

Recommendations to Strengthen USDA's Support of Research and Science for Climate-Smart Agriculture

Robust and targeted research and science are fundamental to U.S. food and agriculture's response to climate change and our ability to leverage the sector to provide natural climate solutions. Our food system is vulnerable to a changing climate but also has the potential to mitigate greenhouse gases through innovative natural climate solutions that build soil health, farm resilience, and deliver ecosystem services to rural and urban communities alike. We need a research enterprise that is laser focused on the challenges before us. We need a national effort on improving soil health; soil carbon sequestration research, measurement, and verification techniques; animal feeds that reduce enteric emissions; and new seed varieties including cover crops that help us sequester more carbon or are otherwise adapted to climate change. We need a strong evidence-base to underpin public and private investment. We also need economic research and behavioral studies about new practice adoption, along with continuously improving models and predictive capacity. Strong USDA investment in research will enable U.S. agriculture to harness mitigation and market opportunities and meet the challenge of a changing climate head on.

CFAD is also releasing two additional resources: a set of recommendations for investing in federal programs to expand on-farm conservation adoption and a concept note for the development and operation of a USDA "Climate Bank," creating financial incentives for land management innovation on hundreds of millions of acres of working lands to curb the effects of climate change. These actions will promote broader adoption of agricultural conservation practices on working lands and improve farm profitability, increase resilience, reduce risk, enhance environmental performance, and sequester carbon. USDA has the opportunity to send a strong signal to farmers, ranchers, and foresters; the supply chain; and the American public that our food system is committing to climate-smart agriculture and forging a path toward net zero emissions. CFAD looks forward to working with USDA and Congress as they develop policy and programs that work for producers, the environment, and society.

About CFAD

AGree's [Climate, Food, and Agriculture Dialogue](#) includes farmers, ranchers, and foresters; environmental NGOs; supply chain companies; and former government officials. We share a common view that **climate change demands ambitious and durable federal policy solutions that are commensurate with the urgency and scale of the problem.** We see U.S. food and agriculture system as a crucial source of solutions to climate change. These solutions must provide transparency and promote affordability while distributing costs and benefits in such a way that promotes equity and value to land managers. The scientific consensus that the climate is changing at an increasingly rapid pace is incontrovertible. The timeframe for taking meaningful action to avoid catastrophic impacts is running short. Our guiding principles for federal policy on climate change and food systems can be viewed [here](#).

Introduction

USDA is the leading funder of basic and applied agricultural research, through both intramural and competitive mechanisms. In this document, we outline priorities to enable USDA to bring climate change mitigation solutions within a broader scope of federal and private investment in agricultural research. Research to support producers' ability to adapt to the variable conditions caused by climate change is important but is not the subject of this paper.

Federal climate change mitigation research spans multiple USDA research and extension agencies and programs, as well as other federal agencies. Much is already known about agricultural practices and technologies that can reduce emissions or sequester carbon while contributing to soil health or other agronomic goals. Collectively, we refer to systems that use these practices and technologies as "climate-smart agriculture."

Research can improve the evidence base around climate-smart agriculture where there are still gaps, identify and inform strategies to overcome barriers to adoption at scale, monitor trends in GHG emissions and sequestration on agricultural and forest lands, and align goals at the farm scale with those of ecosystems and society at larger scales. Our recommendations focus on USDA and its federal partners as these provide the largest levers to achieve scale of mitigation. At the same time, these recommended actions will support and expand upon important work being conducted by land grant institutions, other universities and institutes, the Foundation for Food and Agriculture Research (FFAR), commodity and grower groups, and the private sector.

Goals and Objectives

For USDA to achieve its goal of advancing climate-smart agriculture, it must strategically align its vast research expertise and resources. A climate-smart agriculture research enterprise should be developed that coordinates economic, social, and environmental sustainability research across USDA mission areas, the US government, and non-federal research partners and builds the research infrastructure needed to facilitate this important work.

USDA research needs to be precompetitive, scalable, and benefit all farmers, ranchers, and foresters in order to achieve near term impacts and position the diversity of U.S. agricultural systems to make ambitious and durable contributions to climate change mitigation. We recommend that USDA's research and science programs focus on a limited number of specific objectives to achieve this goal:

- I. Coordinate science and research to maximize the effectiveness and impact of public investments.
- II. Build the business case for climate-smart agricultural practices, including the case for public benefits and public investments in farmer incentive programs.
- III. Improve USDA data sharing policies and infrastructure to facilitate research conducted by trusted partners.
- IV. Support equitable engagement by diverse producers and agricultural systems.

- V. Improve the rigor of climate models and measurements to support the U.S. Greenhouse Gas Inventory and reduce risk in private environmental markets.
- VI. Create new tools and practices to expand the climate-smart agriculture toolkit.

I. Coordinate Science and Research

Coordinating USDA's climate research investments is critical to ensure that USDA funding has the greatest impact and best complements and leverages private sector research investments.

USDA's immediate, highest priority should be to create a "Climate Research Coordinator" position to develop a coherent "all of USDA" climate research strategy across its agencies, coordinate climate research with other federal agencies, and engage with external research stakeholders. This position could be created in the Office of Chief Scientist to work with the Secretary's USDA Climate Advisor and other climate research leads within USDA.

A Climate Research Coordinator should be tasked with preparing an inventory of USDA climate mitigation and adaptation research to better leverage existing efforts, identify gaps for future research, and avoid duplication in efforts. This inventory should include research conducted by the Office of Research, Education and Economics (ARS, ERS, NIFA, AFRI, NASS), plus the Office of Farm Production and Conservation (NRCS, RMA, FSA) and the Office for Trade and Foreign Agriculture Affairs (FAS), as well as other federal agencies engaging in climate research including the Environmental Protection Agency, National Science Foundation, U.S. Geologic Service, Department of the Interior, Department of Energy, and USAID.

USDA should publicly release an annual report of the inventory's findings and host "state of the science" meetings to engage the research community and other stakeholders. External research stakeholders that should be engaged include historically black colleges and universities, land grant institutions, food and agriculture technology companies, foundations, think tanks, forestry and agricultural groups, non-governmental organizations, and leading public and private sector researchers from the international community.

In addition to coordinating research moving forward, USDA should analyze existing research archives to mine datasets that can provide useful insights moving forward. Historic information can be used to build the evidence base for climate-smart practices and support efforts to set industry baselines for carbon sequestration. Understanding the body of agricultural research to date will support the Climate Research Coordinator in developing a cohesive and informed research agenda moving forward.

II. Build the Business Case for Climate-Smart Practices

Farmers, ranchers, and foresters will only adopt climate-smart practices at the rate needed to substantially reduce agricultural emissions once they understand the clear economic benefits of doing so. USDA-supported intramural and extramural research can play a critical role in building this business case for co-investments in climate-smart agriculture practices by individual producers while articulating

the return on investment to society from public investment and supporting development of the private marketplace.

USDA should direct research assets to conduct precompetitive analysis and modeling that demonstrates the economic value associated with climate-smart agriculture practices, including by:

- Estimate the cost of implementation and return on investment for individual growers that adopt individual or stacked climate-smart practices.
- Quantify the public benefits derived from climate-smart practices, including landscape-level impacts. These could include linked benefits between working lands and built environments for flood risk reduction, water quality improvements or fire risk reduction (e.g., [Iowa Watershed Approach](#) funded by HUD), as well efforts to quantify multiple benefits from existing farm programs like the Conservation Reserve Program.
- Research the longevity and durability of environmental benefits from climate-smart practices, including dynamics such as the relationship between the length of practice implementation and accrual of soil carbon, the effects of practice reversion/termination and variability across geographies and production systems.
- Study potential positive and negative impacts of current federal policy incentives on conservation practice adoption and crop and livestock diversification, including how adjustments to the federal crop insurance could promote conservation. This work could also consider the use of Marketing Assistance Loans for diversification of farming operations.

This research should consider impacts of climate-smart practices on the diversity of agricultural operations, including dynamics such as size, region, commodity, and level of capital that can influence profitability. Building the business case for conservation is a keystone for increasing adoption of practices and should be a priority that is expressed in research projects across the board, not segmented into siloed research projects. Most importantly, the findings must be shared with producers and other agriculture stakeholders. Technical assistance providers, particularly NRCS field offices and land grant university extension offices, can help with disseminating information to producers that is specific to their geographic area.

III. Improve USDA Data Sharing Policies and Infrastructure

Connecting the extensive agricultural research community to USDA's vast agricultural datasets is a critical strategy to quickly and efficiently answer key research questions about the multiple benefits of climate-smart agricultural practices while building trust across the agricultural research community.

USDA should engage trusted research partners in advancing USDA research priorities by developing data sharing and research infrastructure that allows farmers and university researchers to access anonymized USDA datasets. The scale and scope of the agriculture research investments needed to meet the climate crisis can be accomplished through developing partnerships with land grant universities, commodity groups, and others. USDA has several datasets that can be used by external researchers to relate conservation practices to farm profitability, helping to build the business case for climate-smart agriculture.

USDA data infrastructure should be modernized in a way that respects farmer data privacy and autonomy, reduces reporting burden, and communicates useful research conclusions back to producers to inform decision-making. By investing in improvements to data collection systems and streamlining data management processes, USDA can simplify the data reporting process, which is overly burdensome for many farmers and ranchers. Creating channels to clearly communicate how producer data is being used, allowing producers to opt in or out of research projects, and allowing producers that opt in to easily access their data and research results can build trust in the farmer and rancher community that their data is being used responsibly and effectively to generate knowledge that will ultimately benefit their operations.

IV. Support Equitable Engagement by Diverse Farmers, Ranchers, and Farming Systems

For the entire agricultural sector to succeed in reducing its emissions, all types of producers must be engaged. **USDA should therefore ensure that diverse farmers, ranchers, and farming systems can participate in federal conservation programs and adopt climate-smart agricultural practices.** This is key to reaching scale of adoption in an equitable way. Strategies for supporting equitable producer engagement include:

- Partner with state Departments of Agriculture, land grant cooperative extension offices, and NGOs to expand extension and outreach, particularly to small and disadvantaged farmers and non-operating landowners.
- Conduct engagement and extension to historically disadvantaged farmers and ranchers, drawing from examples in the Sustainable Agriculture Research and Education (SARE) program.
- Conduct social science research to identify barriers to adoption of climate-smart agriculture practices. In particular, study barriers to participation in USDA conservation incentive programs by diverse agricultural producers and producers who rent farmland. Use these findings to identify ways to adjust programs to encourage robust participation.
- Consider the impacts of climate-smart practices on the diversity of agricultural operations, including dynamics such as size, region, commodity, and level of capital that can influence profitability.
- Expand the Specialty Crop Block Grant program to include more emphasis on mitigation practices across the diversity of regional farming systems in coordination with state Departments of Agriculture.

V. Improve the Rigor of Climate Models and Measurements

USDA should improve the rigor and transparency of climate models and measurements to support the efforts of the U.S. Greenhouse Gas Inventory and private ecosystem service markets. Research and science can help ensure that federal investments in climate-smart agriculture and forestry are backed by strong science, using both intramural and extramural research to build the evidence base around the contribution of agricultural practices to greenhouse gas emissions and carbon sequestration. A national

monitoring system that addresses both field-scale and landscape-level climate impacts in particular could enhance the rigor of the measurements and models that underlie public investments and private markets. There is an opportunity to scale up soil monitoring systems now, while developing new technologies that will drive down costs in the future. **The following measures will help USDA build the foundational knowledge necessary to measure the climate impacts of agricultural systems and practices with greater rigor than current efforts can achieve:**

- Improve the modeling of greenhouse gas emissions and carbon sequestration in agricultural soils by funding and conducting research to improve baselines and account for regional variability, greater differentiation of crops and livestock, forestry systems, increased spatial resolution and sources of uncertainty.
- Establish a national soil carbon and nitrous oxide emissions monitoring network, leveraging Agricultural Research Service and Natural Resource Conservation Service research sites together with land grant universities. Research the durability of carbon sequestration, including dynamics such as the relationship between the length of practice implementation and accrual of soil carbon, effects of practice reversion and termination.
- Integrate remote sensing tools (e.g., LIDAR, satellite imagery) with Forest Inventory and Analysis (FIA) and other field plots to improve accuracy and resolution of estimates of greenhouse gas emissions and sequestration in woody biomass (including forests, trees in croplands and grasslands, and urban trees).
- Increase the frequency of the Conservation Effects Assessment Project (CEAP) and add specific climate research objectives to enhance understanding of the relationship between conservation practices, greenhouse gas emissions, and carbon sequestration.
- Develop and pilot more precise and cost-effective carbon measurement tools for agricultural soils.
- Assess and coordinate USDA, DOE and ARPA-E SMARTFARM programs to research and quantify the net greenhouse gas footprint from different biofuel feedstocks, including land use impacts and opportunities for expanded use of agricultural biomass and processing food loss and waste.
- Link the National Soil Web Survey and the National Resources Inventory to better leverage these tools for monitoring changes in soil carbon storage.

VI. Expand the Climate-smart Ag Toolkit

USDA should expand knowledge of climate-smart agricultural practices and develop new practices to accelerate climate change mitigation progress across the full diversity of U.S. production systems.

There is a strong body of existing knowledge about the benefits of common conservation practices in major row cropping systems (e.g., cover cropping and no till) that can be leveraged to expand adoption of some practices today, recognizing variations in efficacy across different geographies and production systems. However, there is also a need to develop new strategies and practices, particularly for other crops; new crop varieties that are both more resilient to climate change and have a smaller GHG footprint; more tools for the major sources of emissions from livestock and nitrogen application; bioenergy from crop, food processing and livestock waste management; and on-farm energy use. Tools that work with the constraints and economics of smaller operations should be considered.

Some research initiatives to expand the climate-smart agriculture toolkit may fit within existing intramural and extramural research initiatives, such as within the Agricultural Research Service (ARS), NIFA's Agriculture Food Research Initiative (AFRI), or through partnership with the Foundation for Food and Ag Research (FFAR). Options that carry too much risk or lack sufficient commercial applications for existing research initiatives to take on may be prioritized by the Agriculture Advanced Research and Development Authority (AGARDA), as soon as that new authority receives congressional appropriations and has a leader nominated by the administration. All of these federal research initiatives should coordinate with ongoing private sector efforts to develop innovative agriculture technologies so as to complement rather than duplicate those efforts.

The following recommendations are designed to help USDA fill existing practice and knowledge gaps to facilitate broader practice adoption among U.S. producers.

- Invest in research and development in crop breeding for deep-rooted or perennialized analogues to current commodity crops that would sequester more carbon in root systems.
- Research, validate, and pilot commercial technologies, such as nitrogen inhibitors, soil carbon measurement tools and livestock feed additives, to inform food and ag sector decision-making.
- Conduct research into new ways to reduce emissions from nitrogen fertilizers, enteric fermentation, and manure management.
- Invest in improving tools and practices for diverse farming operations, such as farms that grow multiple crops and integrated crop-livestock systems.
- Research embedded energy in irrigation and other farm management as a basis for considering expansion of incentives for on-farm energy use, including replacement of less energy efficient farming equipment.
- Review opportunities for utilization of agricultural biomass and food processing waste streams, including bioenergy production and pyrolysis to create biochar.
- Audit the state of the science on climate impacts of various livestock and grazing practices and determine which are most likely to reduce risks and contribute to climate change mitigation.
- Advance options for carbon sequestration and emission reductions through aquaculture, including emerging opportunities such as kelp farming.
- Research plant genomics to identify varieties or specific genes that could be enhanced to provide benefits for climate change mitigation or resilience.

Conclusion

Climate change solutions must be supported by research and science. The solutions must be inclusive of the diverse interests that make up our food and agriculture system, which can be both a contributor and a solution to climate change. Coordinating the science and research to maximize effectiveness and the impact of public investments is imperative. If we can use our research enterprise to build a data-driven business case for climate-smart agricultural practices, we can create appropriate incentives and adoption to drive the management changes we need to see across U.S. working lands.