reduce GHG emissions or sequester carbon. These practices may generate carbon offsets, a tradeable commodity in carbon markets.
- **Purchasers** of carbon offsets include entities that use the offsets to comply with mandatory emission-reduction requirements or corporations and individuals pursuing voluntary GHG emissions reduction goals.
- **Carbon market programs** enroll participants and offer financial opportunities for implementing specified practices that are associated with GHG mitigation in agriculture and forestry.
- **Carbon registries** track the ownership of carbon offset projects and issue offset credits for verified and certified units of emission reductions or removal. Carbon registries may serve as carbon standards, establishing general rules and requirements for certifying carbon offsets; accreditors of third-party verifiers of carbon offset projects; and developers and approvers of carbon offset protocols.

- **Technical assistance providers** advise participants on implementing agriculture and forestry practices associated with generating carbon offsets.
- **Third-party verifiers** are individuals who are not participants and who are not employees of carbon market programs, who verify that participants correctly implemented carbon offset protocols.

## Carbon Offsets

A carbon offset is a measurable reduction, avoidance, or sequestration of GHG emissions used to compensate for emissions elsewhere.[5] Offset projects often involve land-based activities, particularly projects in the forestry and agriculture sectors. Forest landowners can generate offsets through afforestation (i.e., establishing tree cover on previously unforested lands) and reforestation projects, among others. Agricultural producers can generate carbon offsets by beginning new practices, such as cover cropping or installing methane digesters to manage livestock waste. As offset projects can involve different GHGs, they are typically quantified in terms of metric tons of $CO_2$-equivalent ($MTCO_2e$).[6]

Carbon offsets are key instruments in both compliance and voluntary carbon markets. Many compliance market frameworks, such as cap-and-trade programs, allow covered entities to use a limited number of carbon offsets to help achieve compliance. In voluntary markets, companies and other entities may purchase unlimited offsets to pursue voluntary GHG emissions reduction goals.

The option to use carbon offsets could allow some entities to continue with their current emission levels, or perhaps even to increase them, depending on the circumstances. This may raise concerns at facilities such as fossil-fuel-fired electric power plants or petroleum refineries that produce both GHG emissions and traditional air pollutants. Such pollutants may present risks to human health on a local or regional scale, while GHG emissions present risks on a global scale.[7] The ability of industrial facilities to use carbon offsets in lieu of directly reducing their onsite GHG emissions has sometimes raised concerns[8] that some stakeholders categorize as an "environmental justice" issue.[9] This issue is beyond the scope of this report.

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[5] A *carbon offset* is a tradeable instrument that may be certified to represent an amount of carbon dioxide equivalent reduced, avoided, or sequestered, which can be sold to another party to compensate for its GHG emissions. Some entities—including many carbon market programs in agriculture and forestry—instead use the term, *carbon credit*. These terms are generally interchangeable, and in this report, we preferentially use the term *carbon offset*.

[6] *$CO_2$ equivalents* are used because GHGs vary by global warming potential (GWP). GWP is an index developed by the Intergovernmental Panel on Climate Change (IPCC) that allows comparisons of the heat-trapping ability of different gases over a period of time, typically 100 years. Consistent with international GHG reporting requirements, EPA's most recent GHG inventory (with data from 2019) uses the GWP values presented in the IPCC's 2007 Fourth Assessment Report. For example, based on these GWP values, a ton of methane is 25 times more potent than a ton of $CO_2$ when averaged over a 100-year time frame.

[7] The Clean Air Act regulates air pollutants, such as sulfur dioxide and nitrogen oxide. Whether and how carbon offsets might affect air quality and compliance with federal and state air pollution laws are beyond the scope of this report.

[8] For example, environmental justice concerns regarding offsets have generated considerable interest in the context of California's cap-and-trade program, which allows offsets as a compliance alternative. For more information, see CARB, "Cap-and-Trade FAQ," https://ww2.arb.ca.gov/resources/documents/faq-cap-and-trade-program. See, for example, Danae Hernandez-Cortes and Kyle C. Meng, *Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market*, National Bureau of Economic Research, 2020; and Lara J. Cushing et al., *A Preliminary Environmental Equity Assessment of California's Cap-and-Trade Program*, University of Southern California Dornsife Equity Research Institute, 2016.

[9] There is no definition of *environmental justice* in federal law. Some have interpreted the terms "environmental justice

### Offset Quality and Credibility

A primary concern regarding the use of offsets in compliance and voluntary markets is their quality and credibility. The availability of offsets that do not actually reduce GHG load in the atmosphere could undermine the overall policy goal of achieving specific GHG emission reductions. Problems with offset quality and credibility can raise questions about the effectiveness of compliance and voluntary markets. Research and policy measures have sought to correct such problems as the markets have evolved.[10]

The quality and credibility of carbon offsets may be considered in terms of broad metrics including *realness, additionality, leakage, permanence,* and *verification* (see the **text box** for definitions). Offsets viewed as high quality are generated by implementing GHG mitigation *protocols* that account for each of these metrics.[11] Protocols are specific to individual GHG mitigation practices (e.g., cover cropping, afforestation), and they standardize the measuring, reporting, and verification (also referred to as MRV) requirements for generating carbon offsets.

**Selected Metrics for Carbon Offset Quality and Credibility**

***Realness*** refers to whether the offset represents an actual and quantifiable amount of carbon sequestration or reduction in GHG emissions.

***Additionality*** means that the GHG mitigation would not have occurred without the purchase of the carbon offset. As such, participants do not generally earn offset credits for the continuation of existing practices and activities, but rather for the initiation of new practices and activities.

***Leakage*** refers to an increase in GHG emissions outside of the project area in response to decreases in production within the project area. High-quality carbon offsets are generated with processes that take steps to prevent leakage.

***Permanence*** refers to the duration of stored carbon. Many carbon standards require 100-year permanence. Carbon registries can address the risk of impermanence by holding some offset credits in reserve. All or some of these *reserve offset credits* can be cancelled if a certain amount of the stored carbon is released before the agreed duration is reached.

***Verification*** is making sure that the offsets were quantified correctly – a process usually conducted by a third party (i.e., not the project developer, participant, or purchaser).

## Carbon Markets

The two general categories of carbon markets—compliance carbon markets and voluntary carbon markets—are described below.

(or injustice)" and "environmental equity (or inequity)" broadly to describe the perceived disproportionate impacts of pollution across populations that possess different demographic characteristics (e.g., age, gender, race, national origin, occupation, income, or language). See CRS In Focus IF10529, *Role of the U.S. Environmental Protection Agency in Environmental Justice*, by David M. Bearden and Angela C. Jones.

[10] For more information and analyses of these issues, see Government Accountability Office (GAO), *Climate Change Issues: Options for Addressing Challenges to Carbon Offset Quality*, GAO-11-345, February 2011; and GAO, *Carbon Offsets: The U.S. Voluntary Market is Growing, but Quality Assurance Poses Challenges for Market Participants*, GAO-08-1048, August 2008.

[11] For specific information regarding the generation of carbon offsets in agriculture and forestry, see "Agricultural Offsets and Carbon Markets" and "Forest Offsets and Carbon Markets."

## Compliance Carbon Markets

Compliance carbon markets typically support a regulatory program that requires GHG emission reductions.[12] An example of a compliance market framework is a GHG emission cap-and-trade system, which creates a cap on GHG emissions for covered entities (e.g., fossil-fuel-fired power plants) while providing the sources with flexibility—whether to use on-site reduction or emissions trading, among other possibilities—when complying with the emissions cap. There are currently two compliance markets in the United States: California's cap-and-trade program and the Regional Greenhouse Gas Initiative (RGGI) that operates in 11 states.[13] **Appendix A** provides details about these markets and the European Union's Emissions Trading System (ETS).

In a cap-and-trade system, entities subject to the cap are often referred to as covered entities. Covered entities may include facilities that directly release GHG emissions, such as fossil fuel-fired electric power plants or specific industrial operations, which generally include facilities in carbon-intensive industries like steel, cement, and chemical manufacturing.

To date, proposed legislation that would cap GHG emissions would not include agricultural facilities, such as farms and livestock operations, in the list of covered entities.[14] Including facilities in the agriculture sector as covered entities could pose some implementation challenges because some agriculture-related emissions are released from a relatively large number of discrete sources, including crop and animal operations.[15]

Whether or not these agricultural operations are directly subject to an emissions cap, they could be impacted by a federal cap-and-trade system. Generally, a cap on GHG emissions or the fossil fuels that generate them is expected to increase the prices of fossil fuels, as well as the prices of goods and services produced using these materials, such as electricity.[16] This outcome is inherent to a GHG emission cap because the cap is intended to (a) increase the relative price of more-carbon-intensive energy sources compared with less-carbon-intensive alternatives, (b) encourage innovation in less-carbon-intensive technologies, and (c) promote other activity (e.g., energy efficiency) that may decrease emissions. These expected outcomes will have some economy-wide impacts, affecting the agricultural sector and a wide range of other sectors. The ultimate impacts would depend on the design and specific circumstances of the federal program.

In a cap-and-trade program, an emissions cap is partitioned into emission allowances (or permits). Typically, in a GHG cap-and-trade system, an *emission allowance* represents the authority to emit one $MTCO_2e$—the same measure used for carbon offsets. At the end of each established compliance period (a calendar year or multiple years), covered entities submit emission allowances to an implementing agency to cover the number of tons emitted during the period.

[12] Compliance carbon markets may also be described as regulatory or mandatory carbon markets.

[13] For more information on California's cap-and-trade program, see California Air Resources Board (CARB), "FAQ Cap-and-Trade Program," https://ww2.arb.ca.gov/resources/documents/faq-cap-and-trade-program. The RGGI states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey (rejoined in 2020), New York, Rhode Island, Vermont, and Virginia (joined in 2021). For more information on RGGI, see CRS Report R41836, *The Regional Greenhouse Gas Initiative: Background, Impacts, and Selected Issues*.

[14] See CRS Report R45472, *Market-Based Greenhouse Gas Emission Reduction Legislation: 108th Through 117th Congresses*. Some recent proposals would provide a rebate to farms for the increased costs of fuels (e.g., gasoline) resulting from the carbon price on fossil fuels (e.g., H.R. 2307).

[15] According to the U.S. Department of Agriculture's (USDA's) 2017 Census of Agriculture, there are more than two million farms in the United States and over 93.6 million cattle, among other livestock. USDA National Agricultural Statistics Service, "Table 1. Historical Highlights," *2017 Census of Agriculture*, 2019.

[16] For more discussion, see CRS Report R45625, *Attaching a Price to Greenhouse Gas Emissions with a Carbon Tax or Emissions Fee: Considerations and Potential Impacts*.

Generally, if an entity did not provide enough allowances to cover its emissions, it would be subject to penalties.[17] Depending on the cap-and-trade design, an entity may acquire sufficient allowances by buying them from the implementing agency, from another covered entity that may have excess, or in a commodities market, while some systems allocate allowances for free, at least for an initial period.

Under an emissions cap, some covered entities may have a financial incentive to make reductions beyond what is required, because they can (1) sell unused emission allowances to entities that face higher costs to reduce their facility emissions, (2) reduce the number of emission allowances they need to purchase, or (3) bank emission allowances—if allowed—to use in a future compliance period.

When entities are allowed to buy and sell emission allowances, a cap-and-trade system creates an emissions trading market, like a commodities market. This is why cap-and-trade is often called a "market-based mechanism." Depending on design details, emission allowance trading may involve not only sources directly subject to an emissions cap but also a range of brokers and intermediaries.

### *Carbon Offsets in Compliance Carbon Markets*

A primary benefit of carbon offsets in a compliance market could be improved cost-effectiveness of the overall GHG reduction program. Carbon offsets would provide additional emission reduction or sequestration opportunities—beyond those available at covered entities. Instead of making direct, onsite reductions, such as installing new equipment or improving operational efficiency, covered entities could purchase offset credits, which represent emission reductions or sequestration from other sources, such as agriculture and forestry operations. In some cases, the offset credits would present a lower-cost alternative to onsite emission reductions, thus lowering the cost of compliance for covered entities.

The ability to generate and sell offset credits in a compliance market could provide a financial incentive for non-covered sources to reduce, avoid, or sequester emissions. As previously noted, non-covered sources in compliance frameworks often include agricultural operations and forestry activities. Sequestration from land use activities, particularly in the forestry sector, offers the potential for further reductions in net GHG emissions. A compliance market that allows these activities as carbon offsets could support objectives of overall reductions in U.S. GHG emissions by providing a financial incentive to reduce or sequester emissions in these sectors. As discussed in **Appendix A**, the California and RGGI cap-and-trade systems both allow for carbon offsets from selected agricultural and forestry activities.

The use of carbon offsets raises similar concerns in both compliance and voluntary carbon markets. These include concerns related to the quality and credibility of offsets (see "Offset Quality and Credibility").

## Voluntary Carbon Markets

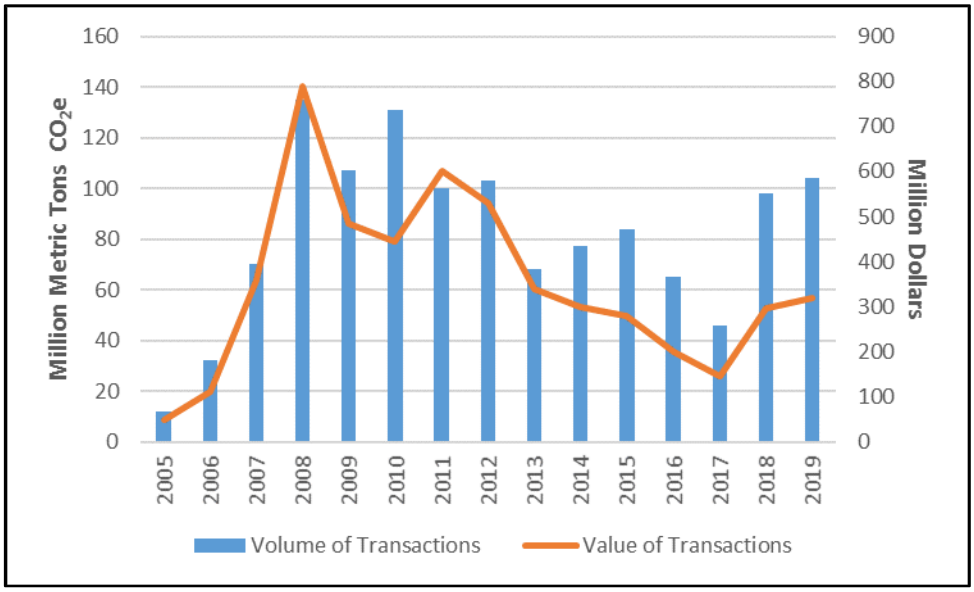
In the United States and around the world, a number of businesses, interest groups, organizations, and individuals are purchasing carbon offsets. These exchanges represent a voluntary market (or noncompliance market) for offsets, because these parties are not required to directly reduce their emissions or purchase offsets. The motivating factors for these purchases may vary. For example, some businesses and individuals may value their contribution to abating climate change, or be

[17] For additional details, see CRS Report R45625, *Attaching a Price to Greenhouse Gas Emissions with a Carbon Tax or Emissions Fee: Considerations and Potential Impacts*.

seeking to enhance their public image, for example by claiming that all or part of their GHG-emitting activities (e.g., travel or specific events) are "carbon neutral." Others may hope to take credit for the offsets in a future program that includes a compliance market, a possibility that would depend on the details of the future program.[18] Others may see a value in gaining experience in a carbon market to give them advantage in a future compliance market.

**Figure 1** illustrates the estimated volume and value of voluntary carbon market transactions between 2005 and 2019, based on survey data collected by Ecosystem Marketplace. According to these global data, in 2019, renewable energy projects, and forestry and land-use projects, accounted for 42% and 37%, respectively, of the volume of transactions.[19] As the figure indicates, estimated global offset transactions in 2018 were approximately 100 $MMTCO_2e$.[20] This volume of offsets is far smaller than total U.S. and global GHG emissions. As a point of reference, U.S. total emissions were 6,677 $MMTCO_2e$ out of total global GHG emissions of over 47,000 $MMTCO_2e$ in 2018.[21]

**Figure 1. Estimated Worldwide Volume and Value of Carbon Offset Transactions in Voluntary Carbon Markets**




**Source:** Prepared by CRS; data from Forest Trends' Ecosystem Marketplace, *Voluntary Carbon and the Post-Pandemic Recovery, State of Voluntary Carbon Markets Report*, September 2020, https://wecprotects.org/wp-content/uploads/2020/11/EM-Voluntary-Carbon-and-Post-Pandemic-Recovery-2020.pdf.

**Notes**: Carbon offsets in the figure include seven broad categories: renewable energy; forestry and land use; waste disposal; household devices; chemical processing/industrial manufacturing; energy efficiency/fuel switching; and transportation. According to the Ecosystem Marketplace report, "most voluntary offsets are transacted

[18] For example, policymakers may decide not to include emission reductions achieved from certain projects or from activities conducted before the compliance program began. When designing a mandatory emission reduction program, this issue is often a subject of considerable debate.

[19] Forest Trends' Ecosystem Marketplace, *Voluntary Carbon and the Post-Pandemic Recovery, State of Voluntary Carbon Markets Report*, September 2020.

[20] One $MMTCO_2e$ equals one million $MTCO_2e$.

[21] Although 2019 is the most recent year of GHG emissions data in the United States, global emissions data are current through 2018. Therefore, U.S. data are from EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018*, 2020. Global data are based on the most recent data (2018) for all countries from Climate Watch (managed by the World Resources Institute), https://www.climatewatchdata.org.

bilaterally and over-the-counter, with no centralized repository for price and volume data. Ecosystem Marketplace gathers this fragmented data by reaching out to all known market participants individually with a globally recognized "Ecosystem Marketplace Carbon Survey." The dollar values are not adjusted for inflation.

A variety of different entities buy and sell carbon offsets in the various voluntary markets. The quality of the offsets in the voluntary markets varies because there is no recognized central authority and no universally accepted standards or guidelines for generating offsets (see the **text box** "Selected Metrics for Carbon Offset Quality and Credibility"). Some sellers offer offsets that comply with relatively rigorous, independent standards. Others sellers offer offsets that meet the seller's self-established guidelines.

## Carbon Registries and Programs

Carbon registries support carbon markets by tracking the ownership of offset projects, such as agricultural and forestry projects, and issuing offset credits for units of emission reductions or removal that have been verified and certified.[22] To avoid double-counting concerns, registries assign offset credits with serial numbers. If an entity, such as a covered emission source, submits the offset credit for compliance purposes or a company or individual claims a reduction in a voluntary market, the registry retires the serial number. In both compliance and voluntary carbon markets, carbon registries play a key role. Some carbon market frameworks require that carbon offsets originate from specifically approved registries.

A selection of carbon registries is listed below.

- Verra Registry (a program under Verra)[23]
- American Carbon Registry[24]
- Climate Action Reserve[25]
- The Gold Standard[26]

Some carbon markets allow only offsets from certain carbon registries for use in their markets. For example, the Verra Registry, the American Carbon Registry, and Climate Action Reserve are approved registries in California's cap-and-trade program, whereas The Gold Standard is not an approved registry for California's program but is used by other programs. According to the 2020 Ecosystem Marketplace report, offsets issued under Verra (formerly the Verified Carbon Standard) accounted for the largest percentage (over 40%) of offsets transacted in voluntary markets in 2019.[27]

In addition to serving as carbon registries, each of these entities performs additional roles in carbon markets. For example, Verra operates the Verified Carbon Standard, which establishes general rules and requirements for certification under the Verra framework. Verra also accredits and oversees third-party verifiers of carbon offset projects and develops and approves carbon offset protocols that are widely recognized by compliance and voluntary carbon markets. Climate

[22] For more discussion, see Derik Broekhoff et al., *Securing Climate Benefit: A Guide to Using Carbon Offsets*, Stockholm Environment Institute and Greenhouse Gas Management Institute, 2019.

[23] For more information, see the Verra website at https://verra.org.

[24] For more information, see the American Carbon Registry website at https://americancarbonregistry.org.

[25] For more information, see the Climate Action Reserve website at https://www.climateactionreserve.org.

[26] For more information, see the Gold Standard website at https://www.goldstandard.org.

[27] Forest Trends' Ecosystem Marketplace, *The Only Constant is Change: State of the Voluntary Carbon Markets 2020, Second Installment*, December 2020.

Action Reserve also operates a standard, accredits and oversees third-party verifiers, and develops and approves protocols.

# Potential Role of Agriculture and Forestry in U.S. Climate Mitigation

Agriculture and forestry activities are both sources and sinks of GHG emissions. As sources, some activities generate GHG emissions that are released into the atmosphere and contribute to global climate change. As sinks, they remove $CO_2$ from the atmosphere through photosynthesis and store carbon in vegetation and soils (processes known as removal and sequestration).[28] Neither the emission sources nor the emission sinks from agriculture and forestry are subject to federal regulations that require emission reductions, emission removal, or emission sequestration efforts. Historically, legislative proposals that would establish mandatory GHG emission reduction programs or emission fees have not included requirements for the agriculture or forestry sectors.[29] As discussed above, compliance carbon markets (in certain U.S. states) and voluntary carbon markets have supported carbon offsets in the agriculture and forestry sectors some degree.[30]

**Table 1** identifies the GHG emission sources and sinks in the agriculture and forestry sectors. Regarding emissions related to agricultural production, EPA estimates that the agriculture sector contributed 10% of U.S. GHG emissions in 2019 (670 $MMTCO_2e$), an increase of 12% since 1990.[31] As indicated in **Table 1**, about half of these emissions are from crop production (e.g., soil management), and half are from livestock production (e.g., enteric fermentation, manure management).[32]

Regarding emissions related to forestry, EPA estimates GHG emissions and GHG sequestration from the land-use, land-use change and forestry sector (LULUCF). LULUCF includes various agricultural land uses (e.g., land conversion to cropland), forestry land uses (e.g., forestland remaining forestland), and other land uses (e.g., residential land use). As indicated in **Table 1**, according to EPA, the net result of LULUCF activities in the United States is a relatively large amount of GHG sequestration: 789 $MMTCO_2e$. This total net sequestration reduced the gross U.S. GHG emissions by 12% in 2019.[33] Most of this sequestration is attributable to carbon stocks and carbon uptake by trees in the forestry sector (e.g., forestland remaining forestland, and land converted to forestland).[34]

[28] For more information, see CRS In Focus IF11693, *Agricultural Soils and Climate Change Mitigation*.

[29] See CRS Report R45472, *Market-Based Greenhouse Gas Emission Reduction Legislation: 108th Through 117th Congresses*.

[30] For example, see the number of types of carbon offsets issued in California's cap-and-trade program, *ARB Offset Credit Issuance Table*, available at CARB, "ARB Offset Credit Issuance," https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/arb-offset-credit-issuance.

[31] EPA, "Sources of Greenhouse Gas Emissions," https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions. The 10% contribution relates to gross U.S. emissions.

[32] *Enteric fermentation* refers to digestive processes in ruminant animals like cattle, which result in GHG emissions. For more information, see CRS In Focus IF11404, *Greenhouse Gas Emissions and Sinks in U.S. Agriculture*.

[33] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, April 2021.

[34] For more information, see CRS Report R46312, *Forest Carbon Primer*.

**Table 1. EPA Estimated 2019 GHG Emissions and Sequestration in U.S. Agriculture and Land Use, Land Use Change, and Forestry (LULUCF)**

Million Metric Tons of $CO_2$ Equivalent ($MMTCO_2e$)

| Source | Emissions | Sequestration |
|---|---|---|
| **Agriculture Activities** | | |
| Agriculture soil management ($N_2O$) | 345 | - |
| Enteric fermentation ($CH_4$) | 179 | - |
| Manure management ($CH_4$ and $N_2O$) | 82 | - |
| Fossil fuel combustion ($CO_2$) | 40 | - |
| Other agricultural sources | 25 | - |
| **Total for agriculture sector** | **670** | - |
| **LULUCF** | | |
| Forestland remaining forestland | - | 676 |
| Land converted to forestland | - | 99 |
| Cropland remaining cropland | - | 15 |
| Land converted to cropland | 54 | - |
| Grassland remaining grassland | 15 | - |
| Land converted to grassland | - | 23 |
| Wetlands remaining wetlands | - | 4 |
| Land converted to wetland | .2 | - |
| Settlements remaining settlements | - | 122 |
| Land converted to settlements | 79 | - |
| **Total LULUCF** | **149** | **938** |
| **Total U.S. GHG Emissions from All Sources** | **6,558** | **-** |
| **Net LULUCF** | **-** | **789** |
| **Total Net U.S. GHG Emissions from All Sources** | **5,769** | **-** |

**Source:** Prepared by CRS. Data from EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, April 2021.

**Notes:** Other agricultural sources include rice cultivation (16 $MMTCO_2e$), urea fertilization (5 $MMTCO_2e$), liming (3 $MMTCO_2e$), mobile combustion (1 $MMTCO_2e$), and field burning of agricultural residues (1 $MMTCO_2e$). Indirect emissions from electricity use at agricultural operations (35 $MMTCO_2e$ in 2019) are not included in this table (EPA Inventory, Table 2-12). LULUCF estimates are from Table 6-1.

In terms of national GHG accounting, net emissions from LULUCF contribute to lower total net GHG emissions. Net GHG emissions is a key measurement, because that is generally the metric of emissions targets used by parties to the 2015 Paris Agreement. For example, pursuant to that agreement, the United States released a new Nationally Determined Contribution (NDC)—or GHG target—in 2021[35] aiming to reduce U.S. net GHG emissions by 50-52% below 2005 levels

[35] A binding commitment in the Paris Agreement is that all Parties must communicate their Nationally Determined Contributions (NDC) every five years, containing a GHG reduction pledge and actions, though this content of an NDC is not binding. For more information, see CRS In Focus IF11746, *United States Rejoins the Paris Agreement on*

by 2030.[36] The United States can achieve its emission targets either by reducing direct emissions (e.g., emissions from fossil fuel combustion) or by increasing GHG removal efforts (e.g., sequestration through LULUCF activities identified in **Table 1**). Results from a number of climate models of different climate change scenarios indicate that LULUCF activities could play a key role in achieving specific emission reduction targets (e.g., net zero by 2050).[37] **Appendix B** provides data on historical U.S. GHG emissions and selected GHG emissions targets.

A question policymakers may consider is how much additional carbon removal (i.e., above current business-as-usual or baseline levels) is possible in the agriculture and forestry sectors to help mitigate climate change? The GHG mitigation potential of the agriculture and forestry sectors is subject to a range of factors. These factors include land availability and competition among potential land uses; environmental constraints, such as water availability; federal and state policies, particularly the scope and degree of financial incentives for GHG mitigation; and others. A comprehensive discussion of these factors is beyond the scope of this report.[38]

Multiple studies have estimated the additional GHG mitigation potential of agriculture and forestry activities. A National Academies of Sciences, Engineering, and Medicine analysis in 2019 used the results of relevant studies to estimate what it described as "practically achievable" carbon removal.[39] The authors of this report estimated that—in the United States—carbon removal from forestlands could potentially provide 600 $MMTCO_2e$ sequestered per year and agricultural practices could provide 250 $MMTCO_2e$ per year. They found that these potential amounts could roughly double in size under certain circumstances.[40]

These estimates suggest that the agriculture and forestry sectors could play key roles in meeting U.S. GHG emission reduction goals (see **Appendix B**). The precise roles that the agriculture and forestry sectors may play in U.S. climate policies is uncertain. For further discussion of policy options, see "Questions for Potential Policy Consideration."

# Agricultural Offsets and Carbon Markets

Farmers and ranchers can leverage (1) carbon sequestration and (2) reduced or avoided GHG emissions to generate tradeable carbon offsets for use in carbon markets.[41] As with other offset

*Climate Change: Options for Congress*.

[36] The White House, *The United States of America Nationally Determined Contribution Reducing Greenhouse Gases in the United States: A 2030 Emissions Target*, April 22, 2021.

[37] Net-zero emissions refers to a situation where any continued human-caused GHG from an entity (e.g., country, subnational government, company) is balanced by human, or anthropogenic, carbon removal from the atmosphere that stores the $CO_2$ in geological, terrestrial, or ocean reservoirs, or in products. For a further discussion of these results and related issues, see CRS Report R46807, *Greenhouse Gas Emissions Scenarios: Background, Issues, and Policy Relevance*.

[38] For a further discussion of these factors see National Academies of Sciences, Engineering, and Medicine (NASEM), *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda*, 2019 (hereinafter NASEM 2019).

[39] NASEM 2019. According to the study, these estimates would include existing practices that could be implemented at rates that do not require land-use conversion and would not jeopardize food security and biodiversity of intact native ecosystems.

[40] NASEM 2019, p. 135.

[41] Forestry offsets are discussed later in this report (see "Forest Offsets and Carbon Markets"). Other industries may also generate marketable offsets, but are beyond the scope of this report. Additionally, this section focuses on agricultural offsets for use in existing carbon markets, and does not address potential future compliance or regulatory measures that could be imposed on the agricultural industry.

categories, standardized and transparent processes for developing agricultural carbon offsets increase confidence in their quality and utility for potential use in carbon markets.

There are many potential paths to generating agricultural carbon offsets. Farmers and ranchers do this independently or by joining in agricultural *carbon market programs* (also referred to as *carbon market initiatives*) designed to facilitate participation in carbon markets (see "Private Agricultural Carbon Market Programs" and **Table 2**). The **text box** below describes an example process for generating agricultural carbon offsets. The inclusion of one or another entity in the example process does not indicate endorsement by CRS.

**Generating Agricultural Carbon Offsets: An Example Process**

A *project developer* (e.g., Corteva) incorporates one or more *protocols* (e.g., the Soil Enrichment Protocol) developed by a *carbon registry* (e.g., Climate Action Reserve) in designing a *carbon market program* (in this example, Corteva's Carbon Initiative) to generate carbon offsets. Protocols are specific to individual GHG mitigation practices (e.g., cover cropping, no-till farming), and they standardize the measuring, reporting, and verification (also referred to as MRV) requirements for generating carbon offsets. The project developer enrolls *participants* (e.g., farmers, ranchers), who implement the protocols. Protocols generally require that *third-party verifiers* (e.g., SGS) independently confirm that the requirements of the protocol were met, before offset credits are issued. The project developer may register the carbon offsets with a carbon registry, and may sell the carbon offsets to *purchasers* (e.g., private companies, individuals) on compliance or voluntary carbon markets.

Profits associated with each carbon offset may be reduced by: initial costs associated with enrolling in a carbon market program and implementing new practices; ongoing costs of measuring, reporting, and verifying carbon offset protocols; and transaction costs associated with and registering and selling carbon offsets.

For more information, see

Corteva, "Corteva's Carbon Initiative," https://granular.ag/carbon.

Climate Action Reserve, https://www.climateactionreserve.org; and Climate Action Reserve, "Soil Enrichment Protocol," https://www.climateactionreserve.org/how/protocols/soil-enrichment.

SGS, https://www.sgs.com.

Carbon protocols address two general categories of agricultural management activities:[42]

- **Soil Carbon Sequestration** projects involve implementing agricultural practices that research has shown can increase carbon in soils. These practices may include using no-till or reduced-till soil management, cover crops, and diversified crop rotations.
- **Reduced or Avoided GHG Emissions** projects involve implementing agricultural practices that decrease or avoid GHG emissions in agriculture (e.g., $CO_2$, nitrous oxide, methane). These practices may include improving nitrogen use efficiency for crops (e.g., fertilizer use protocols); managing animal waste with anaerobic digesters, composting, or improved storage; and improving water and residue management in rice cultivation.

Carbon registries—in their roles as carbon standards—have developed a variety of relevant protocols for agricultural management activities. For example, the American Carbon Registry has

[42] These activities can involve implementing *climate-smart agricultural practices*. According to USDA, "Climate-smart practices include activities that store carbon and improve resilience and soil health, such as reduced and no-till, cover crops, and prescribed grazing; reduce GHG emissions, including methane and nitrous oxide, using practices such as ruminant feed management, manure management, and fertilizer management; improve on-farm energy efficiency, such as improved irrigation efficiency, reduced fuel use, and energy conservation; and improve forest management to increase forest resilience and health." USDA, *Climate-Smart Agriculture and Forestry Strategy: 90-Day Progress Report*, May 2021 (hereinafter USDA *90-Day Progress Report* 2021).

an approved protocol for "compost additions to grazed grasslands;"[43] Climate Action Reserve has protocols for "soil enrichment," "rice cultivation," and "U.S. livestock;"[44] and the Verified Carbon Standard has six approved protocols for agriculture, including protocols for soil carbon, sustainable agricultural management, and reduced nitrogen fertilizer use.[45]

Carbon markets vary in the types of agricultural offsets they accept. Voluntary carbon markets may accept both general categories of agricultural carbon offsets, and various specific protocols within these categories. Existing U.S. compliance markets currently do not allow for offsets from soil carbon sequestration, but they do accept offsets from reduced or avoided agricultural GHG emissions (see also **Appendix A**). The California and RGGI cap-and-trade programs each have five offset categories, and soil carbon sequestration is not among them. Both programs include offset categories that reduce agricultural methane emissions: both allow for manure management with anaerobic digesters, and California's offset categories also include reduced methane in rice cultivation.

## Agricultural Carbon Offset Quality

As with other carbon offsets, key concerns regarding the quality of agricultural carbon offsets include realness, additionality, prevention of leakage, permanence, and verification. These general criteria are described in the **text box** "Selected Metrics for Carbon Offset Quality and Credibility," above. The following points identify potential issues specific to agriculture, with respect to these criteria.

- **Realness.** It is technically challenging to quantify the amount of carbon that is stored in agricultural soils through practices such as reduced and no-till farming. Soils are disperse and soil carbon dynamics are complex. It is more straightforward to quantify emissions through direct monitoring of a single emissions source, as is possible with a methane digester for livestock manure.
- **Additionality.** Offering offset credits for the initiation of new practices raises the question of how to engage with *early adopters*, or those farmers and ranchers who adopted climate-smart agricultural practices before offset credits were offered.
- **Leakage.** Preventing leakage may be a challenge. Leakage could occur, for example, if new practices reduced crop yield in one field, which was compensated for by planting additional crops or implementing more-GHG-intensive practices in another field.
- **Permanence.** Many carbon standards require 100-year permanence, which can be a challenge for agricultural soils in which a change in practice can lead to the release of stored carbon.
- **Verification.** The need for verification raises the questions of whether there are sufficient numbers of third-party verifiers qualified to assess agricultural offset projects, and how to reduce transaction costs associated with verification.

[43] American Carbon Registry, "Carbon Accounting: Standards and Methodologies," https://americancarbonregistry.org/carbon-accounting/standards-methodologies.

[44] Climate Action Reserve, "Protocols," https://www.climateactionreserve.org/how/protocols.

[45] Verified Carbon Standard, "Methodologies," https://verra.org/methodologies.

Concerns about the quality of agricultural carbon offsets have affected their use in carbon markets. For example, some researchers suggest that concerns about the quality of agricultural offsets have contributed to limitations on their acceptance within compliance carbon markets.[46] Protocols intended to bolster the quality of agricultural carbon offsets may increase costs to farmers and reduce the profitability of generating carbon offsets.[47] Many of these are transaction costs related to monitoring, reporting, and verification requirements of offset protocols.[48]

## Private Agricultural Carbon Market Programs

In recent years, private companies have launched a variety of agricultural carbon market programs (see examples in **Table 2**), most of which engage with voluntary carbon markets. While some of these programs directly pay farmers and ranchers (*participants*) to begin implementing new, specified management practices, most assist participants in producing, verifying, and selling carbon offsets in a carbon marketplace. These programs have different requirements regarding the geographic location of the land enrolled, minimum acreage, allowable practices, contract duration, recordkeeping, data sharing, the value and timing of payments, and other variables. Some private companies launch agricultural carbon market programs as their sole business interest, while others use such ventures to support their corporate social responsibility or sustainability pledges.

While participants can engage in carbon markets outside of carbon market programs, doing so without joining a carbon market program can be costly for small-scale participants, largely due to measuring, reporting, and verification (also referred to as MRV) requirements associated with many carbon offset protocols (also referred to as methodologies).

[46] See, for example, Brian C. Murray, "Why Have Carbon Markets Not Delivered Agricultural Emission Reductions in the United States," *Choices*, vol. 30, no. 2 (2015).

[47] For a discussion of potential issues and concerns related to agricultural carbon offset quality, see Dan Blaustein-Rejto, "Dishing the Dirt on Ag Carbon Credits," *AFN*, July 13, 2021.

[48] For example, an analysis by the Environmental Defense Fund (EDF) estimated that in some scenarios, monitoring, reporting, and verification transaction costs for implementing the rice protocol approved by California's cap-and-trade program could amount to twice the potential revenue from selling the resulting offset credits. Jeremy Proville, "Barriers to Tapping the Potential of Carbon Markets for Agriculture," EDF blog, January 21, 2021.

**Table 2. Selected Agricultural Carbon Market Programs Operating in the United States**

| Initiative | Eligibility/Requirements | Practices | Certification | Compensation | Website |
|---|---|---|---|---|---|
| Bayer Carbon Initiative | 17 eligible states. Min. 10 acres. Corn or soybeans. 10-year enrollment, then 10-year practice retention. | New no-till, strip till, or cover cropping (some credit for existing practices). | Bayer verifies practices based on data farmers upload to Bayer's digital platform, Climate FieldView, and satellite data. | Per acre/per practice, up to $9/acre/year. Payments eligible for up to 5 years of past practices on/after January 1, 2012. | https://www.cropscience.bayer.com/who-we-are/farmer-partner-resources/carbon-program/united-states |
| CIBO Impact | United States. Row crops. No min. acres. One-year commitment. | New cover crops, conservation tillage, no-till, strip till, crop rotation, reduced nitrogen. | CIBO verifies practices with satellite-based and AI-enhanced remote sensing, supplemented by interviews. CIBO quantifies GHG flux with computer modeling. | Per carbon credit, set at $20/credit, sold on the CIBO marketplace. CIBO keeps 20% of sale price. | https://www.cibotechnologies.com |
| Corteva Carbon Initiative | In 2022: 11 U.S. states and 17 crop types. 5-year contract. 3-5 years of historical practice data. | New no-till, strip till, or cover cropping; increasing nitrogen efficiency; increasing crop diversity. | Climate Action Reserve verifies and issues carbon offset credits. Corteva and Indigo pay certification costs. | Per carbon offset credit. Indigo Ag sells the credits. Payment to farmer is based on sale price: minimums of $15/credit, and 75% of sale price, to farmer. Payments vest over 5 years. | https://granular.ag/carbon |
| Ecosystem Services Market Consortium (ESMC) | Current pilots until anticipated 2022 launch: specific U.S. regions. No min. acres. 10-year contract. | Practices specific to production systems and geography. | ESMC certifies ecosystem credits based on its methodology. | Per specific ecosystem services provided (incl. additional carbon sequestered), based on ESMC analysis. | https://ecosystemservicesmarket.org |
| Farmers Business Network (Gradable Carbon) | United States. Min. 250 acres. Five-year contract. | New (or within prior two years) no-till, reduced till, cover cropping, diversified crop rotation, reduced nitrogen. | Gradable generates credits based on data farmers upload. | Per carbon offset credit (initial min. $20/credit). Farmers can wait up to 5 years to sell at contemporary market price. | https://www.gradable.com/carbon |

| Initiative | Eligibility/Requirements | Practices | Certification | Compensation | Website |
|---|---|---|---|---|---|
| Indigo Carbon | 28 eligible states. Field crops. Min. 150 acres. 5-year contract. | New reduced-till or no-till, cover cropping (new, diversifying, or extending duration), reduced fertilizer use, rotation diversification. | Indigo determines carbon sequestration based on data farmers upload to Indigo's digital platform, and some soil sampling. Independent carbon credit issuers (Verra, Climate Action Reserve) verify carbon credits. | Per carbon offset credit, (min. $15/credit). Indigo sells the credits and compensates the farmers. Payments subject to multi-year vesting requirements to ensure soil carbon and emissions levels are maintained over time. Growers receive 75% or more of the credit sale price. | https://www.indigoag.com/carbon/for-farmers |
| Farmers Edge (Smart Carbon) | Canada and certain U.S. states. No min. acres. | New cover crops, intercropping, no-till, reduced-till, nutrient management, direct seeding, crop rotation, crop diversification. | FarmersEdge determines carbon sequestration based on data automatically uploaded from fields to FarmCommand, its digital platform. Third-party verifier verifies the credits, which are then recorded with a carbon registry. | Per carbon offset credit (estimated $10/acre). Farmers Edge aggregates carbon offsets across producers, sells credits, and compensates farmers, retaining an administrative fee. | http://farmersedge.ca/carbon |
| Nori | United States. Croplands not enrolled in the USDA Conservation Reserve Program since 2000, with historical practice data. No min. acres. 10-year contract. | Practices not specified. "Regenerative practices" adopted within the last 10 years, using Nori's U.S. Croplands Methodology. | Farmer selects third-party verifier and pays verification costs. Verification once every three years. | Nori issues "Nori Carbon Removal Tonnes" (NRT) certificates for farmers to sell in the Nori marketplace. 1 NRT = 1 ton CO2e stored for 10 years. Farmers receive total sale price, less a 15% transaction fee for Nori. | https://nori.com/for-growers |
| Nutrien Carbon Program | Pilot (as of 2021): United States (15 states) and Canada (3 provinces). Expansion expected in 2022. Crops. | Under development. Nitrogen management, soil heath (low and no-till, cover crops). | Under development. Anticipated use of existing protocols. Nutrien's Agrible sustainability platform for data collection. | Per carbon offset credit. Framework under development. | https://www.nutrien.com/sustainability/strategy/feeding-planet-sustainably/carbon-program |

| Initiative | Eligibility/Requirements | Practices | Certification | Compensation | Website |
|---|---|---|---|---|---|
| Rabobank (Rabo Carbon Bank: Carbon Farming) | Pilot (as of 2021): United States and the Netherlands. Row crops, land with historical practice data. | Reduced/no tillage, reduced inputs, planting of cover crops, crop rotations, optimized grazing patterns, species composition, agroforestry. | Under development. In discussions with certification bodies to verify methodologies and validate carbon stock levels measured in the soils. | Per carbon offset credit. Anticipated $25-$50/credit, less a transaction fee for Rabobank. | https://www.rabobank.nl/en/about-us/carbon-bank/carbon-farming |

**Source:** Table created by CRS from multiple sources (see "Website" column for original sources).

**Notes:** CRS identified more than 10 private agricultural carbon markets announced or in operation, and selected those in this table to exemplify various approaches. The different designs and requirements may result in different degrees of quality, including realness, permanence, leakage, and other characteristics discussed in the text.

a. One *offset credit* represents sequestration of one metric ton of carbon dioxide equivalent ($MTCO_2e$).

Carbon market program requirements, including those regarding eligibility, allowable practices, and certification, can affect the participation of farmers and ranchers, the quality of carbon offsets generated, and the extent to which a program is achieving its stated goals. For example, while those programs with shorter contracts and fewer requirements regarding the continuation of GHG mitigating practices may reduce barriers to entry for farmers and ranchers, they also may call into question the permanence of the carbon offsets generated. Those programs that permit compensation for past GHG-mitigating practices may encourage the participation of more farmers and ranchers, but they may not generate offsets that meet the additionality criteria for high-quality offsets. Offsets that do not meet additionality or permanence criteria potentially may be sold in voluntary carbon markets, calling into question whether they are achieving the intended goals of offsetting GHG emissions from other industries and activities.

## Stakeholder Views

While carbon markets can offer farmers and ranchers new sources of income, they can also raise some concerns. Stakeholders in agricultural and environmental communities display a variety of viewpoints regarding agriculture's inclusion or exclusion in carbon markets. Views have shifted over time, and can vary based on individual policy proposals. Stakeholder views discussed in this section are not necessarily representative of all views.

Most agricultural interest groups have expressed support for the industry's inclusion in carbon markets, provided that markets

- are voluntary for farmers and ranchers (i.e., any agricultural emissions abatement or sequestration efforts are voluntary);
- provide a financial incentive to participate that outweighs costs to the farmer or rancher;
- provide workable practices that can be incorporated into a farming or ranching operation; and
- include assurances for failures (e.g., reversal) beyond the control of the producer.

Among supporters, the Food and Agriculture Climate Alliance (FACA) is a coalition of organizations representing diverse interests of the food, agriculture, forestry, and environmental sectors. It launched in 2020 to promote shared climate policy priorities.[49] Among its many recommendations, the group supported the development of a U.S. Department of Agriculture (USDA) *carbon bank* and legislation that would establish a third-party certification program for agriculture's participation in carbon markets.[50]

General opposition to the inclusion of agriculture in carbon markets has come from some environmental and farming groups. In general, these groups have expressed concerns about (1) the effectiveness of carbon markets to result in real net emissions reductions and (2) the potential disproportionate benefit to large operations, with small- and medium-scale farmers and ranchers

[49] For more information, see the Food and Agriculture Climate Alliance (FACA) website at https://agclimatealliance.com. Founding members include American Farm Bureau Federation, Environmental Defense Fund, FMI, National Alliance of Forest Owners, National Association of State Departments of Agriculture, National Council of Farmer Cooperatives, National Farmers Union, and The Nature Conservancy.

[50] For additional information on the USDA carbon bank proposal, see FACA, *Food and Agriculture Climate Alliance Carbon Bank Recommendations*, May 2021. Legislative support was for the 116th Congress' Growing Climate Solutions Act introduced in the House (H.R. 7393) and Senate (S. 3894). For additional discussion on this bill, see "Legislative Developments".

struggling to gain market entry.[51] Among opponents, the Institute for Agriculture and Trade Policy (IATP) and the National Family Farm Coalition (NFFC) argue that (a) agricultural offsets for use in carbon markets have not led to real and sustainable GHG mitigation, (b) they risk the health and economic security of communities, and (c) they draw attention away from policies that IATP views as better suited to addressing climate change.[52] Other concerns raised about agriculture's participation in carbon markets center on issues related to inadequate measurement tools, impermanence of soil carbon, low prices for participation, and undermining potentially more effective and holistic agricultural practices as ways of improving the environment.[53] Opposition to the carbon bank proposal is primarily directed at whether USDA has authority to carry out such an activity.[54]

Overall, both supporters and opponents of including agriculture in carbon markets have stated support for continuing and expanding existing USDA conservation programs and research efforts related to climate change mitigation and adaptation (see "Selected USDA Policies and Activities"). The exact scope and scale of expansion that they would support, however, varies.

# Forest Offsets and Carbon Markets

Similar to agriculture, forest landowners can leverage forest carbon sequestration and GHG mitigation to generate tradeable carbon offsets (or other carbon market instruments; see the **text box** "Forest Carbon Leases for Harvest Deferrals," below). Forests sequester and store large amounts of carbon and have the potential to mitigate future GHG emissions, though how much is an area of ongoing debate.[55] The capacity of forestry projects to provide offsets for use in a carbon market is potentially substantial, however, and several forestry-related activities are approved to earn offset credits in existing compliance and voluntary markets.[56]

As for agriculture, there are many potential paths to generating forest carbon offsets. Forest landowners can do this independently or by working with a project developer or joining a forest carbon market program (see "Private Forest Carbon Market Programs"). The steps involved in generating forest carbon offsets generally are similar to those involved in agricultural carbon offsets. The following **text box** describes an example process.

[51] For example, see Georgina Gustin, "Politicians Are Considering Paying Farmers to Store Carbon But Some Environmental and Agricultural Groups Say It's Greenwashing," *Inside Climate News*, April 16, 2021.

[52] IATP and NFFC, *Why Carbon Markets Won't Work for Agriculture*, Fact Sheet, February 4, 2020 (hereinafter IATP and NFCC 2020).

[53] IATP and NFFC 2020.

[54] Liz Crampton and Helena Bottemiller Evich, "Boozman: Vilsack Doesn't Have Authority to Create Carbon Bank," *Politico*, February 2, 2021.

[55] For more information on the amount of carbon in forests and the carbon sequestration implications of different forest types, see CRS Report R46312, *Forest Carbon Primer*. For an example of the ongoing debate regarding the GHG mitigation potential of forests, see Jean-Francois Bastin et al., "The Global Tree Restoration Potential," *Science*, vol. 365, no. 6448 (2019), pp. 76-79; Joseph W. Veldman et al., "Comment on "The Global Tree Restoration Potential," *Science*, vol. 366, no. 6463 (2019); and Jean-Francois Bastin et al., "Response to Comments on 'The Global Tree Restoration Potential,'" *Science*, vol. 366, no. 6463 (2019).

[56] Other market types and non-market mechanisms may also provide some sort of offset credit related to forestry activities, for example, Reducing Emissions from Deforestation and Forest Degradation (REDD+) projects in developing countries. Discussion of these mechanisms is outside the scope of this report. For more information, see CRS Report R46952, *Reduction in Emissions from Deforestation and Forest Degradation (REDD+)* and Patrick Maguire et al., *A Green Growth Spurt: State of Forest Carbon Finance 2021*, Ecosystem Marketplace, June 2021.

### Generating Forest Carbon Offsets: An Example Process

A *forest landowner* earns offset credits after demonstrating compliance with an established forest carbon *project standard* (or specific *protocols*) as developed and approved by a *carbon registry*. The carbon offsets may be sold to *purchasers* (e.g., private companies) on compliance or voluntary carbon markets. Compliance with the forest carbon project standard is demonstrated through rigorous measuring, reporting, and third-party verification processes. The offset amount credited is typically the difference between the carbon sequestered through the new forest management activities implemented in the forest carbon project standard as compared to a baseline, usually representing the carbon sequestered under a business-as-usual approach. The measuring, reporting, and verification process (also referred to as MRV), along with the quantification of the baseline carbon stocks and potential for additional carbon sequestration, requires investments in forest inventorying and knowledge of forest carbon dynamics and accounting. These requirements often lead to a forest landowner working with a consultant or project developer and generally lead to high transaction costs both upfront and through the term of the carbon offset (which could range from 1 to 100 years).

Many carbon markets accept forest carbon offsets, and have developed carbon project standards and protocols for three general categories of forest management activities, listed below.

- **Afforestation and Reforestation (A/R)** projects involve establishing tree cover to previously non-forested land (*afforestation*) or restoring tree cover to previously forested land that recently lost tree cover (*reforestation*).
- **Avoided Conversion (AC)** projects involve preventing the conversion of forestland to non-forested land (e.g., preventing *deforestation*).
- **Improved Forest Management (IFM)** projects involve land management activities that increase or maintain a baseline level of carbon stocking. In other words, projects that increase average forest carbon per acre across the project site, across varying time scales.

The standards associated with several carbon registries (e.g., American Carbon Registry, Climate Action Reserve, and Verra) each have protocols related to these three categories of forest management activities. Voluntary markets recognize each of these standards, and California's compliance market approves each as an Offset Project Registry.[57] RGGI also accepts offsets for the three categories of forest management activities, although it has some restrictions related to afforestation projects.[58] The specific requirements and carbon counting protocols for the forest management activities differ among the different protocols and markets and, as a result, they may offer varying levels of credits for similar activities. Additional domestic (or international) carbon markets not listed or discussed in this report may also have a forest carbon project standard.

### Forest Carbon Leases for Harvest Deferrals

While the most common forest carbon product is a carbon offset (traded on many voluntary or regulatory markets), there are also other carbon products available for forestry activities, such as cost-share payments or annual leases. For example, in 2021, Natural Capital Exchange (NCX, formerly SilviaTerra) launched a new carbon product and marketplace that allows a forestland owner to sell, or more accurately to lease, the additional carbon accumulated through delaying a timber harvest for one year. This is a targeted, short-term Improved Forest Management project that pays a landowner to increase the forest carbon per acre by deferring harvest activity for one year. The short-term length is intended to maximize the present climate benefit per dollar of present cost for the landowner and increase flexibility for the forestland owner. The payment is made at the end of the year, and the price is determined at an open auction. The first auction was held in March 2021 and resulted in the sale of

[57] For more information, see CARB, "Offset Project Registries," https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/offset-project-registries.

[58] Within RGGI's offset protocols, forest projects fall within the "Sequestration of Carbon Due to US Forest Projects" category. Afforestation projects are only available in CT and NY. For more information, see https://www.rggi.org/allowance-tracking/offsets/offset-categories/forestry-afforestation.

130,000 tons of carbon offsets by over 100 different landowners delaying harvests over 1.17 million acres. See http://www.ncx.com for more information.

## Issues and Concerns Related to Forest Carbon Offsets and Markets

The issues and concerns related to forest carbon markets are similar to those related to agricultural carbon offsets and carbon markets generally: realness, additionality, prevention of leakage, permanence, and verification (see **text box** "Selected Metrics for Carbon Offset Quality and Credibility," above). There are also concerns related to offering carbon offsets for plantation forestry,[59] and general concerns regarding the extent to which providing forest carbon offsets might substitute for more reliable GHG reductions.

- **Realness.** Realness is not as great a concern in forest carbon offsets as it is with agricultural carbon offsets. Numerous studies have addressed how to quantify carbon stored in trees, forest litter, and forest soils. However, researchers and stakeholders continue to debate if and how to address carbon stored in wood products and specific carbon accounting practices.[60]
- **Additionality.** Additionality is a specific concern across all forest offset project types. This is in part because many of the activities that generate offset credits are also common forest management activities, which creates challenges when determining whether an activity was truly additional or would have occurred anyway.
- **Leakage.** Preventing leakage can be challenging if forest carbon-sequestration projects in one geographic area lead to deforestation outside of the project area.
- **Permanence.** Unforeseen events (e.g., wildfires, insect or disease infestations, or other natural disasters) have the potential to increase carbon emissions rather than sequestration. Carbon standards often mitigate this risk by holding some carbon offsets in reserve or a *buffer account* as a shared insurance pool.
- **Verification.** The need for verification raises the questions of whether there are sufficient numbers of third-party verifiers qualified to assess forestry offset projects, and how to reduce transaction costs associated with verification.

Other concerns specific to forestry carbon offsets include those related to the profitability, scalability, and feasibility of forest carbon projects. For example, current market conditions often do not make forest carbon projects profitable or feasible for smaller forest landowners. Generally, the per-acre costs associated with developing forestry carbon credits (primarily related to the measuring, reporting, verifying, and monitoring requirements, including the costs associated with developing baseline and projected carbon measurements)[61] can be high relative to the potential price the credit may receive in the market. In order to generate a financial return, most participants in forest carbon markets have large land holdings and enroll large projects, and these

[59] *Plantation forestry* generally refers to a type of intensive forest management where the site is intentionally planted in uniform rows of one selected, commercially valuable species.

[60] Some research findings suggest that the financial viability of some forest carbon offset projects is largely driven by carbon accounting methodologies. Christopher S. Galik, David M. Cooley, and Justin S. Baker, "Analysis of the production and transaction costs of forest carbon offset projects in the USA," *Journal of Environmental Management*, vol. 112 (2012), pp. 128-136.

[61] The costs may include those associated with implementing and monitoring the project, producing the data necessary to measure the carbon benefit, and the transaction costs associated with verifying and registering the credit.

usually are corporate landowners. Large, corporate owners account for 20% of U.S. forestlands. Nearly 40% of U.S. forestlands are owned by an estimated 10.6 million families, individuals, trusts, and estates, many of these own fewer than 100 acres. The remainder of U.S. forestlands are publicly owned.[62] Expanding access to forest carbon markets to these landowners has the potential to increase the scale of the aggregate carbon offset benefit.

Another issue is related to accounting for the carbon stored in harvested wood products. The carbon in these products is stored while the product is in use, but eventually returns to the atmosphere upon disposal and decomposition. In principle, substituting a sequestering product, like wood, for a more GHG-intensive product, like steel, could reduce overall GHG emissions. In practice, it is not clear whether this would result in a net GHG reduction, given the complexities related to accounting for the carbon emissions associated with the harvesting, transportation, and production of the wood products. Carbon in wood products is not accounted for in any of the existing markets, largely due to these complexities. Accordingly, carbon offsets are not available for any potential carbon savings related to substituting wood products as an alternative to more carbon-intensive materials.

## Private Forest Carbon Market Programs

Several new and forthcoming forest carbon market programs aim to expand access for smaller landowners to forest carbon markets.[63] Many of these programs rely on allowing multiple landowners to pool their lands together to obtain economies of scale. Many of these programs also use technological advancements and remote sensing data (usually provided by the USDA Forest Service's Forest Inventory and Analysis program) to lower the transaction costs associated with measuring and quantifying carbon. The following are examples.

- The NCX forest carbon lease market is open to landowners of any size, and also provides access to a proprietary mapping resource, Basemap, to facilitate enrollment.[64] The first market auction was held in March 2021.
- The American Carbon Registry released in 2021 an IFM protocol for enrolling lands ranging from 40 to 50,000 acres.[65] Core Carbon (from Finite Carbon) is developing a free digital platform with access to several mapping resources to facilitate the enrollment process, and was expected to launch the platform in summer 2021.[66]
- The Family Forest Carbon Program,[67] developed by The Nature Conservancy, American Forests Foundation, and TerraCarbon, anticipates enrolling projects ranging from 20 to 1,000 acres and was expected to launch in summer 2021. The protocol is being reviewed and validated by Verra.[68]

[62] Sonja N. Oswalt et al., *Forest Resources of the United States, 2017*, USDA Forest Service, GTR-WO-97, March 2019.

[63] *Forest carbon market programs* are also known as *forest carbon market initiatives*.

[64] For more information, see the NCX website at http://www.ncx.com.

[65] American Carbon Registry, "IFM on Small No-Industrial Private Forestlands v1.0," September 2021. Available at https://americancarbonregistry.org/carbon-accounting/standards-methodologies/small-non-industrial-private-forestlands.

[66] For more information, see the Core Carbon website at http://www.corecarbon.com.

[67] For more information, see American Forest Foundation, "Family Forests Carbon Program," https://www.forestfoundation.org/what-we-do/increase-carbon-storage/family-forest-carbon-program.

[68] As of the date of this report, the Verified Carbon Standard Methodology for Improved Forest Management is under

Some of these initiatives were funded through grants from USDA, and many also received funds provided through corporate philanthropy.[69]

## Stakeholder Views

While carbon markets can offer forest landowners new sources of income, they have also raised some concerns. Some of these concerns and views have shifted over time, and may vary based on individual policy proposals. Stakeholder views discussed in this section are not necessarily representative of all views.[70]

In many cases, stakeholders in both the forestry and environmental communities generally agree on the potential role of forests in climate mitigation and adaptation. There is broad agreement on the need for financial assistance to support forest carbon management generally and to facilitate participation by small forest landowners in climate programs and markets specifically. This includes support for programs to pay landowners to protect existing forestlands or for improving the management of existing forests, such as those payments provided through carbon markets. In some cases, however, there are differing viewpoints regarding the operation of specific forest carbon offsets, typically related to the role of timber harvesting and wood products. Industry organizations generally support policies and programs that would encourage new and innovative uses of wood products as substitutes for more carbon-intensive materials rather than policies and programs that include restrictions or prohibitions on timber harvesting (as is the case in some forest carbon standards).

## Forestry Carbon Market Programs on Public Lands

Nearly 40% of the forested areas in the United States are publicly owned, mostly by the federal government but also by state and local governments.[71] Some—but not all—of the forest carbon project standards allow for nonfederal, publicly owned forestland to generate carbon offsets. The extent that forest carbon project standards allow for projects on federal lands to generate carbon offsets is mixed, however, generally due to concerns related to permanence and additionality. More specifically, permanence concerns include the extent that any future administrative—or legislative—activities could result in changes to the project's capacity to generate the carbon offset. Additionality concerns relate in part to how to calculate the baseline, business-as-usual carbon measurements for federal land management activities and if and how to incorporate consideration of agency resource availability into those calculations.[72] Other concerns relate to specific legal questions, such as if issuing a credit would confer any sort of property right to the holder.[73]

assessment; see https://verra.org/methodology/methodology-for-improved-forest-management.

[69] For example, the Family Forest Carbon Program was funded in part through a Conservation Innovation Grant from the USDA Natural Resources Conservation Service (NRCS), but also received funding from Amazon, 3M, and other corporate donors. NCX received funding through the Microsoft Climate Innovation Fund and other investors. BP is an investor in Finite Carbon's parent company, Finite Resources. These examples are provided as illustrative of the mixed funding sources and is not a comprehensive list of all public funders or corporate donors to these programs.

[70] This section was informed by policy statements from the Forest-Climate Working Group, National Association of State Foresters, Society of American Foresters, and the American Forest Foundation.

[71] Sonja N. Oswalt et al., *Forest Resources of the United States, 2017*, USDA Forest Service, GTR-WO-97, March 2019.

[72] Gordon Smith, *Forest Offset Projects on Federal Lands*, Climate Action Reserve, March 8, 2012.

[73] Discussion of the legal aspect of these issues is outside the scope of this report.

The Climate Action Reserve, for example, will only register credits for forestry projects on federal lands if the project is accompanied by a legislative or regulatory approval to ensure permanence and additionality.[74] In 2019, the American Carbon Registry denied approval of a protocol for generating carbon offsets from the National Forest System (NFS, managed by the U.S. Forest Service in USDA) lands in the southwestern United States. The methodology was not approved in part due to complications in calculating the baseline carbon assessment and uncertainties related to future federal land management decisions, among other factors.[75] However, other carbon registries have accepted project-specific carbon offsets generated on National Wildlife Refuge System lands managed by the U.S. Fish and Wildlife Service.[76]

The National Forest Foundation (NFF), a congressionally chartered foundation supporting management of the NFS, has initiated several attempts to establish carbon offsets on NFS lands.[77] Starting in 2008, the NFF established demonstration reforestation carbon offset projects on two different national forests in California.[78] Though the initial plan was to register the offsets with the American Carbon Registry, they have not been registered as of the date of this report.[79] Further, the American Carbon Registry reports at least one of the projects has been cancelled.[80] These projects were funded through corporate donations to NFF's Carbon Capital Fund. The NFF offered corporate and individual donors the opportunity to donate to the Carbon Capital Fund to support generating carbon offsets from other reforestation projects;[81] these carbon offsets were not accredited, registered, sold, or traded, but were reportedly third-party verified and subject to "financial" and "biological" additionality tests.[82] The NFF continues to accept donations for NFS

[74] Gordon Smith, *Forest Offset Projects on Federal Lands*, Climate Action Reserve, March 8, 2012.

[75] For more information, see American Carbon Registry, "Inactive: Southwestern Forest Restoration: Decreased Wildfire Severity and Forest Conversion," available from https://americancarbonregistry.org/carbon-accounting/standards-methodologies/inactive-methodologies.

[76] See, for example, the Restoring a Forest Legacy at Upper Ouachita National Wildlife Refuge project as approved in 2011 by the Climate, Community, and Biodiversity Standard on the Verra Registry and Reed Porter et al., Restore America's Estuaries and the Marine Affairs Institute, *Legal Issues Affecting Blue Carbon Projects on Publicly-Owned Coastal Wetlands*, February 2020. For more information on the different types of federal land, see CRS In Focus IF10585, *The Federal Land Management Agencies*.

[77] The National Forest Foundation (NFF) was established by the National Forest Foundation Act, P.L. 101-593, Title IV (16 U.S.C. 583j). For more information on the National Forest System, see CRS Report R43872, *National Forest System Management: Overview, Appropriations, and Issues for Congress*.

[78] For more information on the NFF's projects, see U.S. Forest Service, San Juan National Forest, "Reforestation Project to Begin in Bear Creek Burned Area North of Vallecito," press release, October 7, 2011; and American Carbon Registry, "American Carbon Registry Named the Most Widely Used Forest Carbon Standard in North America," press release, November 5, 2012. The American Carbon Registry maintains an information page for each project: the San Juan National Forest Demonstration Project is available at https://acr2.apx.com/mymodule/reg/prjView.asp?id1=108; and the Angeles National Forest Carbon Demonstration Project is available at https://acr2.apx.com/mymodule/reg/prjView.asp?id1=168.

[79] U.S. Congress, Senate Committee on Energy and Natural Resources, *Hearing on Forest Management, Forest Products, and Carbon*, 117th Cong., 1st sess., May 20, 2021 (testimony of Mary Mitsos, NFF President and CEO). For information regarding the status of each project, see their respective project information page on the American Carbon Registry, as listed in the previous footnote.

[80] The American Carbon Registry project page for the San Juan National Forest Demonstration Project indicates the project is cancelled. More information on the project is available at NFF, *Carbon Demonstration Project San Juan National Forest Missionary Ridge*, October 2016. The project was verified in 2016.

[81] U.S. Forest Service, Ecosystem Services, NFF Carbon Capital Fund website at https://www.fs.fed.us/ecosystemservices/Carbon_Capital_Fund.

[82] For more information, see U.S. Forest Service, Ecosystem Services, NFF Carbon Capital Fund FAQs website at https://www.fs.fed.us/ecosystemservices/Carbon_Capital_Fund/faqs.shtml. See also U.S. Forest Service, *Modification No. 1 to the Master Memorandum of Understanding between the National Forest Foundation and U.S. Forest Service*,

reforestation activities—and did so prior to the establishment of the Carbon Capital Fund—and is reportedly pursing a new protocol through Verra for generating carbon offsets from forest restoration projects on NFS land.[83]

# Selected USDA Policies and Activities

USDA has broad general authority to assist agriculture and forestry operations through research, technical support, financial assistance, and education. The department's involvement in markets for environmental goods and services involving the agriculture and forestry sectors began mostly through various pilot programs starting in the 1990s with nutrient credit trading, wetland mitigation banking, and carbon offset projects.[84] These programs provided a market for farmers to sell nutrient, wetland, or carbon farm-based offsets to emitters/dischargers that were looking to buy offsets to mitigate their own emissions/discharges. In 2006, USDA released a departmental regulation defining its policy on market-based environmental services, citing interest in a variety of environmental factors (e.g., greenhouse gases, water, air, wetlands, and wildlife habitat) and mechanisms (e.g., credit trading, insurance, mitigation banking, and eco-labeling).[85] This departmental regulation did not create or increase USDA's authority and only applied internally to USDA agencies.

The Food, Conservation, and Energy Act of 2008 (2008 farm bill; P.L. 110-246), contained a new Environmental Services Markets provision (§2709) to facilitate the participation of farmers and landowners in environmental services markets. The Environmental Services Markets provision provided USDA new authority by directing the department to develop technical guidelines for measuring farm- and forestry-based environmental services. The provision provided priority to developing guidelines for participation in carbon markets. This was an indirect reference to various agriculture and forestry provisions in bills under consideration as part of the broader climate change debate at the time. Following enactment of the 2008 farm bill, USDA established the Office of Ecosystem Services and Markets, which was renamed the Office of Environmental Markets. Presently, both the Office of Environmental Markets and the Climate Change Program Office are under the same leadership within the Office of the Chief Economist.[86]

As part of implementing requirements of the Environmental Services Markets provision, USDA contracted with university and private researchers to develop technical guidelines and science-based methods for estimating the GHG and carbon sequestration impacts of agricultural and forestry practices at the individual farm, ranch, or forest scale. Two interim technical reports were released in 2011[87] and 2012,[88] and a final report was published in 2014.[89] The 2014 report

No. 1993-SU-11130000-035, July 2007.

[83] U.S. Congress, Senate Committee on Energy and Natural Resources, *Hearing on Forest Management, Forest Products, and Carbon*, 117th Cong., 1st sess., May 20, 2021 (testimony of Mary Mitsos, NFF President and CEO).

[84] USDA, Economic Research Service, "The Use of Markets to Increase Private Investment in Environmental Stewardship," ERR-64, September 2008.

[85] USDA, "USDA Roles in Market-Based Environmental Stewardship," Departmental Regulation 5600-003, December 20, 2006.

[86] For more information, see CRS Report R46454, *Climate Change Adaptation: U.S. Department of Agriculture*.

[87] Karolien Denef, Shawn Archibeque, and Keith Paustian, *Greenhouse Gas Emissions from U.S. Agriculture and Forestry: A Review of Emission Sources, Controlling Factors, and Mitigation Potential*, prepared by ICF International and Colorado State University for USDA, Interim Project Technical Report, December 2011.

[88] Ibid.

[89] Marlen Eve, et al., *Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale*

includes a set of consensus-based methods to account for GHG emissions associated with agriculture, forestry and land-use change activities at the entity scale.[90] The report provides the foundation for USDA entity-level tools, such as COMET-Farm and COMET-Planner, to estimate GHG benefits from conservation and land management activities.

COMET-Farm and COMET-Planner are online tools developed by USDA's Natural Resources Conservation Service (NRCS) and Colorado State University.[91] COMET-Farm provides a site-specific estimate of GHG emissions from on-farm operations based on existing management practices identified by the user. COMET-Planner provides generalized estimates of GHG impacts of select NRCS conservation practices if applied to an operation.[92] A modified version of COMET-Planner is currently used by the California Department of Food and Agriculture's Healthy Soils Program (HSP).[93] Under California's HSP, COMET-planner has been expanded to estimate GHG reductions, and it approximates program payments associated with NRCS conservation practices specific to HSP. HSP includes, among other components, financial incentives for farmers and ranchers to implement conservation practices that improve soil health, sequester carbon, and reduce GHG emissions.[94] The program is funded, in part, through the state's cap-and-trade program. Another adaptation of COMET-planner—the Carbon Reduction Potential Evaluation Tool—overlays data from the 2017 Census of Agriculture to allow comparisons among practices, estimated costs, and potential impact across states and regions.[95]

Another example is a tool created by USDA's Agricultural Research Service (ARS)—the Dairy Gas Emissions Model (DairyGEM). DairyGEM is a software tool for estimating ammonia, hydrogen sulfide, GHG, and volatile organic compound emissions of dairy production systems as influenced by climate and farm management.[96] The software predicts the GHG emissions from a simulated dairy production system.

USDA also conducts ongoing research to assess carbon sequestration and GHG emissions mitigation potential for agriculture and forestry through management and production practices. One example of such research is the Greenhouse gas Reduction through Agricultural Carbon Enhancement network (GRACEnet). GRACEnet is an ARS initiative with the primary objective "to identify and further develop agricultural practices that will enhance carbon sequestration in soils, promote sustainability and provide a scientific basis for carbon credits and trading programs."[97] Other research examples are GHG market grants funded through NRCS'

*Inventory*, USDA, Office of the Chief Economist, Technical Bulletin No. 1939, July 2014.

[90] Entity scale generally refers to all lands for which the landowner has management responsibility.

[91] COMET-Farm may be accessed at https://comet-farm.com/Home, and COMET-Planner may be accessed at http://comet-planner.com.

[92] NRCS develops and maintains a list of nearly 170 conservation practices standards. A practice standard includes information on why and where a practice is applied, as well as the minimum requirements that must be performed in order for it to achieve its intended purpose. These standards serve as technical guides that are modified to local conditions. NRCS also ranks select conservation practice standards according to their GHG reduction and carbon sequestration potential. The NRCS *GHG and Carbon Sequestration Ranking Tool* may be found at https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/air/quality/?cid=stelprdb1044982.

[93] To access the HSP version of COMET-Planner, see http://comet-planner-cdfahsp.com.

[94] For additional information, see California Department of Food and Agriculture, "Healthy Soils Program," at https://www.cdfa.ca.gov/oefi/healthysoils.

[95] For additional information, see American Farmland Trust, "The CaRPE Tool," at https://farmland.org/project/the-carpe-tool.

[96] For additional information, see https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/dairy-gas-emissions-model.

[97] USDA, ARS, "National Program 212: Soil and Air," *GRACEnet Introduction*, https://www.ars.usda.gov/natural-

Conservation Innovation Grants (CIG) program,[98] as well as projects under the Soil Health Demonstration Trial (SHD) component of CIG.[99] The SHD collects data on soil health effects of implementing conservation practices and systems, including carbon sequestration. The information collected includes the environmental and financial effects of implementing select practices. Similar to the objectives of GRACEnet, SHD data could add further evidence of the effects that agricultural practices have on carbon sequestration in soils, thus providing additional scientific evidence for designing and valuing carbon offsets and trading programs.

**USDA Forestry Carbon Measurement Resources**

The USDA Forest Service (FS) has several resources available related specifically to carbon sequestration and GHG mitigation on forests. For example, the FS's Forest Inventory and Analysis (FIA) program is responsible for collecting, analyzing, and reporting information on the nation's forest resources. The FIA program includes several resources related to measuring and quantifying the carbon on forested lands, such as providing access to remotely sensed information for carbon estimation. The FS also has developed various other tools related to carbon inventory, management, and reporting. For example, the Forest Vegetation Simulator is an approved tool to estimate carbon stock changes for offset projects registered by the American Carbon Registry.

For more information, see

FS, FIA, Forest Carbon Science and Reporting website at https://www.fia.fs.fed.us/forestcarbon/default.asp.

FS, Northern Research Station, Carbon Tools website at https://www.nrs.fs.fed.us/carbon/tools.

American Carbon Registry, Methodology for the Quantification, Monitoring, Reporting, and Verification of Greenhouse Gas Emissions Reductions and Removals from Afforestation and Deforestation of Degraded Land, Version 1.2, May 2017, https://americancarbonregistry.org/carbon-accounting/standards-methodologies/afforestation-and-reforestation-of-degraded-lands.

In March 2021, as part of the Biden Administration's *Executive Order on Tackling the Climate Crisis at Home and Abroad*, USDA issued a notice in the *Federal Register* requesting public comment on a series of questions related to climate-smart agriculture.[100] The department also held 10 stakeholder listening sessions with over 260 participants. In May 2021, USDA released a 90-day progress report based on this feedback that outlines seven recommendations for a "climate-smart agriculture and forestry strategy."[101] One recommendation focuses on ways USDA can support new and better markets for products generated through climate-smart practices. This includes recommending support for identifying and verifying GHG benefits and facilitating the participation of farmers, ranchers, and landowners.[102]

In September 2021, USDA announced that it would use the Commodity Credit Corporation to fund a new climate partnership initiative.[103] According to the request for information notice

resources-and-sustainable-agricultural-systems/soil-and-air/docs/gracenet-introduction.

[98] For additional information on CIG, see NRCS, "Conservation Innovation Grants," at https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig. For GHG market-specific CIG projects, see those listed under the "Greenhouse Gas Markets" heading of the NRCS Environmental Markets website: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/emkts/?cid=nrcseprd1396024.

[99] For additional information on the SHD, see NRCS, "CIG On-Farm Conservation Innovation Trials," https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/cig/?cid=nrcseprd1459039.

[100] USDA, Office of the Chief Economist, "Notice of Request for Public Comment on the Executive Order on Tackling the Climate Crisis at Home and Abroad," 86 *Federal Register* 14403, March 16, 2021.

[101] USDA *90-Day Progress Report* 2021.

[102] USDA *90-Day Progress Report* 2021, pp. 9-10.

[103] USDA, "USDA Announces $3 Billion Investment in Agriculture, Animal Health, and Nutrition: Unveils New Climate Partnership Initiative, Requests Public Input," press release, September 29, 2021. For additional information on the CCC, see CRS Report R44606, *The Commodity Credit Corporation (CCC)*.

published in the *Federal Register*, the Climate-Smart Agriculture and Forestry Partnership Program would focus the use of climate-smart practices in the marketing of agricultural commodities.[104] The term *climate-smart commodity* "refers to an agricultural commodity that is produced using farming practices that reduce GHG emissions or sequester carbon."[105] The notice requested information and ideas of how to overcome market related barriers such as lack of standard definitions of climate-smart commodities; lack of standards for measurement of climate benefits from conservation practices; high transaction costs; potential double-counting of benefits; and limited small producer participation. USDA is requesting comments on options to reduce or remove these barriers and to promote select climate-smart practices for new or increased market access. The USDA notice also posed specific questions, many similar to those outlined in the "Legislative Developments" section.

# Legislative Developments

Legislation introduced in the 117th Congress would address policies and activities associated with agriculture and forestry offsets and carbon markets. As of the writing of this report, the Senate had voted on one of the bills. None had received a vote in the House. The various proposed legislation discussed in this section would not set a price for carbon, create a federal carbon bank, or create or regulate a carbon market.

The Senate passed the Growing Climate Solutions Act of 2021 (S. 1251) on June 24, 2021. Its companion bill (H.R. 2820) was introduced in the House in April 2021, with original cosponsors from both parties. Both the House and Senate bills would authorize the Secretary of Agriculture to develop a program to reduce barriers to entry for farmers, ranchers, and forest landowners in voluntary environmental credit markets.[106] Among other components, these bills would create a USDA certification program for third-party verifiers and for providers of technical assistance to farmers and ranchers considering or implementing carbon offset protocols. The USDA certification program would establish qualifications for third-party verifiers and providers of technical assistance, and the legislation would require USDA to establish and maintain a list of USDA-backed protocols for voluntary environmental credit markets.[107]

Reactions to this legislation have been mixed. Among supporters, the legislation's sponsors assert that it would "help solve technical entry barriers that prevent farmer and forest land owner participation in carbon credit markets."[108] Among opponents, the Minority Leader of the House Agriculture Committee has called it a "big-government solution in search of a problem."[109] On September 23, 2021, the House Agriculture Committee held a hearing on "Voluntary Carbon

[104] USDA, CCC, "Climate-Smart Agriculture and Forestry Partnership Program," 86 *Federal Register* 54149, September 30, 2021.

[105] Ibid.

[106] The text of this bill refers to "environmental credit markets" and not specifically "carbon markets."

[107] The bills define a *voluntary environmental credit markets* as "a voluntary market through which agriculture or forestry credits may be bought or sold." They define an *agriculture or forestry credit* as "a credit derived from the prevention, reduction, or mitigation of greenhouse gas emissions or carbon sequestration on agricultural land or private forest land that may be bought or sold on a voluntary environmental credit market."

[108] Abigail Spanberger, "On Earth Day, Spanberger, Bacon Reintroduce Bipartisan Growing Climate Solutions Act with Broad Coalition of Support from Farm, Environment, & Industry Organizations," press release, April 22, 2021.

[109] House Committee on Agriculture Republicans, "Republican Leader Thompson Issues Statement on Growing Climate Solutions Act," press release, June 24, 2021.

Markets in Agriculture and Forestry."[110] During this hearing, Members expressed a variety of perspectives including both support for and opposition to a USDA role in standardizing voluntary carbon markets for agriculture and forestry.

Other bills introduced in the 117th Congress more specifically address forest carbon markets. For example, the Rural Forest Markets Act of 2021 (S. 1107/H.R. 3790) was introduced in the Senate in April 2021, and in the House in June 2021. This legislation would direct the Secretary of Agriculture to establish an investment program within USDA to provide financing of up to $150 million per project to facilitate the sale of forest carbon offsets in a carbon market (voluntary or other). The investment program could be through the issuance of an "environmental impact bond, loan, or other investment vehicle" as determined by the Secretary; the legislation does not define or provide any additional parameters regarding the financing. Eligible projects would use a protocol approved by a "credible, third party entity" and be on land that was historically forested using native tree species. The Secretary of Agriculture would be required to consider ways to minimize, to the extent practicable, disruptions to traditional forest products markets.

Another bill introduced in the 117th Congress would address generating forest offsets on federal lands. The America's Revegetation and Carbon Sequestration Act of 2021 (S. 2836) was introduced in the Senate in September 2021. Section 201 of the legislation would direct the NFF, in consultation with the Secretary of Agriculture, to establish and use a protocol for calculating the predicted increase in carbon sequestration—or avoided release of carbon due to reduced wildfire risk—for specified improved forest management (IFM) activities. The protocol would include estimating the carbon associated with timber harvesting and stored in durable wood products. The legislation would authorize the NFF to manage financial transactions between the federal government and any nonfederal entity related to the generation of carbon credits on specified NFS lands or participation in a carbon credit program, as defined in the bill.[111] The legislation would further authorize the Secretary to receive and use those funds for implementing specified IFM activities.

# Questions for Potential Policy Consideration

Congressional, corporate, and public interest in GHG mitigation and interest in the potential to create new financial opportunities for farmers, ranchers, and forest landowners has grown in recent years. New carbon market programs for agriculture and forestry continue to emerge in response. Carbon markets and carbon offsets in the agriculture and forestry sectors raise a number of questions for ongoing policy consideration. Included below are examples of some of the questions that Congress and others may consider during policy deliberation.

## General Questions

Generating high-quality and credible carbon offsets from agriculture and forestry can be expensive. Financial costs include program design; digital platforms for recordkeeping and data

[110] U.S. Congress, House Committee on Agriculture, Hearings, *Voluntary Carbon Markets in Agriculture and Forestry*, 117th Cong, 1st Sess., September 21, 2021.

[111] S. 2836 (as introduced) would not apply to National Forest System (NFS) lands east of the 100th meridian or those lands administered through the Bankhead-Jones Farm Tenant Act (7 U.S.C. §1010 et seq.; this generally refers to NFS lands designated as *national grasslands*) (§201(a)(4)). The bill defines a *carbon credit* as a carbon or greenhouse gas credit, offset or other defined unit as approved by a credible, third-party entity and as determined by the Secretary of Agriculture (§201(a)(1)). The bill would define a *carbon credit program* as a voluntary program or market that issues, assigns, trades, or sells carbon credits (§201(a)(2)). The bill would exclude activities which compete with or are adverse to the issuance, assignment, trading, or selling of forest carbon in the private sector (§201(a)(3)(E)).

collection, which may include sample collection or remote sensing with satellites; third-party verification; and carbon offset registration.

- Who might, or should, pay these administrative and transaction costs? The project developer? The participating farmer, rancher, or forest landowner? The end-purchaser of the carbon offsets? How might "who pays" be aligned with "who benefits"?
- If the participating farmer, rancher, or forest landowner pays for the transaction costs, what impact would this have on the potential profitability of enrolling in a carbon project?
- Are any of these programs likely to impose higher costs on consumers for finished goods? If so, which approaches may be likely to impose the most cost and which the least?

Private carbon market programs for agriculture and forestry have different recordkeeping and data sharing requirements. Participants must agree to these requirements.

- What protections, if any, should private carbon market programs implement regarding the security and privacy of participant data?
- Should private carbon market programs limit the data they collect in order to balance quality control with the time commitment and financial cost to participants?

Carbon offset supply and demand can be volatile in carbon markets.

- What factors drive demand for carbon offsets, and how may different policies affect demand?
- As project developers enroll more participants, and more carbon offsets are generated, how might this increase in supply affect the price of carbon offsets?
- Will participant concerns about the profitability of carbon offsets limit the supply of carbon offsets?

Most carbon markets seek new GHG reductions or carbon sequestration. As such, farmers, ranchers, and forest landowners who are already implementing climate-smart practices—or early adopters—are often either ineligible to participate in carbon market programs, or cannot financially benefit from generating carbon offsets.

- Should carbon markets consider or compensate early adopters, and if so, how?

Carbon market programs have different criteria regarding eligibility, allowable practices, and verification, among others. Less stringent requirements may reduce barriers to entry for farmers, ranchers, and forest landowners, but may call into question the additionality or permanence of the offsets they generate. More stringent requirements may increase barriers to entry, but strengthen the additionality and permanence of generated offsets. Offsets that do not meet stringent additionality or permanence criteria potentially may be sold in voluntary carbon markets.

- Are agriculture and forest carbon market programs achieving their intended goals of using agriculture and forestry practices to offset GHG emissions?
- Should there be safeguards or assurances for the quality of offsets sold in voluntary carbon markets?
- How should carbon market programs balance their accessibility to farmers, ranchers, and forest landowners, and their quality standards for carbon offsets?

# Considerations for Congress

Some have suggested that the federal government should play a role in establishing or supporting carbon markets, or in creating an enabling environment for the participation of forest landowners and agricultural producers in existing carbon markets. Others have argued that nonfederal entities should continue to play these roles without federal government involvement. Congress may consider a variety of questions as part of this debate.

## Potential Federal Role in Establishing or Supporting Carbon Markets

As Congress considers policy options related to carbon markets for the agriculture and forestry sectors, general questions remain about whether the federal government should be involved and if so, how much or how little involvement the federal government should have.

- Should the federal government play a role in establishing, implementing, overseeing, auditing, or participating (as a federal landowner) in voluntary carbon markets? What would be the federal government's proper role, if any?
- How might federal involvement impact the existing voluntary market structure?

For environmental services to be bought and sold in a marketplace, some basic market mechanisms must exist, including supply, demand, and rules for exchange. In most such markets, environmental services supply and demand is driven by government regulation. USDA is not the lead agency implementing federal regulations that typically underpin the establishment of environmental markets, including carbon markets.[112]

- How large a role should or could USDA have in carbon markets?
- Is there a role for regulations in this area, or are voluntary incentives sufficient to achieve the GHG mitigation?

Some have suggested that the federal government should play a role in stabilizing carbon offset prices by establishing a "carbon bank,"[113] while others have criticized this proposal.[114]

- Should the federal government play a role in stabilizing carbon offset prices? If so, what role? And why?

The number of private carbon market programs for agriculture and forestry is increasing. Each program has different requirements, potential costs, and potential benefits for participants. The Growing Climate Solutions Act of 2021 (S. 1251/H.R. 2820) would have USDA play a role in standardizing (1) protocols and (2) qualifications for third-party verifiers and providers of technical assistance associated with carbon markets.

- Is there a public benefit from the federal government compiling and comparing protocols, qualifications, and programs associated with carbon markets?

[112] For example, EPA oversees water quality trading under the Clean Water Act and the U.S. Fish and Wildlife Service (FWS) administers conservation banking in response to the Endangered Species Act. For more information, see EPA's water quality trading website at https://www.epa.gov/npdes/water-quality-trading, and FWS's conservation banking website at https://www.fws.gov/endangered/landowners/conservation-banking.html, respectively.

[113] See, for example, Robert Bonnie, Leslie Jones, and Meryl Harrell, "United States Department of Agriculture (USDA)," *Climate 21 Project*, November 2020.

[114] See, for example, Zack Colman, Liz Crampton, and Helena Bottemiller Evich, "Biden Mulls Giving Farmers Billions to Fight Climate Change. Even Farmers are Unsure about the Plan," *Politico*, March 29, 2021.

- Should the federal government assist farmers, ranchers, and forest landowners in evaluating private programs for their particular circumstances, or otherwise facilitate their participation in carbon markets?

## Protocols and Carbon Offset Quality

Transparent and scientifically sound GHG mitigation and sequestration protocols are typically required to build the confidence of carbon offset purchasers and other stakeholders in the quality of carbon offsets generated. Private carbon standards and carbon programs have developed different protocols for generating carbon offsets through various climate-smart practices in agriculture and forestry.

- How are private sector entities building stakeholder confidence in the quality of carbon offsets generated though agriculture and forestry?
- Is there a role for the federal government in researching and quantifying baseline conditions against which GHG mitigation or sequestration gains achieved through agriculture and forestry practices are measured?
- What role, if any, should the federal government play in developing efficient means of measuring or modeling soil carbon sequestration or GHG mitigation in agriculture and forestry?
- Should the federal government play a role in researching and developing scientifically sound protocols for generating carbon offsets in agriculture and forestry?
- Should the federal government play a role in curating, evaluating, certifying, or standardizing such protocols? If so, what should that role be?
- What role, if any, should the federal government play in rewarding early adopters for past agriculture and forestry practices or for continuation of these practices?

## Equity and Access to Carbon Markets

Congressional policymakers may consider whether all forest landowners and agricultural producers have equal opportunities to engage in carbon markets, and whether to act to address any barriers to participation. Some stakeholders have expressed concerns that factors such as land tenure and operation size may limit carbon market participation to certain landowners and agricultural producers. Regarding land tenure, farmers who rent at least some of the land they farm might not be in a position to enter into multiyear contracts under a carbon market program.[115] Regarding operation size, from one perspective, farmers, ranchers, and forest landowners with larger operations may have more opportunities to participate in carbon markets due to economies of scale and their likely lower transaction costs compared with those with smaller operations. Alternatively, those with smaller forestlands, farms, and ranches might have more opportunities to participate, because they are more likely to own their land and operate more diverse systems (e.g., they may farm a variety of crops or implement a variety of forestry or agricultural practices).

- What additional information, if any, would improve understanding of potential barriers to participation in carbon markets for agriculture and forestry?

[115] For more information on U.S. farmland ownership see USDA, Economic Research Service, "Farmland Ownership and Tenure," November 17, 2020, https://www.ers.usda.gov/topics/farm-economy/land-use-land-value-tenure/farmland-ownership-and-tenure.

- What role, if any, should the federal government play in resolving potential barriers to participation?
- What effect might existing federal policies and programs play in relieving or exacerbating such participation-related concerns?

Unequal access to high-speed internet—particularly in rural areas[116]—may affect farmer, rancher, and forest landowner participation in carbon markets. Some climate-smart agricultural practices require a high-speed internet connection to achieve optimal results (e.g., precision agriculture for fertilizer reduction).[117] Certain GHG mitigation protocols to generate forest and agriculture carbon offsets may also require broadband access (e.g., automated monitoring, reporting, and verification).

- What effect might existing federal policies and programs play in relieving or exacerbating broadband-related concerns of farmers, ranchers, and forest landowners, and what role might that play in access to carbon markets?

## Other Approaches: Alternatives to Carbon Markets

Throughout the U.S. economy, millions of discrete sources generate GHG emissions: power plants, industrial facilities, motor vehicles, households, commercial buildings, farms, and livestock. If Congress were to seek GHG reductions (or removals) from all or some of these sources, policymakers would face a range of options and considerations. For example, Congress could require emission reductions from specific sources or sectors through regulations, such as performance standards, or use market-based approaches to incentivize certain activities. Either approach could involve direct participation of the agriculture and forestry sectors. Analyzing whether agricultural and forestry emissions and potential to sequester GHGs should be included in a compliance program raises a range of issues, including those discussed in this report and others that are beyond the scope of this report. Such issues may include considerations of economic efficiency, implementation challenges, fairness and equity, among others.

Congress may consider supporting project-based GHG mitigation, particularly in the agriculture and forestry sectors, through policy frameworks that do not involve carbon markets. For example, policymakers could encourage GHG mitigation projects in sectors not covered by mandatory programs (e.g., emission caps or carbon taxes or fees) through direct funding programs or adoption of tax incentives, without linking the projects to a compliance market. To some degree, this approach has been underway through several programs implemented by USDA (see "Selected USDA Policies and Activities"). A compliance market program could provide funding for such approaches. For example, if Congress enacted a market-based approach, such as a carbon price or emissions cap for certain sectors, it would likely generate a new source of federal revenue that could be used to fund a program that supports a range of policy objectives through various actions, including GHG mitigation in the agriculture and forestry sectors.[118]

[116] For more information, see CRS In Focus IF11918, *Infrastructure Investment and Jobs Act: Funding for USDA Rural Broadband Programs*.

[117] Precision Agriculture Task Force, *Interim Report to the Federal Communications Commission*, "Examining Current and Future Connectivity Demand for Precision Agriculture," October 28, 2020.

[118] For a further discussion, see CRS Report R45625, *Attaching a Price to Greenhouse Gas Emissions with a Carbon Tax or Emissions Fee: Considerations and Potential Impacts*.

# Appendix A. Selected Existing Compliance Carbon Markets

This section discusses the two existing compliance carbon markets in the United States and the European Union's compliance market. It includes information about the role of carbon offsets in these programs.[119] To date, carbon offsets from agricultural activities have played a relatively minor role in existing compliance carbon markets—in terms of both approved offset project types and actual carbon allowances generated. Offsets from the forestry sector have played a more substantial role.

## California Cap-and-Trade Program

California established a GHG emissions cap-and-trade program that went into effect for the state's electric power sector and selected industries in 2013 and for fossil fuel distributors in 2015.[120] The program covers approximately 80% of the state's GHG emissions.[121] In California's program, approximately half of the emissions allowances are provided at no cost to covered sources and half are sold through quarterly auctions.[122] In the auction held in August 2021, the settlement price was $23.30/metric ton of carbon dioxide equivalent,[123] the highest auction price in the program's history to date.[124] Covered entities in California's program can use offsets to satisfy 4% of their compliance obligation.[125] Approved offset types include the following categories:

1. Livestock manure management projects
2. Mine methane capture projects
3. Ozone depleting substance projects
4. Rice cultivation projects
5. U.S. forests, including forestry management and avoided conversion projects
6. Urban forests, including tree planting and maintenance projects

[119] For a comprehensive list of compliance markets worldwide, including emission trading and carbon price programs, see World Bank, *State and Trends of Carbon Pricing* 2021, 2021.

[120] For further details of this program, see the cap-and-trade regulations CARB, "Cap-and-Trade Regulation," https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/cap-and-trade-regulation.

[121] CARB, "FAQ Cap-and-Trade Program," https://ww2.arb.ca.gov/resources/documents/faq-cap-and-trade-program.

[122] California Legislative Analyst's Office, *Cap-and-Trade Extension: Issues for Legislative Oversight*, 2017.

[123] This measure is used because GHGs vary by their global warming potential (GWP). GWP is an index that allows comparisons of the heat-trapping ability of different gases over a period of time, typically 100 years. Consistent with international GHG reporting protocols, EPA's most recent GHG inventory (April 2021) uses the GWP values presented in the Intergovernmental Panel on Climate Change (IPCC) 2007 Fourth Assessment Report.

[124] CARB, *Summary of California-Quebec Joint Auction Settlement Prices and Results*, August 2021.

[125] In a cap-and-trade program, covered entities must submit emission allowances to an implementing agency to cover the number of tons of GHGs emitted during the compliance period (e.g., the past year or the past several years). This requirement is referred to as the entity's compliance obligation. In California's program, covered entities can submit offsets in lieu of emission allowances to account for 4% of their obligation. In previous years, the offset limitation was 8% (2013-2020). The limitation increases to 6% in 2026. See California Code of Regulations (CCR), Title 17, Sections 95801-96022, https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/cap-and-trade-regulation.

As of September 2021, the state has approved and issued approximately 225 million offset credits.[126] To put this number in context, the cumulative allowance budget for the state's cap-and-trade program was approximately 2.5 billion allowances between 2013 and 2020.[127] U.S. forest projects have accounted for 82% of these offset credits; livestock projects have accounted for 4%.[128] Carbon offsets, particularly forestry projects, issued in California's cap-and-trade program have received scrutiny and criticism.[129] A discussion of these issues is beyond the scope of this report.

## Regional Greenhouse Gas Initiative (RGGI)

Eleven U.S. states participate in RGGI, a cap-and-trade program that went into effect in 2009 and applies to $CO_2$ emissions from electric power plants.[130] The $CO_2$ emissions from covered entities in the RGGI states account for approximately 18% of all energy-related $CO_2$ emissions in the RGGI states.[131] The vast majority of RGGI's emission allowances are sold in quarterly auctions. In RGGI's September 2, 2021, auction, the clearing price was $9.30/ton of $CO_2$, the highest auction price in RGGI's history.[132] RGGI limits offsets to 3.3% of a source's compliance obligation. RGGI offset projects must satisfy a set of detailed requirements (specific to a project type) and be certified by a third party. RGGI offsets must be located in RGGI states. RGGI limits offset projects to three project types:

1. landfill methane reduction;
2. forest sequestration, including afforestation, reforestation, improved forest management, and avoided forest conversion; and
3. avoided methane from manure management practices.

[126] *ARB Offset Credit Issuance Table*, available at CARB, "ARB Offset Credit Issuance," https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/arb-offset-credit-issuance.

[127] Table 6-1 in CCR Section 95841.

[128] *ARB Offset Credit Issuance Table*, available at CARB, "ARB Offset Credit Issuance," https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/arb-offset-credit-issuance.

[129] See, for example, Grayson Badgley et al., "Systematic over-crediting in California's forest carbon offsets program," *bioRxiv*, 2021, https://www.biorxiv.org/content/10.1101/2021.04.28.441870v1; the results of this study were discussed in Lisa Song and James Temple, "The Climate Solution Actually Adding Millions of Tons of $CO_2$ Into the Atmosphere," *ProPublica*, April 29, 2021; CARB responded to questions from Lisa Song (author of the *ProPublica* article) and made its responses available here, https://ww2.arb.ca.gov/sites/default/files/2021-04/nc-carb-response-to-propublica-forest-questions.pdf.

[130] Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey (rejoined in 2020), New York, Rhode Island, Vermont, and Virginia (joined in 2021). The Governor of Pennsylvania has taken steps for the state to join RGGI, but lawmakers in Pennsylvania's legislative bodies have voiced strong opposition to joining RGGI and the Governor's actions to join the program without enacting new legislation. For more information, see the Pennsylvania Department of Environmental Protection RGGI website, https://www.dep.pa.gov/Citizens/climate/Pages/RGGI.aspx.

[131] Based on 2018 $CO_2$ emissions data from the Energy Information Administration, https://www.eia.gov/environment/emissions/state; and 2018 RGGI covered $CO_2$ emissions from the nine RGGI states participating in 2014, at https://rggi-coats.org ("Emissions Reports").

[132] See RGGI's auction results at https://www.rggi.org/auctions/auction-results. RGGI measures its allowance prices in dollars per short tons. For comparison to other programs, this auction price equates to $10.2/metric ton.

The RGGI offsets tracking database lists one offset project: a landfill methane reduction project in Maryland that created approximately 53,000 emission allowances.[133] As a point of reference, the RGGI cap in 2021 is approximately 120 million allowances.

Offset projects in the RGGI program may garner increased interest, as RGGI's emission allowance prices have increased in the past year. The September 2021 auction price of $9.30/ton was 37% higher than the auction price from September 2020 ($6.80/ton).[134]

## European Union Emissions Trading System

In 2005, the European Union (EU) established the Emissions Trading System (ETS), a cap-and-trade program that covers emissions from the electricity sector, selected energy-intensive industries, and domestic aviation.[135] The EU-ETS covers about 40% of total GHG emissions in the EU.[136] The EU-ETS is a key component of the EU's climate mitigation policies. In December 2020, the EU updated its Nationally Determined Contribution (NDC) under the Paris Agreement[137] to include a target of 55% reduction in GHG emissions by 2030 compared with 1990 levels.[138] Between September 2020 and September 2021, EU-ETS emission allowance prices increased from 30 Euros/metric ton to 60 Euros/metric ton (approximately $35/metric ton to $70/metric ton).[139]

Between 2008 and 2020, the EU-ETS allowed covered sources to use specified amounts of offset credits developed from projects located within the EU or in non-EU countries. Starting in 2021, offset projects are not allowed as a compliance option within the EU-ETS program.[140] A discussion of the factors that led to this shift in policy is beyond the scope of this report.[141] Certain project types, particularly land use, land-use change, and forestry (LULUCF) projects, were never eligible to generate offset credits within the EU-ETS.

[133] See RGGI's website at https://www.rggi.org/allowance-tracking/offsets.

[134] RGGI allowance prices are in dollars per short tons. To convert RGGI allowance prices to dollars per metric tons, multiply by 1.1. For example, $9.30/short ton equals $10.23/metric ton.

[135] For more information, see the European Commission EU ETS website, https://ec.europa.eu/clima/policies/ets_en.

[136] European Commission, "EU Emissions Trading System (EU ETS)," https://ec.europa.eu/clima/policies/ets_en.

[137] The Paris Agreement is part of the United Nations Framework Convention on Climate Change (UNFCCC), which has been the primary multilateral vehicle since 1992 for international cooperation among national governments to address GHG-induced climate change. For more information, see CRS In Focus IF11746, *United States Rejoins the Paris Agreement on Climate Change: Options for Congress*.

[138] For more information, see CRS In Focus IF11431, *EU Climate Action and Implications for the United States*.

[139] EU-ETS allowance prices from Intercontinental Exchange, https://www.theice.com/index. Conversion to U.S. dollars based on exchange rate of 1.16.

[140] For more discussion, see the EU-ETS website, "Use of International Credits," https://ec.europa.eu/clima/policies/ets/credits_en.

[141] Experience with certain offset projects likely played a role in this shift. The non-EU projects were developed within the framework of the Clean Development Mechanism (CDM) developed under the Kyoto Protocol. Projects were assessed on an individual basis and approved by an Executive Board in the United Nations. An independent third-party verified the projects emission reductions. Some offset projects developed under the CDM raised concerns of additionality and likely damaged the credibility of offsets in general to some degree. See, for example, Matthew Ranson and Robert N. Stavins, "Linkage of Greenhouse Gas Emissions Trading Systems: Learning from Experience," *Climate Policy*, vol. 16, no. 3 (2015).

# Appendix B. Historical U.S. GHG Emissions and Selected GHG Emissions Targets

The Biden Administration communicated a new Nationally Determined Contribution (NDC) to the Paris Agreement,[142] which contains a new greenhouse gas (GHG) target for the United States: to reduce net GHG emissions by 50%-52% below 2005 levels by 2030.[143] According to the Biden Administration, the NDC "exceeds a straight-line path to achieve net-zero emissions, economy-wide, by no later than 2050."[144] For comparison, the previous U.S. NDC set a target of 26-28% below 2005 levels by 2025, which President Obama had indicated was on a straightline trajectory to a reduction of 80% below 2005 levels by 2050. The content of NDCs is nationally determined and nonbinding, but it should reflect what a party to the Paris Agreement intends to achieve.

**Figure B-1** shows historical net GHG emissions with the 2015 and 2021 NDCs and the Biden Administration's net-zero emissions goal for 2050. In 2019, U.S. GHG emissions, after accounting for removals by carbon sinks, were 5,769 MMT $CO_2$e.[145] The 2019 net GHG emissions were about 13% below net 2005 levels and about 4% above net 1990 levels.

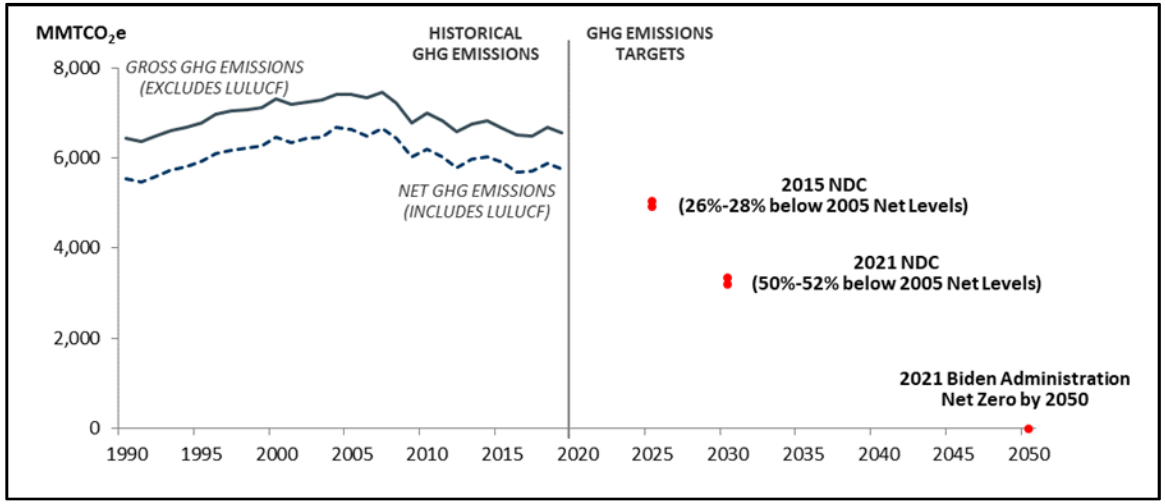
[142] A key requirement of the Paris Agreement is that all Parties communicate their "Nationally Determined Contributions" (NDC) every five years, containing a GHG reduction pledge and actions, though this content of an NDC is not binding. As the United States has newly (again) become a Party, the United States must submit a new NDC.

[143] The White House, *The United States of America Nationally Determined Contribution Reducing Greenhouse Gases in the United States: A 2030 Emissions Target*, April 22, 2021. Hereinafter, 2021 U.S. NDC.

[144] 2021 U.S. NDC, p. 23. Net-zero emissions refers to a situation where any continued human-caused GHG from an entity (e.g., country, subnational government, company) is balanced by human, or anthropogenic, carbon removal from the atmosphere that stores the $CO_2$ in geological, terrestrial, or ocean reservoirs or in products.

[145] U.S. gross emissions (not net of sinks) were 6,558 MMT $CO_2$e in 2019. U.S. sinks removed about 789 MMT in 2019, about 12% of gross emissions (U.S. Environmental Protection Agency, *U.S. Inventory of Greenhouse Gas Emissions and Sinks: 1990-2019*, 2021).

## Figure B-1. Historical U.S. GHG Emissions and Selected GHG Emissions Targets




**Source:** Prepared by CRS. Historical emissions from the U.S. Environmental Protection Agency (EPA), *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, 2021, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

**Notes:** Net greenhouse gas (GHG) emissions includes net carbon sequestration from land use, land use change, and forestry (LULUCF). This involves carbon removals from the atmosphere by photosynthesis and storage in vegetation and soil. Million metric tons of $CO_2$ equivalent ($MMTCO_2e$) is used because GHGs vary by global warming potential (GWP). GWP is an index developed by the Intergovernmental Panel on Climate Change (IPCC) that allows comparisons of the heat-trapping ability of different gases over a period of time, typically 100 years. Consistent with international GHG reporting requirements, EPA's most recent GHG inventory (April 2021) uses the GWP values presented in the IPCC's 2007 Fourth Assessment Report.

The GHG emission targets are the U.S. Nationally Determined Contributions (NDCs) pursuant to the Paris Agreement. For more information on these targets and the Paris Agreement, see CRS In Focus IF11746, *United States Rejoins the Paris Agreement on Climate Change: Options for Congress*.

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