



U.S. DEPARTMENT OF AGRICULTURE

The Role of Agriculture in Climate Change Mitigation



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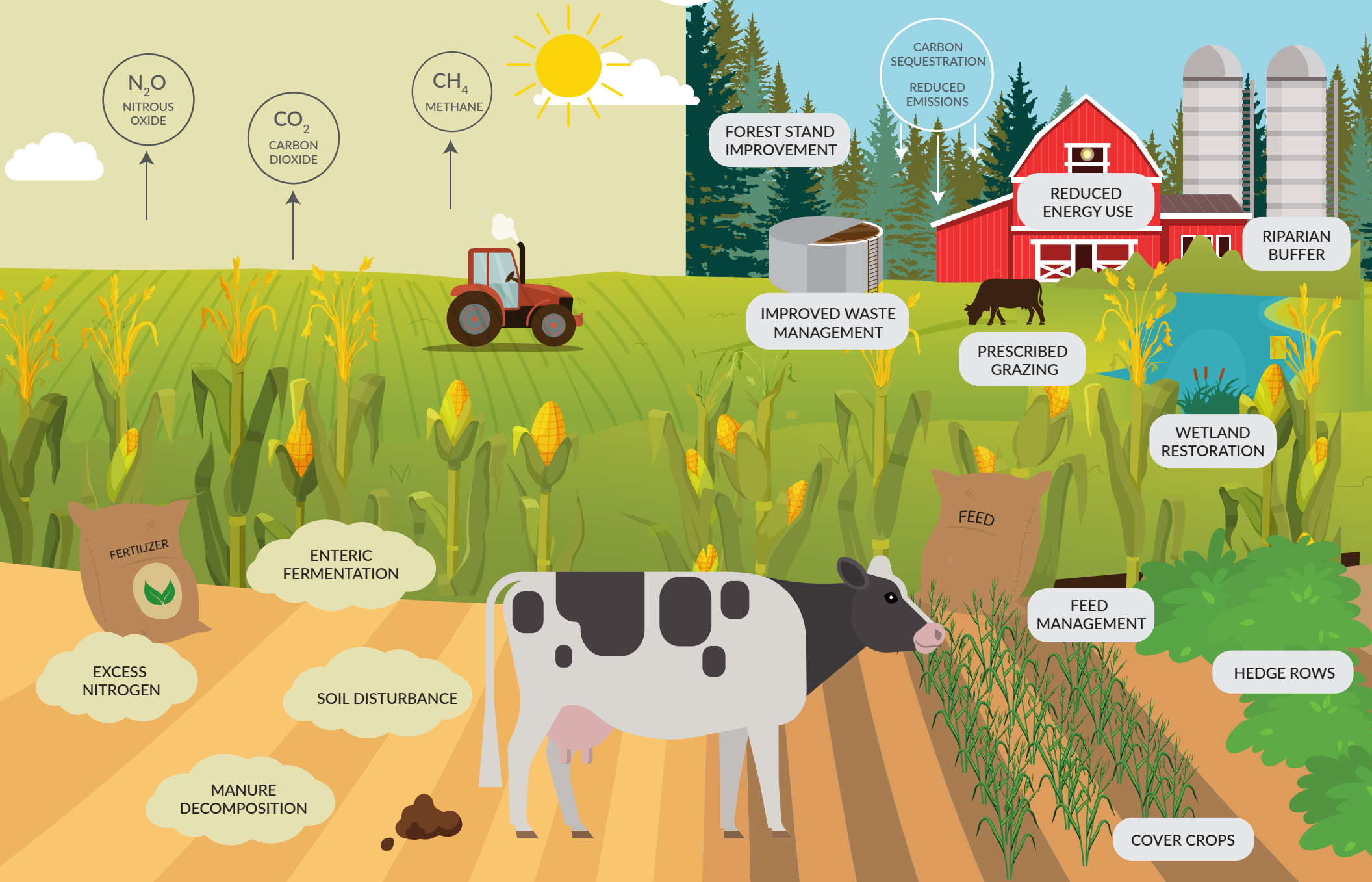
Natural Resources Conservation Service

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AGRICULTURAL EMISSIONS



CLIMATE-SMART SOLUTIONS





Producers and land managers are experiencing firsthand the impacts of climate change, which is caused by the build-up of greenhouse gases (GHGs) in the atmosphere. The agriculture sector is in a unique position – agriculture is a source of GHG emissions but can also be part of the climate change solution. Agricultural producers can play a big role in mitigating climate change by reducing greenhouse gas emissions or removing carbon dioxide from the atmosphere and storing it above or below ground. How does agriculture contribute to greenhouse gas emissions, and how can producers be part of the solution?

How Does Agriculture Contribute to Greenhouse Gas Emissions?

The three primary GHGs of concern in the United States are carbon dioxide, methane and nitrous oxide. In 2022, these three GHGs accounted for 97 percent of emissions in the United States.¹

- ♦ **Carbon dioxide (CO₂)** – 80 percent of total emissions. The largest source is fossil fuel combustion for transportation and power generation.
- ♦ **Methane (CH₄)** – 11 percent of total emissions. Major sources are decomposition of wastes in landfills, enteric fermentation associated with domestic livestock, and natural gas systems.
- ♦ **Nitrous oxide (N₂O)** – 6 percent of total emissions. Major sources are agricultural soil management, wastewater treatment, stationary sources of fuel combustion, and manure management.

Each of these GHGs have different effects on climate change. One reason is the amount of time each of them stay in the atmosphere. Emitted today, carbon dioxide remains in the atmosphere for thousands of years, nitrous oxide remains on average more than 100 years, while methane lasts about 10 years. These GHGs also differ in their ability to trap heat in the atmosphere. When compared to carbon dioxide, nitrous oxide is 265 times more potent, while methane is 28 times more powerful (when evaluated over a 100-year period), making them important GHGs to target for near-term climate mitigation.²

Agriculture contributes about 10 percent of total United States GHG emissions.

¹EPA (2024). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022 U.S. Environmental Protection Agency, EPA 430R-24004. <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022>.

²EPA (2024). “Understanding Global Warming Potentials.” <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>



In 2022, three activities accounted for about 95 percent of United States agriculture sector emissions:

- ♦ **Soil management contributed 49 percent** in the form of **nitrous oxide** from soils. The emissions are associated with activities that increase nitrogen availability, disturb soils, and increase oxidation, such as fertilizer application, irrigation, drainage of organic soils and other agricultural practices.
- ♦ **Enteric fermentation accounted for 32 percent** as **methane emissions** from microbial fermentation that takes place in ruminant animals (e.g., cows, sheep, goats) during the digestive process.
- ♦ **Animal manure management contributed 14 percent** in the form of both **methane and nitrous oxide**. **Methane emissions** are mainly associated with livestock and poultry manure that is stored and treated in liquid systems that promote anaerobic decomposition (e.g., lagoons, ponds, tanks, pits). **Nitrous oxide emissions** occur both directly (excreted from animals) and indirectly (volatilization, runoff, and leaching).

Other minor sources of emissions include methane from rice production, methane and nitrous oxide from burning residues, and carbon dioxide from urea fertilization and liming. Carbon dioxide, methane and nitrous oxide emissions from stationary and mobile on-farm energy, such as fuel consumption from tractors and combines, are also sources of emissions on agricultural operations. Converting forest and grasslands to cropland can also cause emissions as carbon stored in biomass and soils is released during conversion.

At the same time, land use and forestry practices also act as sinks, absorbing or sequestering carbon dioxide from the atmosphere. **In 2021, these sink sources offset about 12 percent of the total GHG emissions in the United States.** Maintaining key land uses, including forests and cropland, and increasing tree cover, biomass, organic matter, and soil carbon across a variety of land uses can help to maintain and further enhance this sink.

How Can Agriculture Be Part of the Solution to Mitigate Climate Change?

Agricultural producers can play an important role in mitigating climate change by both reducing their on-farm emissions from these sources and enhancing the sinks by increasing carbon sequestration in biomass and soils.

The U.S. Department of Agriculture (USDA) is committed to helping agricultural and forestry producers to be part of the climate change solution. USDA's Natural Resources Conservation Service (NRCS) is leading much of this effort by implementing the parts of the Biden Administration's Inflation Reduction Act that provide an additional \$19.5 billion over five years to support climate change mitigation practices in agriculture.

These Inflation Reduction Act funds, in addition to Farm Bill funds, are available to producers through existing NRCS conservation programs: the Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), Agricultural Conservation Easement Program (ACEP) and Regional Conservation Partnership Program (RCPP). Inflation Reduction Act funds, however, must be used for activities that support climate change mitigation.



NRCS Climate-Smart Agriculture and Forestry (CSAF) Mitigation Activities List

The USDA developed the [NRCS Climate-Smart Agriculture and Forestry \(CSAF\) Mitigation Activities List](#) to identify the conservation activities that provide mitigation benefits, which are eligible for Inflation Reduction Act funding.

The activities on this list are included with the expectation they meet two criteria:

1. Is the activity expected to provide net greenhouse gas emission reductions or removal, as supported by the scientific literature?
2. Is there a science-based method to quantitatively estimate these mitigation benefits?

CSAF Mitigation Activities include those that reduce GHG emissions, such as **Nutrient Management** (590) and manure management improvements like **Waste Separation Facility** (632), as well as those that can sequester carbon or increase carbon stocks both above and below ground such as **Conservation Cover** (Code 327) and **Tree-Shrub Establishment** (Code 612).

Updating the CSAF Mitigation Activities List to Keep Up with the Science

Throughout the year, the NRCS Climate Office accepts recommendations for changes (additions or removals) to the CSAF Mitigation Activities List from stakeholders, state technical committees, internal technical staff, other agencies, and the public. The NRCS Climate Office reviews the recommendations and shares them with the NRCS National Discipline Lead (such as the National Agronomist and National Forester), the subject matter expert for the practice. The National Discipline Lead then convenes a team of subject matter experts to formally review the recommendation and examine literature. A review team evaluates the recommendation against the two criteria above.

This same evaluation process is used when an activity is recommended for removal, for example when a practice standard is revised or when new scientific literature or findings are made. After thorough evaluation, the recommendations are provided to the NRCS Chief for decision on changes to the annual list.

Implementing CSAF Mitigation Activities to Provide Mitigation Benefits

Many of the CSAF Mitigation Activities can be implemented in a variety of ways and still have the potential to provide mitigation benefits, including reducing emissions or increasing carbon sequestration.

These include activities such as:

- ♦ **Conservation Cover** (Code 327), **Field Border** (Code 386), **Vegetative Barriers** (Code 601), **Range Planting** (Code 550), **Tree-Shrub Establishment** (Code 612) – establishing and maintaining perennial cover to increase carbon sequestration and contribute to soil carbon stocks.

- ♦ **Soil Carbon Amendment** (Code 336) – improving or maintaining soil organic matter, sequestering carbon and enhancing soil carbon stocks, improving soil aggregate stability, and/or improving habitat for soil organisms.
- ♦ **Residue and Tillage Management, No-till** (Code 329) and **Reduced Till** (Code 345) – reducing soil disturbance, reducing oxidation, and utilizing crop residues – collectively leading to fewer emissions and increased carbon sequestration.

It's important to note that some CSAF Mitigation Activities are expected to provide mitigation benefits only when implemented in a specified way, and that specific implementation is therefore eligible for Inflation Reduction Act funding.

Below are some examples:

- ♦ **Feed Management** (Code 592) – when used to reduce enteric methane emissions from animal feeding operations by manipulating the quantity and quality of dietary nutrients, incorporating feed additives and feed ingredients, or adjusting concentrate-to-forage ratio in livestock and poultry diets to lower methane produced and emitted during digestion.
- ♦ **Combustion System Improvement** (Code 372) – when replacing an existing on-farm motorized device (i.e., tractor, loader, forklift, etc.) powered by an internal combustion engine with a new motorized device powered by an electric motor. May also be used to repower or replace an existing stationary engine (e.g., irrigation engine, etc.) with an electric motor.
- ♦ **Waste Storage Facility** (Code 313) – when a compost bedded-pack system (a waste storage structure where manure is composted within the animal housing) is implemented, reducing emissions compared to a typical liquid storage system.

For more information and examples, see this additional [planner guidance](#).





Improving USDA's Ability to Understand and Measure Mitigation Outcomes

To better understand and measure the climate impacts of these CSAF Mitigation Activities and improve GHG estimates, the Inflation Reduction Act also invests \$300 million over eight years to support USDA's broader Measuring, Monitoring, Reporting and Verification (MMRV) efforts, including:

- ♦ Improving the models used to estimate GHG emissions and soil carbon storage.
- ♦ Improving estimates of the GHG benefits of NRCS conservation programs and practices, as well as the national GHG Inventory.

For more information, see [USDA Investment in Improved GHG Measurement, Monitoring, Reporting and Verification for Agriculture and Forestry through the Inflation Reduction Act](#)

Learn More

For more information on the Inflation Reduction Act, visit: nrcs.usda.gov/inflation-reduction-act.

