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RURAL INVESTMENT:

Building a Natural Climate Solutions Policy Agenda that Works for Rural America and the Climate

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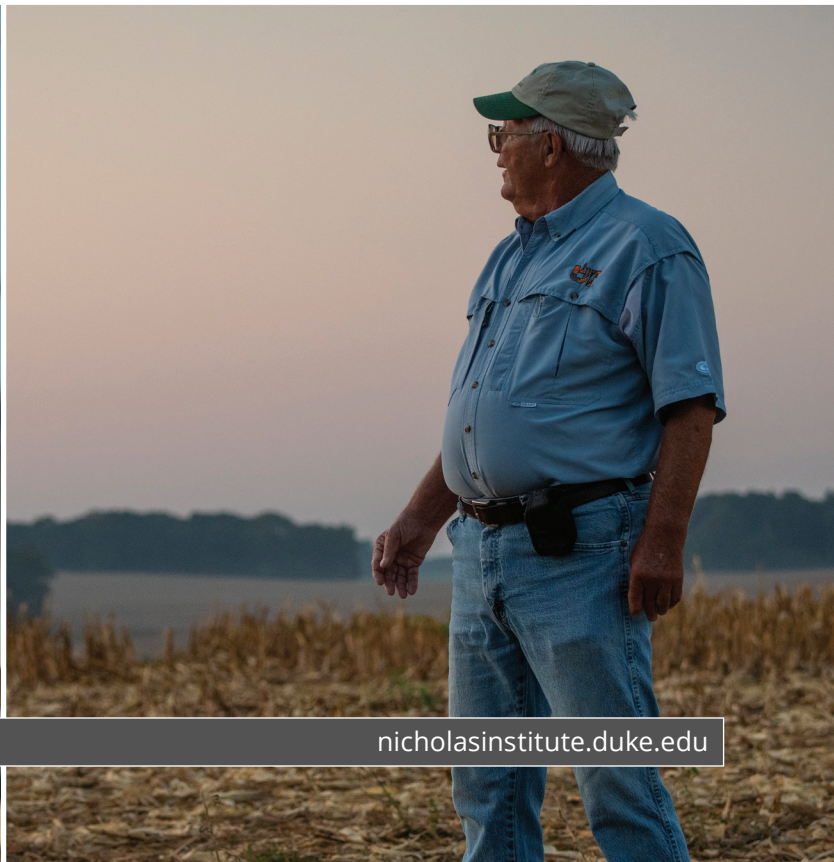

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CONTENTS

Executive Summary

Rural America—particularly its farms, ranches, and forests—is vital to solving climate change. Forests absorb the equivalent of 11–15 percent of U.S. greenhouse gases (GHGs) while agriculture accounts for about 9 percent of U.S. GHG emissions. Under any reasonable scenario, meeting aggressive climate goals will require farmers, ranchers, forest owners and public land management agencies to prioritize climate mitigation across hundreds of millions of acres. Success will require new federal policies and, importantly, accelerated and substantial increases in public and private investment in land management practices that sequester carbon and reduce GHGs. That won't happen without the combined support from rural voters and agricultural and forestry stakeholders.

This report outlines a menu of policy ideas capable of both garnering the necessary support from rural America and helping the U.S. reach its climate goals through natural climate solutions.

This report arrives at this menu of policies by focus on four questions:

(1) **Where are the tons?** Which agricultural and forestry practices result in the most significant GHG emissions reductions and sequestration, and where are those practices likely to occur?

(2) **Where are the stakeholders?** What are the positions of stakeholders in agriculture, forestry, hunting and fishing, outdoor recreation, and environment/conservation with regards to climate policy on agricultural and forest lands?

(3) **What can we learn from state experience** with natural climate solutions?

(4) **What suite of federal policies** could get the necessary GHG reductions and win rural support?

Where Are the Tons?

Understanding which agricultural and forestry practices (i.e., natural climate solutions) and where those practices occur across the country is important in assembling a package of policies that can both meet aggressive GHG mitigation targets and garner the necessary political support. To examine the potential contributions from natural climate solutions, we draw on the U.S. government's 2016 report United States Mid-Century Strategy for Deep Decarbonization (MCS), the study on natural climate solutions from the Nature Conservancy's Joseph Fargione and colleagues, the National Academy of Sciences, Engineering and Medicine's (NASEM) *Negative Emissions Technologies and Reliable Sequestration*, work from the World Resources Institute, and others.

Looking first to forests, the MCS, Fargione, and WRI all point to the vital contribution forests can make to meeting carbon sequestration goals. This is particularly the case with respect to reforestation and improved forest management—both of which are concentrated in the eastern United States. NASEM is less optimistic about carbon sequestration gains from afforestation/reforestation over concerns about land competition from agricultural uses in the face of increasing demands for food production. Addressing catastrophic fire in the western U.S. could be an important source of GHG reductions as well. An important implication of the conclusions from all the studies is that efforts to increase forest carbon would benefit significantly from policies that bolster wood products markets as a means to maintain economic incentives to retain existing forests, to invest in reforestation and improved forest management, and to store carbon in long-lived wood materials.

With respect to agriculture, cover crops, grasslands conservation, nutrient management, reducing livestock methane, and increasing soil carbon are all important strategies to reduce GHGs. (In this report, we do not consider policy approaches that seek changes in U.S. diets, including reductions in meat and dairy consumption, as a GHG reduction strategy.) There is some uncertainty about the potential of increasing soil carbon through conservation tillage, cover crops, and other soil health activities. However, the co-benefits from these activities to agricultural productivity, water quality, drought and flood resilience, and others strongly suggests policy should look to promote soil health practices in agriculture. Additionally, given the need to maintain and expand forests and grasslands while feeding an increasing human population, improving agricultural productivity so that more food can be grown on the same amount of land will be important.

One of the most important conclusions from our analysis is that there are likely many agricultural producers and forest landowners who, because of the nature of their operations and/or the productivity of their lands, won't benefit significantly from policies that focus solely on providing incentives for GHG reductions. Thus, to win broader rural support, federal policy should consider a broader suite of investments in agriculture and forestry focused not just on GHG mitigation, but on climate resilience, agricultural and forest productivity, and nonclimate environmental benefits such as water quality improvements, wildlife habitat, and others.

Where Are the Stakeholders?

There is significantly less support for federal policy to address climate change among rural voters than among their urban/suburban counterparts. Generally speaking, rural voters are more politically conservative and more skeptical of government intervention. Agricultural and forestry organizations, businesses, and officials are closely tied to rural Americans, and their attitudes towards climate policy often reflect this. As the same time, there is significant alignment between activities on farms, ranches, and forestlands that benefit the climate and those that can be beneficial to agricultural and forest productivity and maintaining rural livelihoods. Thus, even with significant concern in rural America around federal climate change policy, there is an opportunity to build a policy agenda that has rural support.

On climate change, forestry groups—landowners, foresters, and industry—have generally been more organized on natural climate solutions policy than their counterparts in agriculture. Over the last decade, the Forest Climate Working Group has organized a broad coalition around both climate mitigation and resilience policies in the forest sector. Given the diversity of crops and livestock systems, the agricultural sector, on the other hand, is more fragmented than forestry and has also generally been somewhat more reticent to engage on climate policy since the defeat of Congressional legislation on climate in 2009–10. That said, there are commodity groups, businesses, farmers, and ranchers themselves, and many others that have been substantively and publicly engaged on climate change policy and efforts to promote climate-friendly farming practices.

Both agriculture and forestry are likely to support natural climate solution policies that are voluntary, landowner-driven, incentive-based, market-oriented, address both mitigation and resilience, provide some insurance against the financial risk of investing in climate mitigation practices, and allow for flexible, collaborative solutions that can be tailored to different landowners/producers and geographies. Importantly, both agriculture and forestry are also increasingly responding to consumers and a marketplace interested in environmental sustainability. Both agriculture and forestry also largely support bioenergy as a climate solution.

Hunting and fishing groups are also an important rural constituency with a significant stake in the potential of natural climate solutions to address many of their priorities. After a hiatus following the defeat of federal climate legislation in 2010, hunting and fishing groups are today re-engaging on natural climate solutions policy, including conservation of grasslands, wetlands, and forests, improved forest management on both private and public lands, protection of wildlife migration corridors, water infrastructure projects, and others.

Environmental and conservation groups are obviously an important constituency who see significant potential value to the climate and ecosystems for natural climate solution policies. A critical component of natural climate solutions policy for these groups will be policies and investments to secure the conservation and restoration of ecologically important lands on both public and private lands. It'd difficult to see many environmental and conservation groups throwing their full weight behind natural climate solutions without significant gains for conservation. We then focus our discussion of these groups on concerns they have voiced on carbon offsets and bioenergy, and the need to avoid polarizing debates around "big versus

small" landowners, and judgements regarding "industrial" agriculture and forestry. Other rural constituencies such as rural electric cooperatives, rural counties, and others also provide opportunities to expand the coalition in support of natural climate solutions.

Focusing on ways to improve the environmental footprint of working lands management through voluntary incentives and market-oriented policies, conserving ecologically important lands, and bolstering rural jobs and economic development should provide enough common ground to find robust support for a comprehensive set of natural climate solutions policies across a significant portion of environmentalists and rural stakeholders.

What Can We Learn from State Policy?

Many states already have considerable experience with natural climate solutions including renewable energy policies and policies that finance agricultural and forestry GHG reductions through carbon offsets and/or direct investments. In the case of the former, renewable energy standards and renewable fuel standards have been enacted in many states, encouraging production of biofuels from agricultural and forestry feedstocks in particular. California's low carbon fuel standard has been particularly important in creating incentives for installation of anaerobic digesters which convert livestock methane into energy or renewable natural gas.

California has also been a leader in developing a market for carbon offsets from both agriculture and forestry. Offsets in California have met with mixed success. Forestry projects have produced significant GHG reductions and significant forest conservation benefits, but high transaction costs have limited landowner participation. In agriculture, livestock methane digester projects have produced many offsets, but, for a number of reasons, other agricultural project types such as those to reduce emissions from rice production have produced few. The experience in California highlights the tension between developing rules to guarantee environmental integrity of offsets while simultaneously keeping transactions costs low in order to encourage participation of agricultural producers and landowners. Offsets have also met with some political resistance in California, particularly from the environmental justice community. Likewise, the Regional Greenhouse Gas Initiative (RGGI), a cooperative effort among 10 Mid-Atlantic and Northeast states to address climate change, allows for offsets but due to lack of demand has seen no offsets generated from agriculture and forestry. Notably, California and RGGI state New Jersey have used proceeds from the sale of cap and trade allowances to support forestry GHG projects as well.

In addition to California and RGGI states, the U.S. Climate Alliance, a bipartisan coalition of 25 governors who have committed to meeting the goals of the Paris Climate Agreement, is deeply engaged in developing a range of natural climate solutions policies through its "Natural and Working Lands Challenge." The Climate Alliance has made making substantial progress by giving states the tools to set climate mitigation goals and develop state-specific plans to achieve those goals, including plans related to sequestering carbon on natural and working lands. Given the interest and expertise of these states, a key consideration that federal policymakers should explore is how to partner with state agencies to advance natural climate solutions. Helping to finance state plans, to provide useful data and scientific research, and to explore ways to deliver technical information and programs to landowners may be an important role that the federal government can play.

What Suite of Natural Climate Solutions Policies Could Garner Significant Rural Support?

Since the late 1990s, climate policy around agricultural and forestry has focused largely on using carbon offsets through a cap and trade program to finance GHG reductions in the land sector. Today, natural climate solutions policy is in flux in large part because the shape and timing of federal climate policy is unclear. Will offsets be incorporated in federal climate policy and, if so, when? No one knows.

In the meantime, there is now significant interest in Congress and among policy advocacy groups to examine multiple approaches to forestry and agricultural climate policy. We examine the potential of carbon offsets, a carbon bank, Farm Bill conservation programs, and tax incentives for financing natural climate solutions.

- *Offsets.* Though there are significant opportunities for offsets in voluntary markets and an emergent international aviation compliance market, we are pessimistic about the workability and political support for offsets in a U.S. compliance market without policy interventions to address their inherent financial and environmental uncertainty.
- *Carbon Bank.* Development of a carbon bank where USDA would use the Commodity Credit Corporation or perhaps other mandatory funding stream to buy carbon, insure carbon projects, and/or otherwise de-risk carbon investments could address issues that have hampered offsets while providing a flexible, market-oriented mechanism to finance natural climate solutions.
- *Tax Incentives.* Tax incentives could provide a flexible tool and the needed resources to finance carbon sequestration at scale. While the experience of tax incentives associated with geologic carbon capture technology suggests the federal tax code could provide useful tools, there are significant design and implementation issues that require additional analysis.
- *Farm Bill Conservation Programs.* Farm Bill programs have the advantage of an existing delivery infrastructure and familiarity among farmers, ranchers and forest owners, but have the challenge of not being designed for GHG mitigation. While forest landowners increasingly use them, conservation programs have been primarily focused on agriculture. Still, these programs could be very valuable in addressing climate resilience of forestry and agriculture if targeted appropriately.
- *Crop Insurance.* Creating incentives for climate smart agricultural practices through the federal crop insurance program could be an effective approach to encouraging GHG mitigation across the 70 percent of U.S. cropland acres enrolled in the program. Given the importance of the crop insurance program to so many in agriculture, proposed policy would require significant buy-in from producers.
- *Research, Technology, and Measurement.* We discuss the potential for significant investments in research, technology, and GHG measurement around agricultural and forest productivity. Linking research to extension and outreach—perhaps through USDA's

Climate Hubs—is vital to providing good information on both climate mitigation and resilience to farmers, ranchers, forest owners and land managers.

- *Public Lands and Wildfire Management.* Emissions from catastrophic wildfire could negate GHG reductions elsewhere without substantial investments in forest restoration and wildland firefighting. Strengthening markets for low-value timber harvested as part of forest restoration projects will be important.
- *Providing Technical Assistance and Outreach to Farmers, Ranchers, and Forest Owners.* Natural climate solutions won't implement themselves. In addition to financial incentives, policy and resources are needed to provide technical assistance to farmers, ranchers, and forests owners in designing and implementing land management practices. This assistance can be provided through existing government and nongovernmental networks.
- *Beginning, Minority, and Tribal Farmers, Ranchers, and Landowners.* We also suggest ensuring that resources are set aside for beginning farmers and ranchers, minority producers and landowners and tribes in implementing natural climate solutions.

Rural Investments

Importantly, we believe there are a suite of investments that could facilitate natural climate solutions but that have not been central to the discussion of agricultural and forest climate policy to date. With these ideas, we hope to broaden the discussion to include a broader set of investments, while recognizing that more work needs to be done on the precise nature of the policies that would implement these ideas. These investments include:

- *Bioenergy.* Investments in the capture and transport of livestock methane and production of sustainable biofuels have the potential to provide economic opportunities while reducing GHGs.
- *Forestry, Forest Jobs, and Forest Mills.* Investments to support new wood technologies such as mass timber, mills in the west to support forest restoration, and jobs in forest management and restoration, and low-impact logging could build support for natural climate solutions in forested rural areas. Using government procurement to increase demand for mass timber and wood biomass could support those investments. Further, the U.S. will need to substantially bolster its seedling growing capacity to increase rates of afforestation/reforestation.
- *Agriculture.* Extending broadband to rural communities can assist in development of smart grids and support precision agriculture. Investing in cover crops, double-cropping systems, biochar production and compost facilities, and the businesses that support those activities could provide jobs and GHG benefits.

Coronavirus and Rural Investment

The writing of this report was begun before COVID-19 had surfaced in America and was completed as state governments had moved most of the country to lockdown. The virus will have devastating impacts on many families. Increasingly clear, as well, is the enormous impact the

virus is having and will have on the U.S. economy and the ability of Americans to make ends meet. Agriculture and forestry producers, landowners and businesses are already being impacted through markets for food and fiber. While current policy should rightly focus on the response to the virus, assisting our health care system and workers, and the immediate needs of millions of unemployed Americans, there will come a time when policymakers turn towards economic recovery. We believe that there will be a strong economic rationale and broad political support for legislation that invests in natural climate solutions.

CONCLUSION

To be successful in securing the necessary resources for natural climate solutions, policymakers should consider a comprehensive suite of policies for fully engaging agriculture and forestry in addressing climate change. Such a package should be designed as a rural investment package with broad benefits for agriculture and forestry, rural communities, the conservation of ecosystems and the climate. While climate mitigation goals would be central to such a package, other investments in climate resilience, bioenergy, wood markets, rural job opportunities should and must be part of the package.

A rural investment package need not be tied to a comprehensive climate package passed by some future Congress, though it certainly could. Advocates for natural climate solutions should be prepared for that eventuality but also for opportunities to advance a rural investment package through economic recovery legislation in the wake of the coronavirus, standalone legislation, opportunities in annual federal budgets, a potential national infrastructure package, or even the use of administrative policies and discretionary dollars at USDA and the U.S. Department of Interior.

Such a rural investment package must be designed based not just on where the tons are, but on where Congressional votes and, ultimately, where rural voters are.

INTRODUCTION

Climate science strongly suggests that the United States must reduce emissions to net zero by 2050. Without substantial contributions from American agricultural and forest lands, meeting that goal will be very difficult, if not impossible. U.S. forests sequester the equivalent of 11 to 15 percent of U.S. greenhouse gas emissions annually.[1] Preserving and enhancing that carbon sink is vital to meeting U.S. emissions targets. Agriculture accounts for about nine percent of U.S. GHG emissions and has substantial potential to reduce emissions of carbon dioxide, methane and nitrous oxide while sequestering carbon in soils, grasslands and trees.

Most land in America is privately owned. What farmers, ranchers, and forest landowners (including Native American tribes) choose to do with their lands matters immensely to U.S. efforts to combat climate change. Fortunately, many of the conservation practices that benefit the climate (e.g., soil conservation, reforestation, manure management, nutrient management) also can benefit the operations and profitability of farmers, ranchers, and forest owners. Moreover, sound, incentive-based climate policy can support rural jobs and bolster farm, ranch, and forest economic viability. Of course, implementing many of these practices still requires financial resources and other assistance; conservation is not free.

Motivating action by farmers, ranchers, and forest owners to invest in conservation practices that reduce GHGs at the scale necessary will require a substantial investment of public and private resources. Public lands management can also make a notable contribution through forest restoration, reforestation, and efforts to reduce the threat of catastrophic wildfire. Building the political support to make substantial investments in these natural climate solutions will require convincing the American voters, particularly rural ones, of the necessity of such a large public investment.

Climate policy is a hard sell in rural America, however. Climate change is highly polarizing in rural America with just over half of rural Americans in support of taking action.[2] Strong resistance to government policy—particularly on climate—suggests that approaching climate policy with rural constituencies, including agriculture and forestry, will require a new approach, one that listens to rural voters, farmers, ranchers, and forest owners, responds to their needs, and designs policy accordingly.

Past efforts to pass comprehensive climate legislation have focused largely on carbon offsets as a means to finance investments in agricultural and forestry practices that provide GHG emissions reductions. Carbon offsets and other investments in agriculture and forestry were also seen as a means to win over support from rural stakeholders for comprehensive climate legislation. Today, however, there is more uncertainty about the form that national climate policy will take once there is support in Congress and the Executive Branch. Will national policy take the form of a cap and trade program, a carbon tax, a carbon fee and dividend, a national cap with state implemented strategies, or regulations under the existing Clean Air Act? We don't know. Consequently, we don't know if carbon offsets or other policies will finance implementation of natural climate solutions on U.S. lands.

Given this policy uncertainty and the fundamental need to win over rural constituencies to support investments in natural climate solutions, we argue that we need to think far more broadly about the potential solutions available for motivating natural climate solutions. We argue that we need to meet rural constituencies and voters where they are and design policies that meet their needs while providing the necessary climate benefits. Natural climate solutions have the potential to unite left and right, urban and rural, in a way that many aspects of climate policy do not.

Specifically, we argue that policymakers, advocates for climate legislation and rural stakeholders should design natural climate solutions as an investment in rural America that provides not just climate benefits, but that supports American farmers, ranchers, forest owners, agriculture and forestry businesses, hunting and fishing, and rural communities.

This report begins with a discussion of the size, distribution, and costs of GHG emissions reductions across various agricultural and forestry practices. The second section of the report describes that policy positions of farm, ranch, forestry, environmental/conservation, and other relevant stakeholders in regard to broad policy approaches to addressing natural climate solutions.

We then describe the policy landscape for addressing natural climate solutions and those policy approaches which have the greatest potential not just to provide climate benefits but to win the support of rural stakeholders. We then describe a series of policies that we believe are foundational to achieving climate benefits from the agricultural and forestry sectors, that have the potential to provide substantial economic opportunities for these sectors, and, thereby, provide substantial political support for natural climate solutions.

By designing policies that simultaneously produce climate benefits and meet the needs of farmers, ranchers, forest owners, and, more broadly, rural voters and communities, we can garner public support necessary to achieve the GHG reductions necessary while building broad bipartisan support for natural climate solutions.

I. WHERE ARE THE TONS IN AGRICULTURE AND FORESTRY?

Meeting aggressive U.S. climate reduction targets by 2050 and beyond requires both substantial GHG reductions from American forests and agricultural lands and significant uptake of carbon in soils and vegetation. This section looks at existing estimates of agriculture and forestry's potential to mitigate climate change. Examining which land management practices have the greatest potential to reduce GHGs has obvious implications for designing policies to achieve those reductions, as does understanding where those practices most likely will occur. Understanding this is critical to assembling a coalition of agricultural, forestry, rural, and environmental stakeholders needed to advance appropriate natural climate solutions policies.

To examine the potential contributions from natural climate solutions, we draw on the U.S. government's 2016 report United States Mid-Century Strategy for Deep Decarbonization (MCS), the study on natural climate solutions from the Nature Conservancy's Joseph Fargione and colleagues,[3] the National Academy of Sciences, Engineering and Medicine's *Negative Emissions Technologies and Reliable Sequestration,* and work from the World Resources Institute. We then examine the geography of natural climate solutions. Lastly, we draw conclusions from the analysis.

Overview of Natural Climate Solutions

Forests and agriculture already play an important role in GHG emissions and sequestration in the United States. Forests absorb about 11–15 percent of U.S. GHG's annually through regrowth and net expansion with about 20 percent of the annual forest sink in wood products.[4] Under current trends, that sink is expected to decline overtime due to slowing growth as forests age, losses of forests to development, and disturbance such as catastrophic wildfire.

Agriculture accounts for about 9 percent of U.S. agriculture emissions. Among non-energy agricultural emissions, nitrous oxide emissions from use of nitrogen fertilizers and manure accounts for 58 percent, methane primarily from livestock accounts for 41 percent, and carbon dioxide from liming and other activities accounts for 1 percent.[5] Looking at sources of emissions from practices (instead of particular GHGs), 49 percent of agricultural emissions are from soil management, 32 percent from enteric fermentation in livestock, 14 percent from manure management, 2 percent from rice cultivation, 1 percent from urea fertilization, and less than 1 percent from lime use.

Forecasting the potential to both increase carbon sequestration in forests and agricultural soils and grasslands and reduce emissions from agriculture is difficult. Such projections have to account for biological factors, competition among different land uses, costs of installing climate beneficial practices, a changing climate, and other factors. Still, the studies below provide significant insight into the potential of natural climate solutions that hold the most promise.

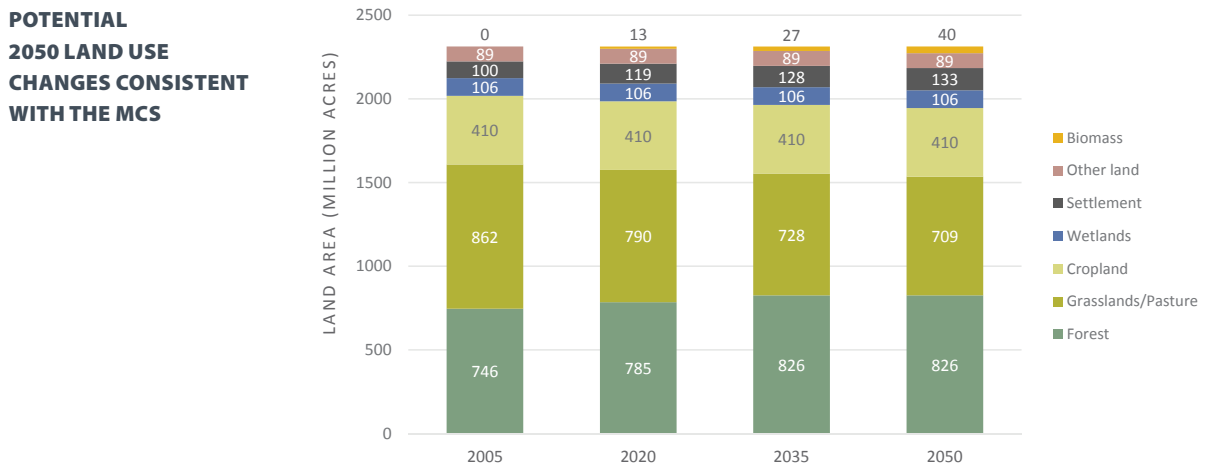
The Mid-Century Strategy

The U.S. government produced the 2016 United States Mid-Century Strategy for Deep Decarbonization (MCS) to evaluate ways the U.S. could reduce GHG emissions by 80 percent by 2050. The MCS found that sequestration in the land sector could offset 45 percent of U.S. GHG emissions by that time. With respect to forests, the MCS projected that meeting this target would require planting 40–50 million acres of new forests, avoiding the loss of 13 million acres of forests, and increasing carbon sequestration in existing forests through lengthened harvesting rotations, reduced wildfire emissions, expanded use of woody biomass for energy, and increased use of wood products.

With respect to agriculture, the MCS projected carbon sequestration practices applied across 70 percent of U.S. cropland, increased agroforestry, and a 25 percent reduction in agricultural methane and nitrous oxide emissions.

An interesting implication of the MCS is the impact on U.S. land use. The chart below shows the substantial increase in forest acres, which the MCS expects would come largely from grasslands and pasture. In practice, this means that the MCS assumes that marginal pasturelands, largely in the eastern U.S., will likely be the lands converted to forests. Note also that croplands and wetlands remain constant under the MCS's projections and that lands devoted to bioenergy production increase to 40 million acres. With respect to croplands, the MCS's assumptions underscore the need for productivity to increase in order to feed a growing population across the same or smaller land base.

Figure 1. Potential Land Use Outcome from Land Use Changes Consistent with MCS



The results presented here exemplify a potential future U.S. land use scenario that could be consistent with the U.S. MCS vision, reflecting 50 million acres of forest expansion, 40 million acres of biomass production, 17 million acres of developed land expansion, and constant cropland levels compared to 2015 areas. Such a future would need to go hand in hand with strategies to minimize impacts to natural grasslands, natural forests, wetlands, and other high-value conservation areas.

The Nature Conservancy's Fargione et al. Study

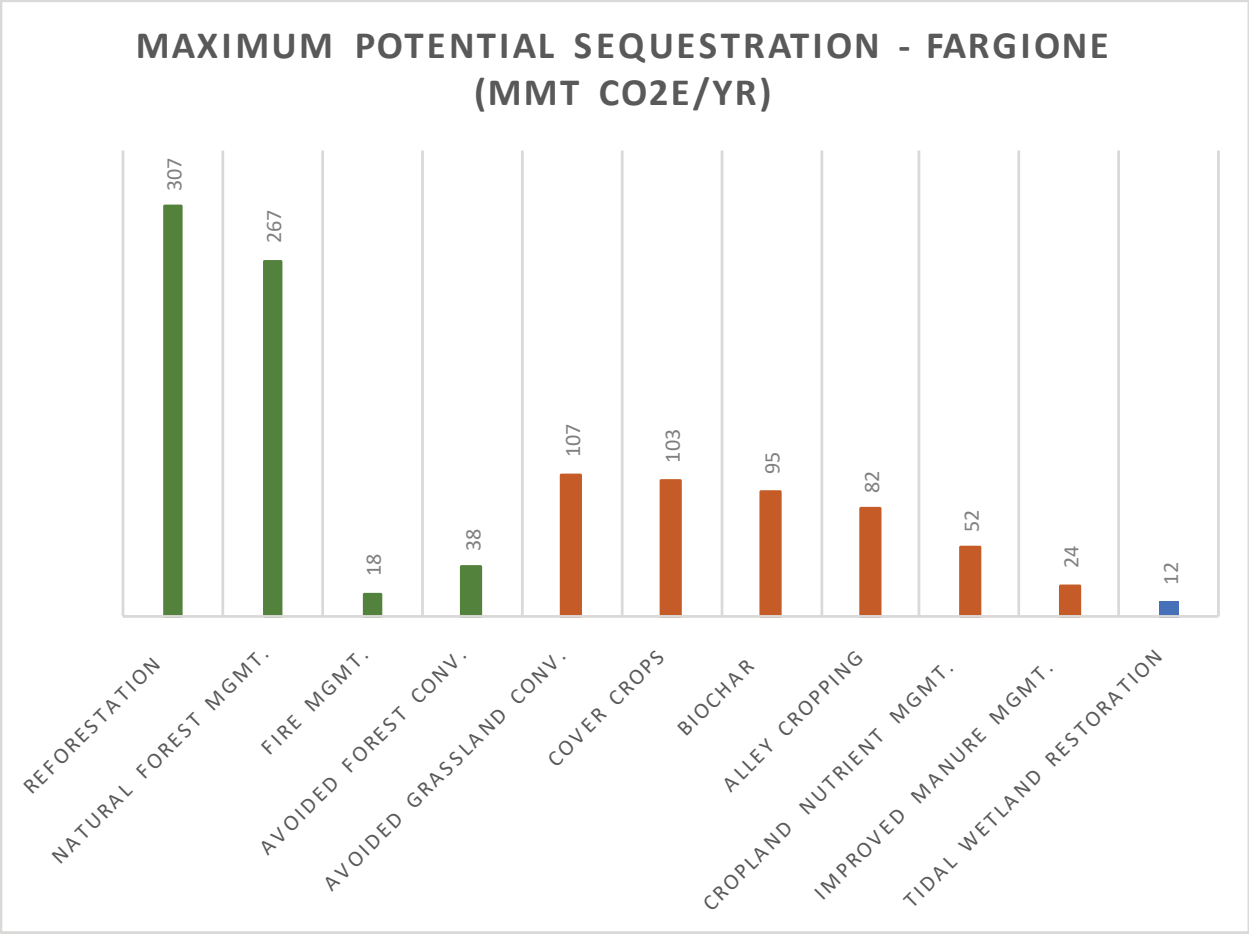
In 2018, Fargione and colleagues[6] at The Nature Conservancy (TNC) quantified the maximum potential of natural climate solutions to reduce GHG emissions and sequester carbon in the U.S. In addition, they evaluated the potential to achieve those reductions at different carbon prices (i.e., $10/MTCO2e, $50/MTCO2e and $100/MTCO2e). The study concluded that a maximum of 1,200 MMTCO2e/year potential exists to sequester or "sink" carbon, equivalent to approximately 21 percent of the U.S.' net GHG emissions for 2016 (this is in addition to the existing U.S. forest sink of 11–15 percent of U.S. emissions). Figure 2, below, depicts the potential GHG impact of the forest, agriculture, and wetland conservation practices with the greatest potential to sink carbon. Of these, forests make the most significant contributions.

Fargione et al., like the MCS, determine that reforestation—or the planting of new forests on nonforest lands—is the most promising practice in terms of GHG mitigation potential. (As noted below in the NASEM study, there is some debate about the extent of land availability for afforestation/reforestation.) One barrier to rapidly increasing reforestation of nonforest lands is availability of seedlings. Former Forest Service scientist Richard Guldin has outlined three barriers to largescale reforestation: (1) identifying appropriate lands, (2) increasing nursery capacity, and (3) increasing the capacity of contractors to plant trees. Fargione et al.'s analysis also concludes that natural forest management on private lands—including extended harvest rotations, improved forestry practices, and reduced impact logging—is also a potentially significant contributor of GHG reductions.

The implications of Fargione et al.'s findings for forests are significant. First, the vast majority of these tons will be sequestered by forests in the eastern U.S. (In fact, about 85 percent of current carbon sequestration occurs in eastern U.S. forests.[7]) Second, both reforestation and natural forest management have important implications for forest products markets, including wood products and woody biomass for energy generation. Specifically, reforestation has the potential to substantially increase timber supply, thereby reducing timber prices and, correspondingly,

reducing the value of existing privately owned forests. Natural forest management entails investments in increasing forest carbon stores in existing forests through longer timber rotations which will also increase timber supply. In both cases, expanding markets for timber could play an important role in encouraging investments in reforestation and forest management. Equally important from a policymaking standpoint, landowners are unlikely to support incentives that would have the effect of increasing U.S. timber supplies unless significant investments are made to expand markets for wood and wood products. Fargione et al. do not estimate gains in the wood products pool as part of their analysis. While not a criticism of the study, given that wood products markets will be important to achieving potential GHG gains from forestry and that wood products already account from some 20 percent of existing forest sequestration, this pool should be an important focus of policy discussions.

Figure 2. Maximum GHG Mitigation Potential from Select Agricultural and Forestry Practices



Source: Fargione et al., 2018.

With respect to agricultural reductions, Fargione et al. found significant opportunity in avoided grassland conversion (to cropland and development)—putting Fargione et al.'s findings somewhat at odds with the MCS, which shows acreage in pasture and grassland shrinking. (As noted later in the report, the Conservation Reserve Program has converted millions of acres of marginal cropland to grassland generating significant annual carbon sequestration.) Both the Fargione et al. and the MCS analyses, however, suggest that in order to increase forest cover and protect grasslands, croplands will have to become more productive.

Fargione et al. indicate significant potential GHG benefits from cover crops, which have co-benefits related to water quality and erosion control. Fargione et al. also consider biochar (a charcoal-like material produced from pyrolysis of organic materials which can be used as a soil additive to increase productivity via improved nutrient retention) extremely promising in terms of carbon retention, though it is not widely used at present.

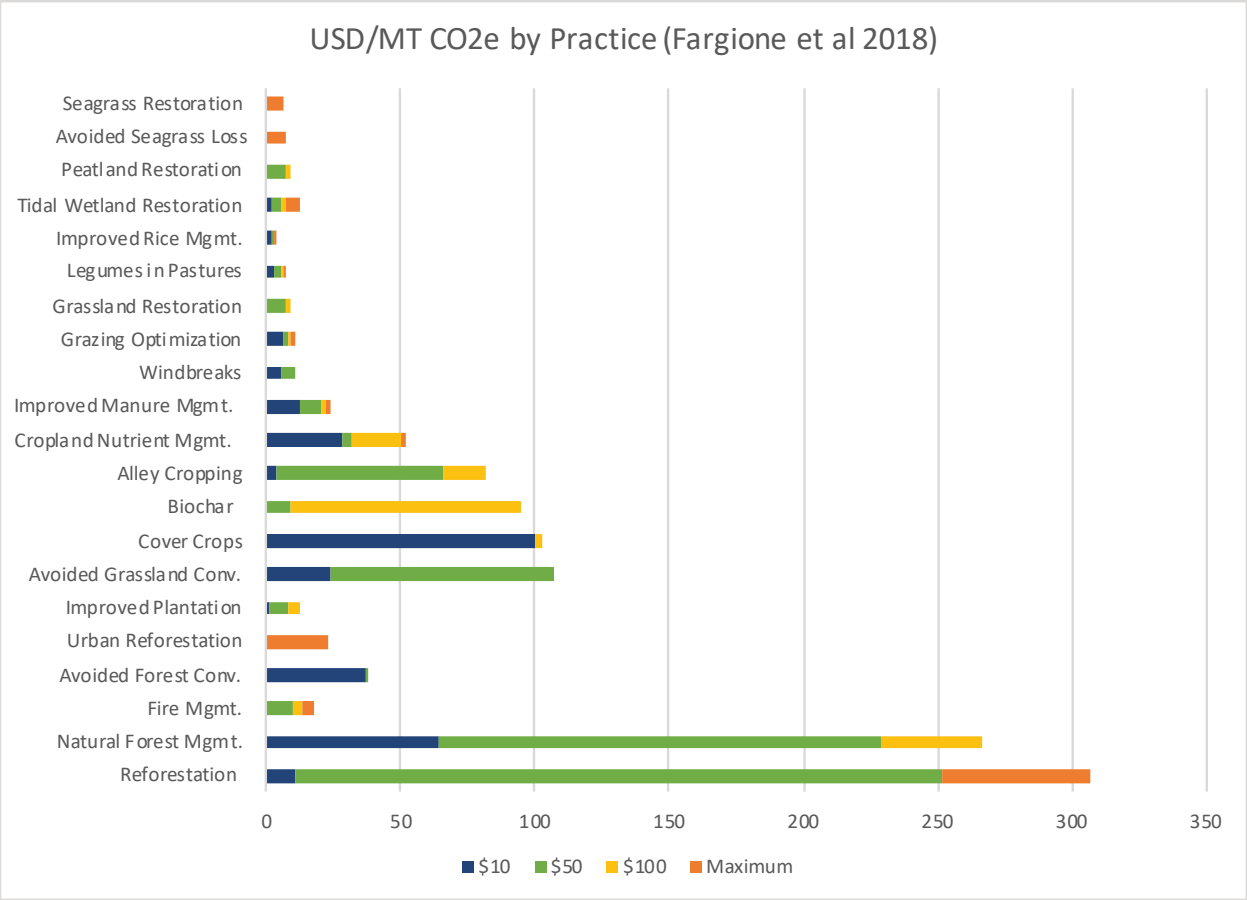
Fargione et al. also project large reductions in nitrous oxide emissions from cropland nutrient management. The study, unlike the MCS and other analyses, does not estimate gains from carbon sequestration in soils through conservation tillage and related soil health practices. This is notable because soil practices have garnered both international and domestic interest as a potential GHG reductions activity. (We provide more discussion on soil carbon below.)

Fargione et al. do estimate gains from activities to reduce catastrophic wildfire at 18 MMT CO2e per year through prescribed fire which is modest relative to reforestation and natural forest management. Wildfire emissions are already significant. For example, in California emissions from wildfire were 36.7 MMT CO2e and 45.5 MMT CO2e in 2017 and 2018 respectively. These emissions were three or more times larger than emissions reductions made as a result of implementation of California's cap-and-trade program.[8]

Wildfire emissions could grow substantially in the future. For example, according to a new analysis by the Union of Concerned Scientists and Woods Hole Research Center (in press) which combines mid-century projections of burned areas and average annual emissions over the past two decades, "boreal fires in Alaska are on track to cumulatively emit ~4 GtCO2 between 2020–2050. This is □1 percent of remaining global emissions (420 Gt CO2) if we are to limit global temperature rise to well-below a 2°C increase above pre-industrial levels in line with the Paris Agreement (IPCC SR1.5, 2018)."[9] Thus, investments in landscape scale forest restoration and wildland firefighting will likely be necessary to maintain forest carbon stores.[10]

Fargione et al. also estimated the cost on a per MTCO2e basis for each practice type. Figure 3, below, provides a comparison of practices, depicted in tons, which includes total costs to implement each practice by price per MTCO2e reduction. Note that many practices will require a range of prices to meet their full potential. Note too that Fargione et al.'s price projections could help policymakers determine on which practices to focus in maximizing carbon sequestered per dollar spent.

Figure 3. Potential and Costs of Natural Climate Solutions



Source: Fargione et al. 2018.

National Academy of Sciences, Engineering and Medicine

The National Academy of Sciences, Engineering and Medicine's (NASEM) 2019 report, Negative Emissions Technologies and Reliable Sequestration: A Research Agenda, examined both biological and technological approaches to removing carbon dioxide from the atmosphere. The report concludes that four negative emissions technologies—afforestation/reforestation, changes in forest management, agricultural soil carbon sequestration, and bioenergy with carbon capture and storage (BECCS)—are ready for deployment immediately.

At the same time, NASEM is less optimistic about the potential of U.S. forestry and agricultural to reduce GHGs. The report concludes that at a cost of $100/ton of CO_2 or less, forestry and agriculture can provide "significantly less" than 1 Gt/year CO_2. NASEM estimates gains from afforestation/reforestation at .15 Gt/year CO_2, from changes in forest management at .1 Gt/year CO_2, from agricultural soil carbon at .25 Gt/year CO_2, and from BECCS at .5 Gt/year CO_2.

The NASEM's report more pessimistic numbers for forestry and agriculture reflect concern about a number of barriers, including costs, governance, permanence, monitoring, and others. In particular, the report raises the concern about availability of land for afforestation/reforestation

and other activities given the food requirements of a growing population and, for this reason, notes the importance of research into improving agricultural productivity.

The potential for sequestration gains in agricultural soil carbon have been of significant interest both domestically and internationally for some time. When soils are plowed or tilled and exposed to air, carbon is oxidized and lost to the atmosphere. Conservation tillage, no-till, cover crops, and other practices can restore soil carbon while providing multiple co-benefits to crop productivity, resilience to drought and flood, improved water holding capacity, and benefits to water quality. New technologies provide the potential to measure soil carbon relatively cheaply. Companies like Nori and Indigo are building business models on the potential to market agricultural soil carbon sequestration.

Yet, investing in soil carbon as a climate solution is not without critics. Some scientists are concerned that there is not enough data across diverse soil types to definitively prove the long-term carbon benefits of conservation tillage and other conservation practices.[11] Despite this controversy, investing in soil sequestration makes sense both because of its potential for substantial carbon storage and the significant associated co-benefits.

Note that over half of the gains in GHG reductions are from BECCS—a technology which produces energy through burning of biomass (e.g., trees, grasses and other biomass) and then injects the carbon dioxide emissions into the ground. BECCS has the potential to create significant demand for production of forest and agricultural biomass.

World Resources Institute

The World Resources Institute (WRI) also has analyzed carbon removal through agriculture and forestry as part of a broader strategy to use carbon removal strategies to meet a net zero emissions target for the U.S. by 2050. WRI's work includes six natural carbon removal pathways, including: reforestation, restocking timberlands, soil carbon management, cropland agroforestry, silvopasture, enhanced root crops, and extended timber rotations.[12]

In the case of forestry, WRI estimates a maximum potential of 53 million acres of reforestation producing 146 MMTCO2e annually and a maximum potential of 65 million acres eligible for silvopasture with a GHG impact of 81 MMTCO2e annually. While WRI's reforestation potential is less than half that of Fargione et al.'s estimate (WRI's analysis used updated mapping from the team that produced Fargione et al.), two points deserve consideration. First, the potential acreage for reforestation is nevertheless significant. Second, Fargione et al. did not include silvopasture in their analysis, suggesting that some of the potential for silvopasture in WRI's analysis may be captured as reforestation in Fargione et al.'s work.

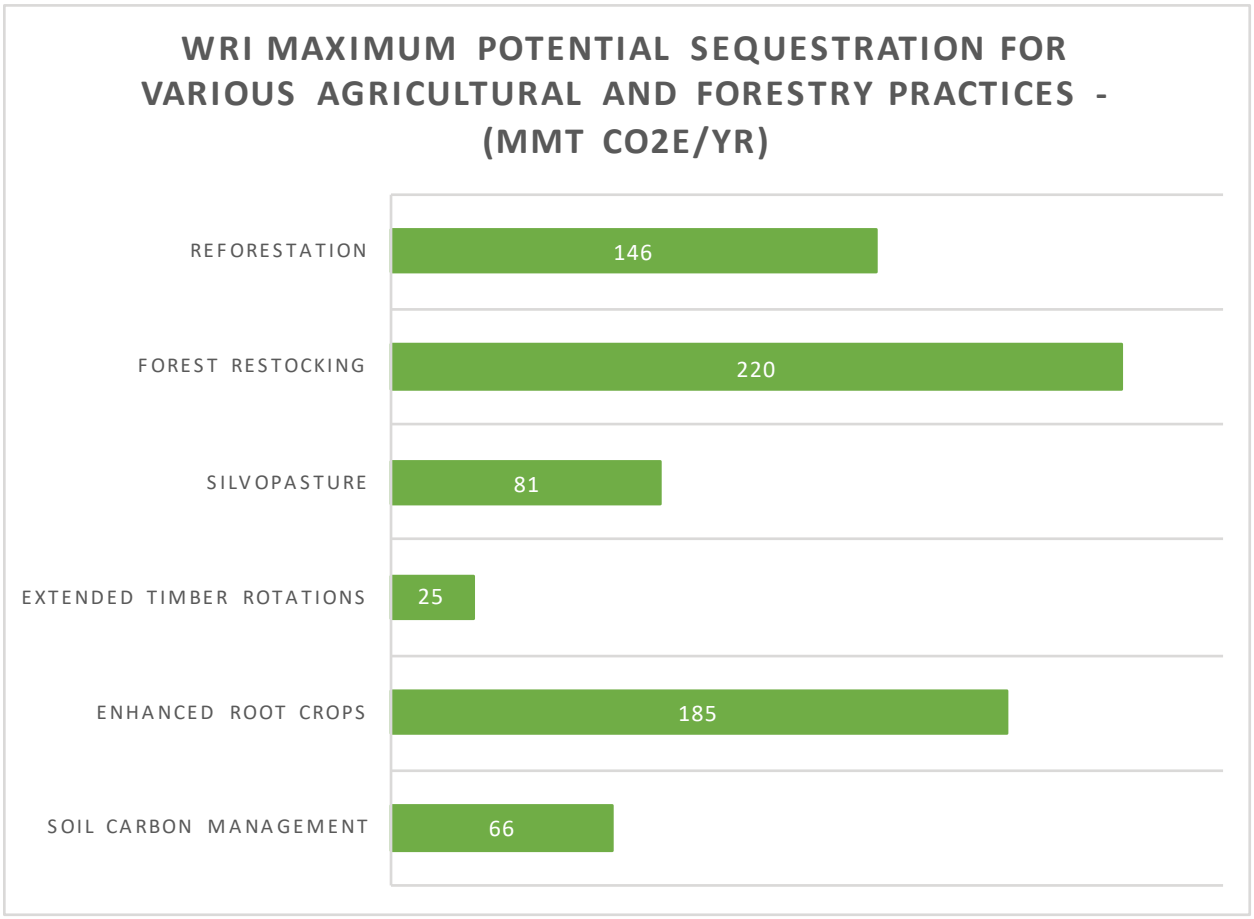
In the case of restocking timberlands, WRI estimates the biggest opportunity is in increasing carbon stocks in degraded timberlands with a maximum potential of 220 MMTCO2e annually.[13] With respect to extended timber rotations (increasing the age at which forests are harvested), WRI estimates that 25 MMTCO2e per year could be captured by 2050 by extending the practice to one million additional acres per year. (The analysis of longer timber rotations includes the impact of leakage—that is, that extending rotation ages in some areas will just shift harvesting

pressure and associated emissions elsewhere. That sad, on many intensively managed forests lands where rotations ages are set to maximize net financial returns and not to maximize timber yields, it may be possible to increase rotations ages in such a way that these lands produce more timber and store more carbon.)

In the case of agricultural lands, WRI estimates a plausible potential range of 100 to 200 MMTCO2e sequestration annually from a combination of conservation tillage, cover crops, and other cropland management practices, accounting for spatial heterogeneity in practice efficacy and practical constraints with respect to soil management in certain regions. Integrating trees into agricultural croplands (through both cropland agroforestry—labeled as "alley cropping" by Fargione et al.—and windbreaks) in WRI's estimation could produce a maximum of 66 MMTCO2e annually.

WRI, like Fargione et al., also considered agricultural innovations that hold promise as natural climate solutions. One such innovation is the development of perennial grain crops which would preclude the need to replant grain crops annually, thereby significantly increasing carbon retention in soils. WRI notes, appropriately, perennial grain crops are still under development, but, if viable and successfully adopted, have the potential to sequester up to 185 MMT CO2e annually.

Figure 4. Maximum Potential Sequestration for Agricultural and Forestry Practices from WRI 2020



Projections of GHG Capture and Emission Reductions via Livestock/ Agricultural Waste-Sourced Methane and Feed Improvements

Given the contribution of livestock methane to U.S. GHG emissions, reducing emissions by capping animal waste lagoons, deploying methane digesters to create energy, and changing animal feed to reduce enteric fermentation all provide substantial opportunities to reduce emissions with sizeable co-benefits. With respect to anaerobic digesters, a variety of federal programs and incentives, including Farm Bill conservation programs, have been supporting capping emissions from livestock manure lagoons for some time.[14]

Deployment of anaerobic digesters to capture biomethane or biogas from manure stored at livestock operations has grown rapidly in recent years, which not only results in renewable energy production and GHG reductions but also provides increased farm income, improved farm nutrient and waste management, improved air and water quality, and job opportunities in rural areas.[15] Growth has been driven by payments for GHG reductions from the capture and destruction of methane through carbon offset protocols, state-level mandates for renewable energy production and federal and state requirements on the transportation fuel sector to use more renewables in transportation fuel. While anaerobic digesters can require a big initial investment, with respect to other energy-related GHG abatement options, RNG production can be highly cost competitive and, in some cases, less than other energy-related reduction strategies.[16] In late 2019, the American Gas Foundation estimated that development of U.S. RNG resources, a consequential percentage of which can be produced from animal manure, could lead to reductions of between 101 and 235 MMTCO2e/year by 2040.[17] Of those projected reductions, the low and high-end estimates for animal manure's GHG emission reduction contribution ranges between 12.3 MMTCO2e/year and 24.5 MMTCO2e/year, respectively.[18]

In 2014, USDA established a goal to reduce emissions by 6.1 MMTCO2e/year by working with livestock producers to install 500 anaerobic digesters across the U.S.[19] USDA has yet to meet this goal but it is included here because it echoes the potential for significant GHG reductions—and renewable energy production—from the sector. Meanwhile, EPA estimates the potential exists to build an additional 8,200 livestock biogas systems, including digesters and equipment to capture methane on manure storage facilities, nationwide.

In addition to the GHG reduction potential RNG production represents, it's important to recognize that including renewable biogas production in a natural climate solutions platform has the potential to bring other stakeholders into the fold, such as the growing industry around RNG production plus natural gas utilities seeking to neutralize the carbon content of their gas supply. The American Gas Foundation's figures, provided below, illustrate the low and high resource potential scenarios for RNG production from animal manure between 2025 and 2040 by geographic region.

Figure 5. RNG Production Potential from Animal Manure, Low Resources Potential Scenario, in tBtu/y

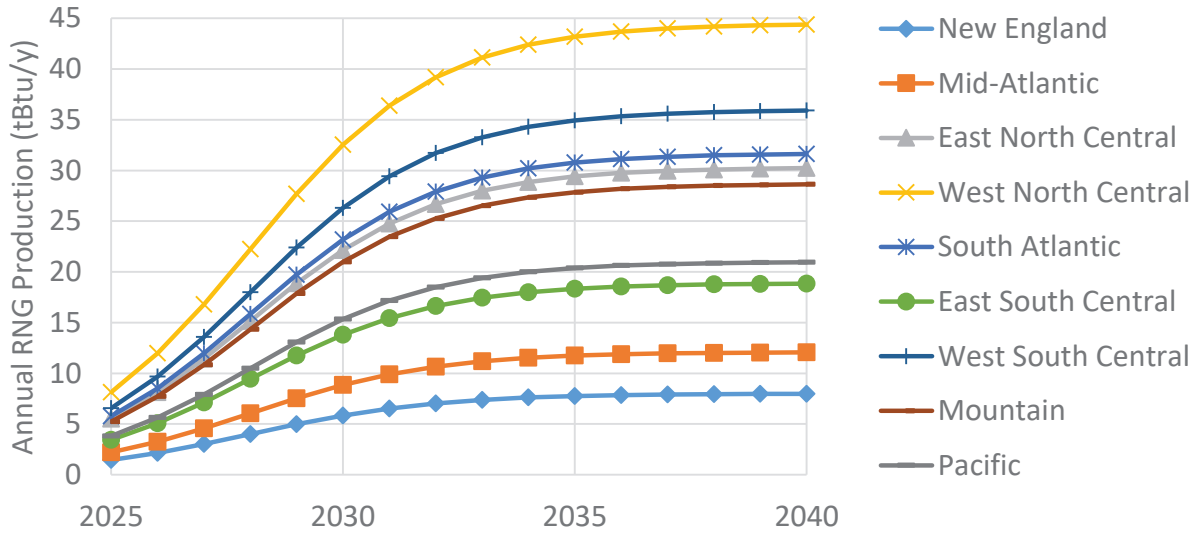
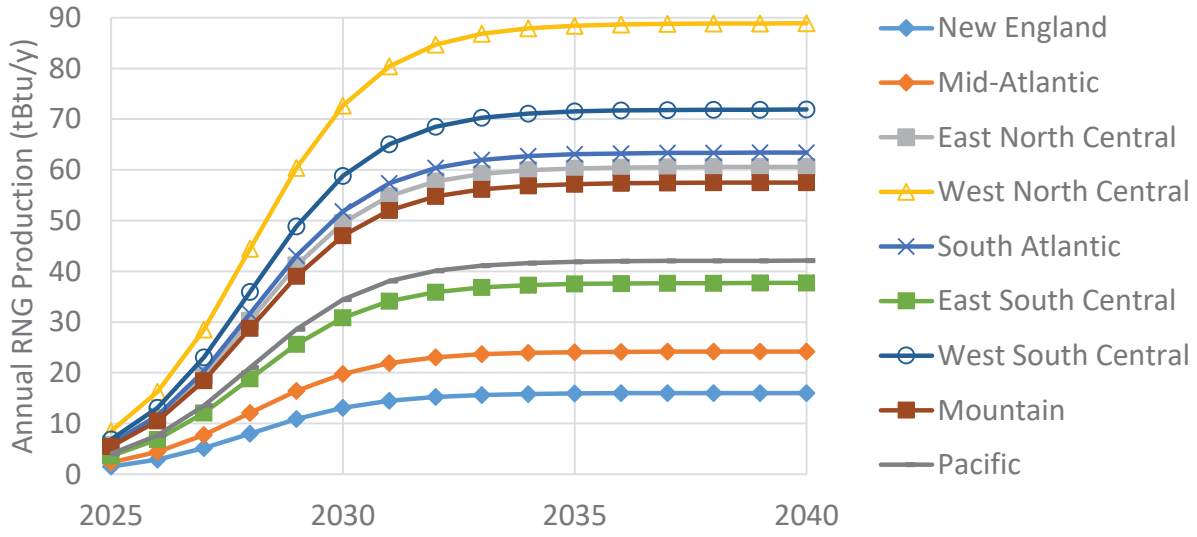


Figure 6. RNG Production Potential from Animal Manure, High Resources Potential Scenario, in tBtu/y



Improved animal feed could also substantially decrease methane emissions from livestock, particularly with respect to enteric fermentation by dairy cows and beef cattle. Improving digestibility of feed to reduce GHG emissions could have a major global impact of around 1,000 MMTCO2e/year.[20] Further research is needed to ascertain the U.S. emission reduction potential associated with modifying animal feed, considering the significant global emission reduction potential. These uncertainties notwithstanding, methane emission reductions, capture and destruction are important practices to consider as they could garner significant stakeholder

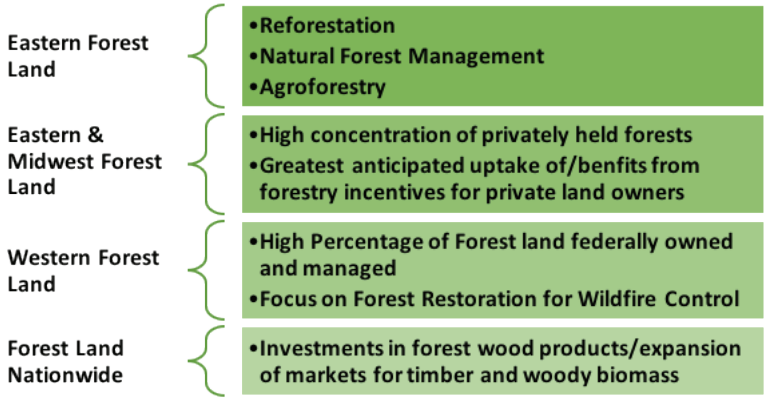
support and provide substantial co-benefits, including improved waste management, new farm income and rural job creation.

The Geography of Natural Climate Solutions

In constructing a policy package that can both mobilize action in agriculture and forestry to address climate change and, importantly, mobilize the necessary political support, the geographic distribution of agriculture and forestry matters tremendously. In particular, from the analysis above, most of the GHG potential in the U.S. land sector will be generated by reforestation and forest activities in the eastern half of the U.S. But, finding the congressional votes for significant federal investments in natural climate solutions will require much broader support. Thus, understanding the geographic diversity of agriculture and forestry, where practices outlined by the MCS, Fargione et al., and WRI and others will occur, and the impact of different policy options in those geographies is critical.

Past climate policy debates—such as those that occurred during consideration of the Waxman-Markey bill in 2009—largely assumed that putting a price on carbon would benefit most of agriculture and forestry and thereby generate political support. Looking at the regional distribution of agriculture and forestry demonstrates that this assumption may be wrong. A package of natural climate solutions that generates substantial support from agriculture and forestry must include a diverse array of policies that can appeal to the disparate needs of different farmers, ranchers, forest owners, and land managers across the country.

Below we match the practices outlined above to their geographic areas on a sector-by-sector basis, thus fully answering the question ***where are the tons?***

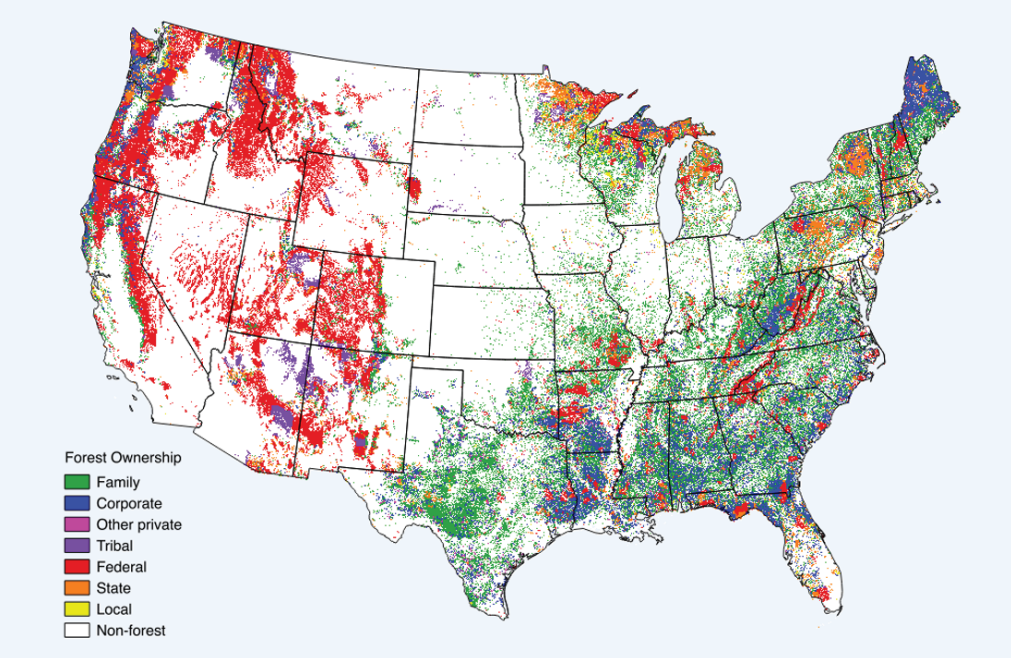


Geography of Forestry Practices as Aligned with Natural Climate Solutions

In the case of forests, as noted above, eastern forests are likely to generate most of the opportunities for reforestation, natural forest management, and agroforestry. In the map of U.S. forests, privately owned forests are concentrated in the East and Midwest and thus forestry incentives are likely to benefit these landowners most. Federal lands, on the other hand, are concentrated in the west. There, investments in largescale forest restoration to reduce the threat of wildfire will be of greater interest to stakeholders in these states.

Investments in forest wood products will benefit forest owners, managers, and businesses across the country, and, as noted above, will likely be necessary to encourage additional investments in forests and generate support from the forest sector.

Figure 7. Forest Land Ownership in the U.S.



Geography of Agricultural Practices as Aligned with Natural Climate Solutions

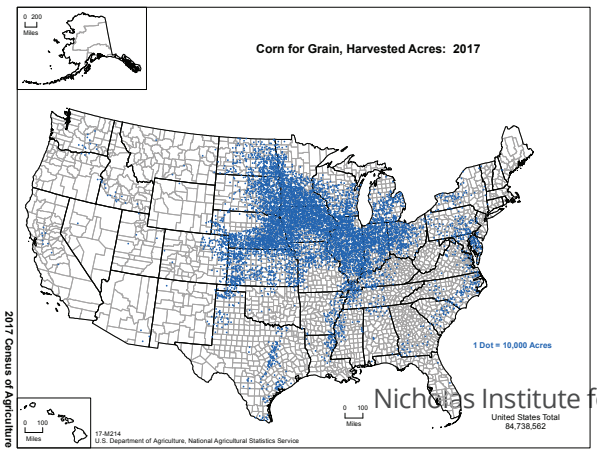
Similarly, agricultural interest in certain types of climate policy varies across regions, cropping systems, livestock operations, and land productivity. Looking at a few maps of the distribution of major agricultural interests shows these differences (we chose to look at only four crops for purposes of illustration). Corn and soybean farmers, concentrated in the Midwest, Plains States, and Mississippi Delta will benefit from policies that reward soil health, improved nutrient management, and biofuel production.

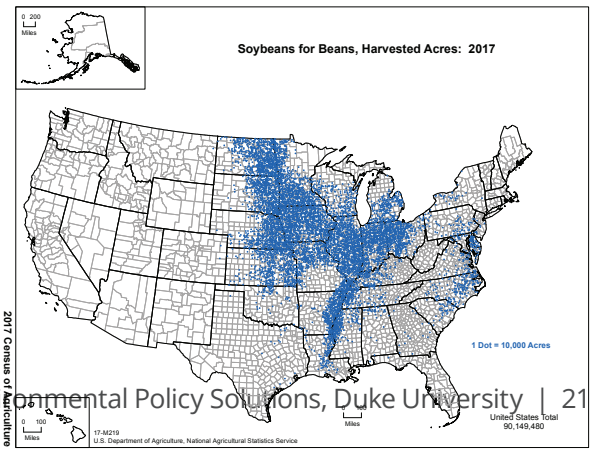
Midwest
Plains States*
Mississippi Delta

- **Corn and Soybean Farmers**
  - Soil Health
  - Improved Nutrient Management
  - Biofuel Production

Great Plains*
Northwest

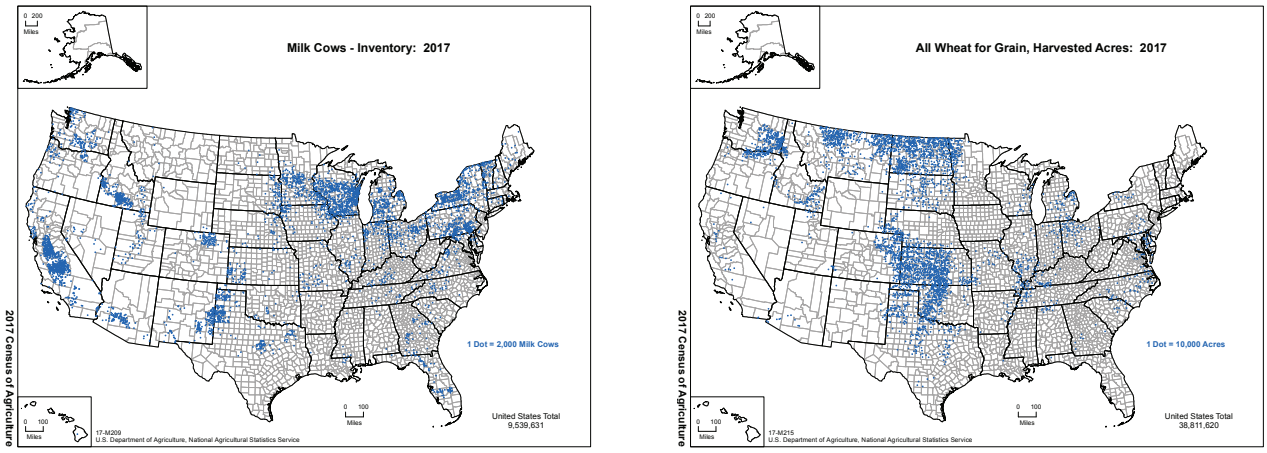
- **Wheat Farmers**
  - Climate Resilience Investments
  - Crop Research for Improved Wheat Varieties





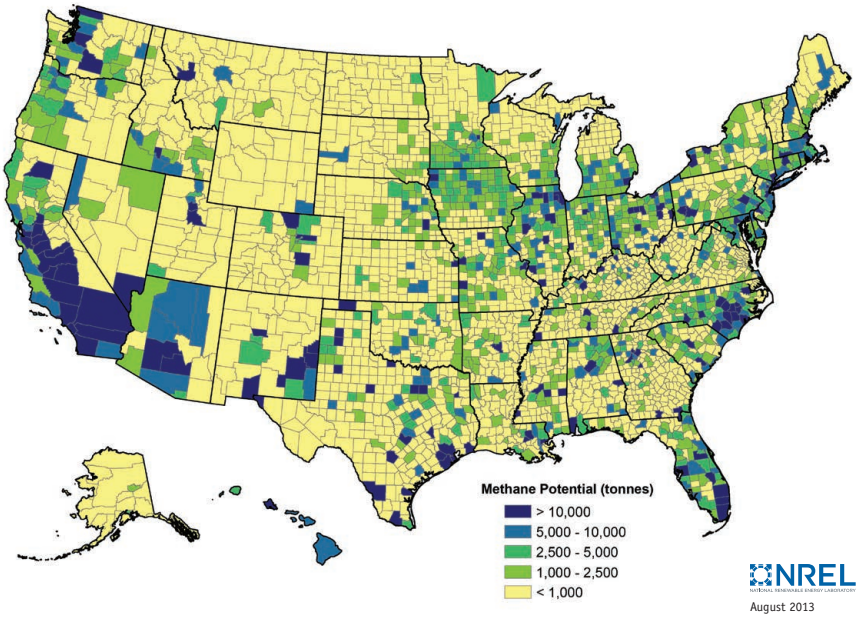
Wheat farmers, on the other hand, concentrated in the Great Plains and Northwest, are less likely to benefit from incentives that reward GHG reductions because their lands tend to be in less productive areas (thus sequestering less carbon). Instead, wheat farmers are likely to be more interested in investments in climate resilience and improved wheat varieties that increase productivity and maintain competitiveness in global markets.

Livestock and Other Agriculturally and Rurally Sourced Methane



Currently, 250 farms have installed digesters.[21] According to the American Biogas Council, new anaerobic digester systems could be implemented on 8,574 additional farm sites across the U.S.[22] These operations, however, are not uniformly spread across the country, as the biomethane map, at right, illustrates, which will likely result in the concentration of biomethane production in areas where livestock production is the densest. Note too that installation of digesters may be difficult for smaller producers who lack the capital and herd size to justify what is now a sizeable investment.

Figure 8. Map of U.S. Biomethane Potential



Anaerobic digestion of animal and farm waste, like the other practices highlighted in this report, provide climate benefits beyond renewable energy production by preventing the release of methane into the atmosphere. Regarding location, programs to help producers install and manage anaerobic digesters for renewable natural gas production in particular are likely to be popular in states with high dairy and swine populations, such as California, the Pacific Northwest, the Upper Midwest, New England and North Carolina. Novel methods for using other feedstocks, such as poultry litter and crop residues, will create additional opportunities for producers and rural communities.

Implications

The distribution of agricultural and forestry GHG mitigation across different farm, ranch, and forest practices and across different geographies has important implications for natural climate solutions, including:

- Basing incentives on carbon benefits of various practices would have disparate benefits across agriculture and forestry. Policies that focus only on paying for GHG benefits will not motivate all farmers, ranchers, forest owners, and other rural stakeholders. A broader investment package will be necessary to motivate agricultural and forestry stakeholders.
- Policy should consider investments in climate resilience as a way to appeal to a broader slice of agriculture and forestry while helping agriculture and forestry adapt to a changing climate. This could benefit all of agriculture and forestry, but particularly operations that are unlikely to sequester significant amounts of carbon or reduce GHGs significantly.
- Bolstering markets for forest products will be important to virtually all forest-related GHG reduction activities on private and public lands and in forests across the country.
- Investments in agricultural productivity will be increasingly important to meet environmental and food production ends.
- Some practices such as biochar and development of perennial grains are speculative but may have significant long-term GHG benefits.
- There are enormous co-benefits from GHG reduction activities across agriculture and forestry. These co-benefits justify broader public support for generation of public goods—like clean water, wildlife habitat, and others—generated from conservation practices that benefit the climate.

II. WHERE ARE THE STAKEHOLDERS?

Winning support from Congress for a significant investment in natural climate solutions will require not only broad public support but, in particular, support from rural voters and important rural stakeholder groups, particularly in agriculture and forestry. In this section of the report, we summarize the positions of forestry, agriculture, environmental/conservation, and rural stakeholder groups with interests that overlap with a natural climate policy solutions agenda. We start by delving into rural American's attitudes towards climate. Throughout and at the end of this section, we use charts to provide more detail, on the policy preferences of these stakeholder interests.

Rural Americans' Views on Climate

Much of rural America, though voicing strong support for the environment, is skeptical about both climate science and climate policy. Rural voters tend to be more politically conservative and more skeptical of government intervention than their urban and suburban counterparts and agricultural and forestry organizations, businesses, and officials often reflect these views.[23]

At the same time, many of the conservation practices that sequester carbon and otherwise reduce GHGs can improve the productivity and resilience of farms, ranches and forests lands. The public—including rural voters—support many of these practices as well because they produce many co-benefits such as water protection, wildlife conservation, and job creation. As a result, ample room exists to develop a menu of policy ideas that can work both for rural interests and the climate.

Forestry Stakeholders

Forestry stakeholders include forest landowners, forest industry (e.g., wood processing facilities, loggers), state and other forestry officials, and the community of forest managers and first responders who work to prevent and fight wildfires. Unlike the agricultural community, the forestry community has reached greater cohesion on national climate policy issues with environmental, conservation, and related interests. This is in large part owing to the work of the Forest and Climate Working Group (FCWG) to build support between the forest and environmental and conservation community. While FCWG certainly does not represent every forestry, conservation, and related organization, it nonetheless has played an important role in building some consensus around forest climate policy—a consensus that recognizes the important role of maintaining and managing existing forests, of planting new ones, and of enhancing incentives, markets for wood, and other financial support of private and public forests.

The FCWG, cochaired by American Forests and the American Forest Foundation, has adopted the following principles:

- Climate change is real, and forests must be part of our nation's response.
- Keeping forests as forests is the foundation to all forest-climate solutions. More than 30 million acres of U.S. forests are projected to be lost to development.
- Forests can do even more to slow climate change if we provide the right science and financial incentives to help private forest owners and public land managers plant and re-plant forests and manage with an eye to carbon.

- Protecting forests from climate change is equally as important as trapping more carbon in forests. Many forest resources could be lost to the stresses of climate change, and cutting edge-science has showed that U.S. forests will lose their capacity to store carbon, and release lots of carbon already stored, if we do not help forests adapt.

Pro-Incentive, Anti-Regulation. Forest landowners and forest industry would adamantly oppose a regulatory approach that requires or regulates implementation of climate mitigation practices on non-federal forestlands because such regulation could effectively diminish the value forest assets. Incentives for forest practices in the Farm Bill and other similar policies have strong support though those programs have tended to focus on small landowners. Large landowners have taken advantage of land conservation programs such as the Forest Legacy Program and others.

Strongly Support Expansion of Markets for Wood Products. Over the last several decades, wood products markets have played an important role in providing economic incentives for landowners to invest in and maintain forests on private lands. These markets are in part responsible for U.S. forests being a significant net carbon sink.[24] On public lands, markets can play an important role in financing forest thinning aimed at reducing catastrophic fire in forests that have been ecologically degraded by decades of suppressing natural fires.

From the standpoint of forest stakeholders, nearly unanimous interest exists among virtually all players to expand markets for new technologies such as cross-laminated timber and mass timber, a technology that utilizes wood panels for wall, floor and roof construction in commercial buildings, including tall buildings. These wood products hold the potential to significantly lower the carbon footprint of large commercial buildings relative to concrete and steel while increasing incentives for landowners to maintain and invest in forests.[25]

It's also worth noting that mass timber, tall wood buildings, and similar wood technologies have strong bipartisan support in Congress as evidenced by passage of the Timber Innovation Act in the 2018 Farm Bill which provides resources for research, outreach, and technical assistance around new uses of wood. Beyond these new technologies, there is strong support to maintain and strengthen markets for more traditional uses such as structural timber and small diameter timber (e.g., paper and woody biomass).

Support Rewarding Carbon Conservation. Forestry stakeholders also see opportunity in a market that rewards landowners for land management practices that sequester carbon, such as reforestation of marginal agricultural lands, carbon-enhancing forest management, conservation of threatened forests, and extended timber rotations. Incentivizing these types of practices will likely find support among landowners and industry, but, as noted previously, landowners' ability to take advantage of these incentives is likely to vary widely based on forest conditions and productivity. For example, in the case of large, institutional landowners, because their land is already forested, it is unlikely they be able to take advantage of reforestation incentives on their existing land-base (though they may be well positioned to acquire new lands for reforestation is justified by markets and incentives). On the other hand, where institutional landowners own forests in the path of development, they will benefit from policies that reward placing lands in conservation easements, for example, which is a strategy for maintaining long-term carbon storage.

Where investment in forest carbon sequestration practices requires landowners to bear the costs of significant investments or present opportunity costs associated with tree planting, new forest management regimes or other practices, then policy will need a mechanism to help landowners or investors manage this risk, through insurance or other mechanisms.

Views Toward Reforestation May Be Mixed. The Mid-Century Strategy, the Fargione et al. paper, and other work places a high priority on reforestation of marginal agricultural and other lands as a climate mitigation strategy. Interest in reforestation as a natural climate solution has increased significantly in the last several months in response to a study by Thomas Crowther which suggested that planting 1.2 trillion trees across the global could make an enormous contribution to slowing climate change.[26] In response, the Trillion Trees Initiative has been launched with support from President Trump and others and has spawned Congressional legislation to significant boost tree planting in the United States.

A large public investment in domestic reforestation, however, will likely raise concerns with at least some and perhaps many in the forestry community unless it is coupled with measures to bolster markets for wood products. Reforestation in many regions will increase timber supplies, thereby suppressing timber prices and lowering the value of timber lands. While many wood processing facilities might appreciate the reduction in their wood procurement costs, forest landowners and integrated companies that own both lands and processing facilities will likely oppose big investments in reforestation without a similar investment in wood markets. There is a strong environmental rationale for bolstering wood products markets, as falling timber prices will increase development pressure on lands in more populated areas as the relative financial gains from forestry shrink in relation to development.

Agricultural groups also may oppose investments in reforestation on prime agricultural lands, as some did during the Waxman-Markey debate in 2009. Investments in reforestation, however, are not likely to be a risk to productive agricultural lands as those lands tend to be more valuable when maintained in crops. But, as a matter of policy, it may still be necessary to clearly steer reforestation incentives away from prime agricultural lands to ameliorate this concern.

Support Forest Restoration and Firefighting Resources to Address Wildfire. Wildland fire, particularly in western forests, could become a much larger source of GHG emissions, as noted above.[27] While fire is a natural occurrence in western and many U.S. forests, decades of fire suppression have increased fuel loads in many forests, making them more susceptible to catastrophic fire. Climate change is exacerbating the problem by drying these forests out rapidly and creating whether conditions ripe for large fires.

Addressing fire in western forests will require landscape-scale forest restoration designed to reduce fuel loads and restore more natural ecological conditions.[28] (Addressing development in the wildland-urban interface is also important, though beyond the issues addressed in this paper.) Reintroduction of low-intensity, prescribed fires will also be crucial. In addition, wood markets, both for solid wood products and low diameter trees, are vital to solving the western fire problem. Investments to bolster forest management, mill capacity for small diameter trees, and logging/forestry jobs will be an important climate policy strategy. Moreover, increasing the

capacity of wildland firefighting resources in the west will be necessary to reduce impacts on lives, homes, and wildlands.

Alaska's forests present a unique problem with respect to fire. As noted above, forthcoming research from the Union of Concerned Scientists and Woods Hole Research Center indicates that emissions from fires in Alaska's boreal forests could be enormous. On the other hand, that same analysis indicates that enhanced fire management could yield substantial and cost-effective carbon emission reductions.[29] Unlike the western U.S. where natural climate policy should center on forest restoration and firefighting investments, Alaska's forests would be better served by a policy that focuses almost entirely on firefighting capacity. While the costs of such a policy could be significant, the investment will also provide significant economic opportunities for economically depressed communities in Alaska.

Assisting Public Lands-Dependent Rural Communities through Secure Rural Schools and Payment in Lieu of Taxes. Secure Rural Schools (SRS) for Forest Service lands and payment in lieu of taxes (PILT) for Department of Interior Bureau of Land Management Lands provide resources for schools, roads, emergency response and other rural community needs for rural communities whose tax bases are limited because of surrounding federal public lands. In the case of SRS, the reduction of timber receipts—25 percent of which are transferred to local governments—has caused hardship for many western rural communities. While this is not a forestry stakeholder issue per se, given the importance of this issue to some western rural communities, it may be worth exploring integrating SRS and PILT into a larger package addressing climate resilience and mitigation on public lands.

Sustainability Matters to Landowners and the Forest Industry. Among investors in forest land, large corporate consumers of wood, and even the broader public, there is growing interest in the sustainability of forests, particularly related to climate change. Third party certification of sustainably managed forests has gained widespread traction in the last two decades as a means to demonstrate stewardship of nonfederal forests. Moreover, certification now plays an important role in acting as a gatekeeper for access to many timber markets. This is important in the context of climate policy because it suggests that interest in the role of forests in climate change by forest landowners and forest industry will be reinforced by consumer preferences. Policies that support forest sustainability, particularly with respect to the millions of small forest owners in the U.S., are likely to garner significant support among forest stakeholders.

Agricultural Stakeholders

Given the diversity of cropping, livestock, and other agricultural systems in the United States, the agricultural sector is more fragmented than is the forestry sector, both in its organizational structure (with many commodity-specific organizations complicating an already highly heterogeneous sector) and its views on policy. That fragmentation is evident in climate policy. Many consumer facing companies such as Cargill, Land O' Lakes, Danone, General Mills, Smithfield, and others have made significant and public commitments to address climate change in their operations and supply chains. Likewise, some commodity groups, such as the dairy industry, are quite forward leaning on climate change. Other commodity groups and agricultural stakeholders, however, have been more reticent to engage on climate policy.

A Nicholas Institute study of rural attitudes on the environment found a strong commitment to conservation and stewardship among rural voters and farm leaders. At the same time, many farmers and ranchers are—like much of rural America—still quite skeptical about climate science and policy.[30] Indeed, even with the promise of increased payments for climate conservation practices on agricultural lands and broader investments in agricultural productivity, many farmers and ranchers are likely to have deep-seated concerns about comprehensive climate legislation for several reasons, including perceived potential impacts on livestock production, fuel and fertilizer costs, concerns about increased regulation, and general skepticism of federal environmental policy. The same Nicholas Institute study found some agricultural leaders somewhat reticent to openly discuss climate change given polarization around the issue in rural communities.[31]

Much of U.S. agriculture is suffering at present from current trade policies. This has relevance for climate policy in two ways. First, farmers and ranchers are heavily focused on economic issues and probably less focused on future climate policy. This has only been exacerbated by the impacts of the coronavirus on agricultural supply chains. Second, some in agriculture are worried that at least a portion of the losses of international trade could be long-lasting or turn into permanent market losses. This latter concern may actually increase interest among some in agriculture in new sources of revenue, including climate incentives and new climate-driven markets.

Pro-Incentive, Anti-Regulation. Like forestry stakeholders, agricultural stakeholders are likely to be adamantly oppose any effort to regulate GHGs or mandate conservation practices of producers. Even beyond that, producers also worry about regulatory creep—for example, where government programs might expose agricultural producers' data to public scrutiny. Producer groups are also quite vocal about wanting USDA, not EPA, to oversee any climate policy that impacts agriculture. This was an important issue to agriculture during the debate of climate legislation in 2009 and 2010 and likely remains so today.

As compared to forest landowners, U.S. agricultural producers are generally far more familiar with incentive and government programs. Many producers have at least some interaction with USDA through the crop insurance program, Farm Bill conservation programs, crop loans, commodity support programs, and a variety of other policies. One challenge with designing incentives to promote natural climate solutions is that a significant proportion of cropland in the U.S. is leased and not owned. This can make it difficult for farmers to make long-term commitments to certain practices on lands they don't own. Developing mechanisms to address this issue should be considered.

Support for Rewarding Voluntary Carbon Conservation. Many agricultural producers would likely do well with a carbon market or incentive policy that rewarded producers based on production of emissions reductions or sequestration. Dairy producers, for example, could benefit from carbon offsets or incentives that rewards them for installation of methane digesters. Likewise, corn and soybean producers may generally do well with incentives targeted at soil sequestration and improved nitrogen fertilizer practices. Yet, even they may not benefit significantly from financial incentives pegged to carbon prices unless those prices are relatively high.

But, just as with forestry, not all agricultural systems will produce substantial revenue from carbon markets or incentives. Wheat producers, for example, are unlikely to generate large payments for soil carbon as their lands tend to be of lower productivity than corn and soybean

lands, and they generally already implement practices that generate substantial soil carbon sequestration. Likewise, cattle ranchers may improve soil health through regenerative grazing practices. Despite the potential importance of those practices (even accounting for the scientific debate regarding the size of the potential contribution of agricultural soil carbon referenced earlier in the report), payments for soil carbon gains likely won't generate substantial new revenue unless carbon prices are especially high.

Protection Against Financial Risks of Climate Practice Implementation. Even for producers who can make profitable investments in carbon, policymakers should look at ways to "de-risk" those investments. Take conservation tillage. Converting to conservation tillage is a leap of faith that requires investment and new cropping practices, all of which may take three to five years for producers to recover their investment. Investments in methane digesters, silvopasture, and other practices carry similar risk. Many farmers have significant loans on crops, equipment and lands, and thus can be risk adverse. To be successful, natural climate solutions policy needs to address the risks of undertaking new climate beneficial practices.

Support for Flexible, Collaborative, Locally Led Solutions. Given the diversity of American agriculture across regions, cropping and livestock systems, and landowner size and objectives, incentives for climate mitigation on agricultural lands must allow for flexibility. Existing Farm Bill programs, such as Conservation Innovation Grants and the Regional Conservation Partnership Program, which have funded climate mitigation activities on working lands have encouraged producers, local partners, and others to band together to design and implement GHG mitigation projects tailored to local conditions. More broadly, collaborative, locally led projects, on both private and public lands, have proven to be very effective for a variety of conservation objectives. GHG policy for agricultural—and forestry lands—should follow suit by supporting locally driven, flexible approaches where possible.

Policy Should Consider Rewarding Early Adopters. Incentives that reward farmers, ranchers, and forest owners for carbon sequestration may not provide significant or any financial reward for those producers or landowners who adopted climate smart land management practices years ago and, as a result, many not see additional carbon gains. Policymakers may want to consider one-time incentive payments or some other mechanism to reward early adopters.

Producers Need (and Want) Technical Assistance. Conservation programs don't implement themselves. One challenge faced by both agricultural producers and forest landowners is the need for good information and expertise in implementing climate smart practices. USDA is clearly an important source of information; investments in the USDA climate hubs (which are designed to provide regionally appropriate information), technical assistance at NRCS, strengthened extension, and improved measurement and monitoring will all be important in supporting the scaling up of climate smart agriculture and forestry on working lands. It may also be important to increase the capacity of such agencies through technology or other means to process contracts and payments. Policy should also support state agencies, land grant universities, and other sources of good information and support for project implementation.

Increased Investments in Productivity and Climate Resilience. While carbon markets and incentives will have variable impacts across different crop and livestock systems, all producers will benefit from investments in agricultural systems, technologies, improved seed varieties, and other

research that improves the resilience and productivity of agricultural systems in the face of climate change. Indeed, there is a substantial argument for investing heavily in agricultural productivity given the need to feed 9.5 billion people in 2050. Put simply, productivity matters a lot. Agricultural efficiency—measured as the amount of food and fiber produced with a given amount of inputs—will be increasingly important. Investments in research by USDA, land grant universities and others should be an important discussion area for policymakers.

Agricultural Businesses Are Driving Sustainability. Seed companies, equipment companies, and other agribusiness could well benefit from renewed investment in climate-friendly agricultural productivity. Indeed, companies like Indigo and Nori are building business models to quantify and deliver carbon revenue to producers and carbon gains to the market. Likewise, agricultural commodity companies such as Cargill and food companies such as General Mills are responding to consumer interest in climate change and sustainability by making public commitments to green their supply chains. Just as investor and consumer interest is driving large forest landowners and forest industry to invest in sustainability, so, too, will interest from food and retail companies drive adoption of climate-smart agricultural practices. Policy could support such commitments by incentivizing climate smart practices on farmland and providing improved data for cost-effective measurement and monitoring. Producers will no doubt want to ensure that they receive adequate financial benefits from participation in these markets.

Incentives That Support Bioenergy Are Important to Much of Agriculture. For the most part, agriculture supports increased bioenergy production. Among other policies, federal and state renewable mandates on utilities and the transportation fuel sector have substantially increased incentives for planting corn and, to a lesser degree, soybeans. While the environmental impact and GHG footprint of biofuels in particular has drawn criticism from many in the environmental community, a USDA study suggests the GHG footprint of corn ethanol and other biofuels has improved dramatically.[32] The livestock industry shares concerns about corn ethanol though for different reasons. Using corn and soybeans as an energy crop drives up feed prices which is an important input for dairies, hog farms, and livestock feedlots. Nevertheless, particularly given the challenges that corn and soybean farmers face as a result of current trade policies, a policy approach that seeks to foreclose biofuels is a non-starter for much of agriculture. A far better approach—one that can win much of agriculture—is one that incentivizes biofuels with better carbon footprints and maintains and enhances economic opportunities for biofuels.

With respect to bioenergy produced by capturing livestock methane (i.e., biogas), there is strong support in agriculture for incentives that reward waste to energy investments.

Concern about Input and Fuel Costs. While the costs of fuels, chemical and other inputs in agriculture aren't significant issues with respect to natural climate solutions policy, they do bear on climate policy more broadly. For example, agricultural stakeholders worried during House consideration of the Waxman-Markey Bill in 2009–10 about the impacts of cap and trade on these costs. Those concerns may arise again if natural climate solutions policy moves forward in Congress as part of a larger climate bill that does not also address input costs for farmers and ranchers.

Creation of Opportunities for Beginning and Minority Farmers. There is substantial interest within the agricultural sector around encouraging younger farmers to enter the business, as well as

retaining minority landowners and encouraging new ones. (There is strong interest in retaining minority landowners in forestry as well.[33]) Indeed, until the last two decades, USDA has a long history of discrimination against minority, tribal, and women producers. It's vital that natural climate solutions not only ensure that programs are implemented equitably but that special efforts are made to encourage and facilitate participation among all landowners. Equity considerations will be important in the design of climate policies and, especially, outreach and technical assistance associated with program implementation.

Hunting and Fishing, Outdoor Recreation

Sportsmen and Women: Focus on Land Conservation and Habitat Protection. In the late 2000s, several organizations in the hunting and fishing community became more active on climate change as evidenced by publications like Season's End: Global Warming's Threat to Hunting and Fishing, authored by Trout Unlimited, Wildlife Management Institute, and others. However, in the wake of failed efforts to pass federal climate legislation in 2009–10, many hunting and fishing organizations turned their attention away from climate change. Given that their memberships skew rural, climate change became far more polarizing for these organizations. Today, many of those organizations are again becoming increasingly interested in helping shape climate policy as it relates to wildlife conservation, habitat, water conservation, coastal resilience, and public lands.

The sportsperson community is likely to be less interested in broad climate policy discussions around carbon taxes, cap and trade, or similar mechanisms. Instead, those groups will be very interested in how resources can be deployed to benefit habitat and wildlife populations. Specific initiatives that could engender significant interest from hunting and fishing groups might include:

- Grassland and wetlands conservation, both of which can produce substantial carbon gains while providing valuable habitat for ducks, grassland birds, and other game.
- Reforestation, improved forest management, and stemming the loss of forests to development on private lands, which benefits game habitat, hunting access to private lands, and water quality and quantity.
- Addressing catastrophic wildfire on public lands, including forest and rangeland restoration, use of prescribed fire and managed wildfire. These activities will improve habitat for a variety of game species including elk, mule deer, sage grouse and others.
- Soil health and nutrient management initiatives on working farms and ranches, which improve water quality in streams, rivers, and estuaries.
- Conservation of wildlife migration corridors, as climate change has already impacted and will impact animal movement.
- Water infrastructure investments.
- Coastal resilience in the wake of sea level rise and extreme weather events.
- Siting of renewable energy.
- Investments in science around the impacts of climate change on wildlife and habitat.

Outdoor Recreation: A Potentially Powerful Constituency. The outdoor recreation industry generates nearly $900 billion in annual consumer spending in the U.S. and millions of associated jobs.[34] The industry is diverse representing companies that, on the one hand, have been out-front in taking pledges to reduce their carbon footprint and, on the other, motorized sports, recreational vehicle interests that may have concerns about broader climate policy. Some recreation companies have been quite vocal in support of conservation initiatives, particularly related to federal lands management and designation of national monuments under the Antiquities Act. Other companies, such as Patagonia, are involved in promoting sustainable agriculture, in part, because of impacts on climate change.

It appears likely that at least portions of the outdoor recreation industry will be active on issues related to climate mitigation and resilience of agricultural and forest lands. There is likely to be significant interest by some businesses and recreation groups around climate impacts and mitigation on public lands, in particular. For example, recreational interests have weighed in on wildfire issues—particularly around the need for funding for forest restoration—in National Forests.

Environmental and Conservation Groups

While issues related to GHGs from fossil fuel use have been dominant in environmental advocacy (for obvious reasons), there is a growing recognition that meeting climate goals is very difficult to impossible without securing GHG reductions from agriculture and forestry. Still, several policy approaches which may be necessary to win over rural constituencies are not without controversy in some parts of the environmental community. We address several of those issues below.

Conservation Investments Are High Priority. Many environmental and conservation groups recognize the enormous potential to finance significant gains in the conservation and resilience of ecosystems through climate policy. This is a critical point. Many in the conservation and environmental community will want to see policies and investments that conserves biologically rich, high carbon lands on both public and private lands and will be hesitant to support a large package for agriculture and forestry without it. For example, on public lands, efforts to encourage the conservation of high-carbon old-growth forests will be critical for many organizations. On private lands, investments in programs that conserve areas of high conservation value or that promote permanent conservation or working lands through easements will be a priority.

Concerns about Offsets. Since the late 1990s, issues related to agriculture and forestry have been controversial within the environmental community because the primary policy mechanism under consideration in U.S. and international policy was offsets. Even as conservation groups look for ways to use offset dollars to finance forest conservation, a sizeable portion of environmentalists opposed offsets out of concerns that they were a distraction from reducing fossil fuel emissions and that environmental integrity could not be guaranteed. Those concerns are still present today (as has been evident, for example, in the recent pushback against the Trillion Trees initiative referenced earlier). Moreover, some environmental justice groups also oppose offsets because they may reduce pressure on emitting industries to switch to cleaner fuels. While voluntary offset programs are unlikely to draw fire, compliance offsets—that is, offsets used to meet regulatory limits on GHGs—may once again fragment the environmental and conservation organizations without some mechanism, at minimum, to ensure environmental integrity.

Hesitancy over Bioenergy. Bioenergy is controversial within the environmental community. In the case of biofuels, many environmental groups have raised concerns about the impact of corn ethanol on water quality, expansion of cropland into grasslands and forests, and impacts on food crops. Moreover, they contend that ethanol's carbon footprint is not much better than that of conventional fuel. In the case of the use of wood for energy, portions of the environmental community have raised strong concerns about the GHG impacts and sustainability of wood energy. Related to biogas and biomethane, groups who oppose concentrated animal feeding operations contend that creating incentives for capturing only subsidizes these operations. While it is unlikely that the most vocal critics can be won over, there is a likely a path forward for bioenergy where some measure of agreement can be found. Most can likely agree on providing incentives, markets, and technology that encourages more sustainable and more carbon beneficial bioenergy.

Big vs. Small Agriculture, "Industrial Agriculture," "Industrial Forestry." There is a tendency among some environmentalists to malign "big agriculture," "industrial agriculture," "non-organic agriculture," and "industrial forestry." These polarizing debates are unlikely to be resolved in the context of climate policy and are better left for another venue. The focus of natural climate solutions policy should be on how policy can reduce GHGs, increase carbon sequestration, and broadly advance sustainability and ecological health, while improving the economic viability of farm, ranch, and forest operations, large and small.

Fear That Wood Product Incentives Will Harm Forests and Forest Ecosystems. Policies to bolster markets for wood products—including bolstering existing markets for sawtimber and expanding markets for biomass and new products such as mass timber—are likely a must for forest landowners and forest industry. Yet, there are organizations in the environmental community who question use of wood in mass timber and commercial building, just as there are organizations that see the promise of these new technologies. As with bioenergy, not all critics in the environmental community will be convinced as to the merit of expanding markets for wood products. Still, over the last two decades, forest certification and use of best management practices have been important in broadening the practice of sustainable forestry in the U.S. A broad consensus around wood products markets likely entails using these tools in addition to improved forest survey data to ensure forest growth continues to outpace removals and that important ecological areas are protected from over-harvest.

Other Rural Organizations

Several rural-oriented groups, such as the National Association of Rural Electric Cooperatives, while not directly active in agriculture, forestry, or climate policy, have a very strong presence in rural communities and hence can wield a great deal of power. Likewise, the National Association of Counties, which represents county officials from across the country, is a strong voice on a variety of challenges facing rural communities. Rural electric cooperatives and county officials often serve as bellwethers of rural attitudes and can often sway rural public opinion. Generally speaking, rural organizations will be focused on affordability and watchful of measures that could make goods and services more expensive. They will also likely prefer flexible, locally driven, voluntary, incentive-based approaches and will oppose regulation, especially "government-imposed, one-size-fits-all policies."

Table 1. Summary of Stakeholder Positions on Natural Climate Solutions Policy and Rural Investment

Forestry Sector	Climate Attitudes	Support	Oppose	Concerns	Rural Invest. Policy
Forest Industry (paper, wood manufacturing, logging)	Significant, though not universal, support for Forest Climate Working Group Principles, including acknowledging climate change, keeping forests as forests, incentive-based approaches, addressing both GHG mitigation and forest resilience. There are others in forestry concerned about regulation of carbon emissions from mills. Many western mills place a high priority on production from public lands. Forest industry and landowners are also responding, through certification and other commitments to consumer and investor interest in climate change and sustainability.	Incentives that maintain and value working forests and bolster markets for wood.	Regulation of lands, regulation of carbon emissions from wood energy, manufacturing	Impacts of climate legislation on wood industry and manufacturing, fuel costs.	Markets for wood, though not universal support for wood energy; forest restoration investments
Forest Landowners Large and small landowners		Policy to expand markets for wood, recognition in policy of working forests as climate solution, working lands incentives	Regulation of forest practices, regulation of carbon emissions from wood energy, manufacturing	Impact of significant afforestation/ reforestation on timber prices.	Markets for wood, including solid wood, wood energy, Conservation of working forests; resiliency measures
Western Mills Typically, smaller mills more reliant on public lands timber		Active management to address forest health on public lands	Reduced management of public lands	Policies that reduce federal lands timber volume	Markets for wood, including particularly solid wood, also wood energy, support for forest jobs in logging, manufacturing.
Forest Agencies, State Foresters		Incentives for forest carbon management in working forests, forest conservation; policy to expand wood markets	Regulation of lands, regulation of carbon emissions from wood energy, manufacturing	Regulation of forest practices, impacts of climate legislation on wood industry and manufacturing	Markets for wood, including solid wood, wood energy, support for forest jobs in logging, restoration; conservation of working forests.
Ag Sector	**Climate Attitudes**	**Support**	**Oppose**	**Concerns**	**Rural Invest. Policy**
Commodity Groups Corn, Soybeans, Wheat, Cotton, Rice	Fragmented; some national and state organizations engaged, but much of membership wary of federal policy	Voluntary incentives for conservation practices, emphasis on cropland productivity/yields, bioenergy	Regulation (esp. environmental) of all of agriculture, including livestock; efforts to limit biofuels; policies that raise input costs	Creeping federal oversight of agriculture; policies that expose landowners' data	Increased agricultural productivity; incentive-based policies, sustainable bioenergy; attracting younger generations to farming; efforts to address crop and grassland resiliency
Agribusiness Cargill, Corteva	Actively developing C reduction strategies and business strategies	Investments in productivity; voluntary incentives for producers; improved seed, input technology	Regulation of agriculture	Creeping federal oversight of agriculture	Increased agricultural productivity; sustainable bioenergy
Agriculture/Food Companies (e.g., General Mills, Danone)	Public-facing companies increasingly responding to consumer demand for supply chain sustainability	Voluntary incentives to support producers; science to measure GHG impacts	Regulation of agriculture	Creeping federal oversight of agriculture; increased input costs	Increased agricultural productivity; investments to improve agricultural sustainability

Livestock Dairy, Swine Producers; Cattle Ranchers	Spectrum of views, dairy has been proactive on sustainability, GHGs; some in hog industry engaged; but strong concern across livestock industry about methane regulation	Voluntary incentives for producers to implement conservation practices	Regulation of methane; efforts to reduce	Concerns about climate legislation impacts; some concern about biofuels impact on feed prices	Methane digesters; improved feed mixes, attracting younger generations to farming.
Hunting & Fishing	**Climate Attitudes**	**Support**	**Oppose**	**Concerns**	**Rural Invest. Policy**
Membership Organizations	General recognition of climate impacts; interest in natural climate solutions;	Conservation of grasslands, wetlands, forests; incentives to improve water quality; public lands restoration; coastal resilience.	Interference with access to hunting and fishing areas.	Some concerns with: (1) bioenergy impacts on habitat; (2) policy impacts on boat/RV fuel prices	Large-scale wetland, grassland and forest restoration; coastal wetlands restoration; access to recreation.
Outdoor Recreation	**Climate Attitudes**	**Support**	**Oppose**	**Concerns**	**Rural Invest. Policy**
Outdoor Apparel Companies, Equipment Manufacturers	Consumer base largely engaged on climate change, with possible exception of motorized outdoor manufacturers	Conservation of public and private land and recreational waters	Policies that restrict recreational access	Some interests concerns about policy impacts on boat/RV fuel prices	Investments that support recreational lands and access; some interest in sustainable agri. And forestry
Environment/ Conservation	**Climate Attitudes**	**Support**	**Oppose**	**Concerns**	**Rural Invest. Policy**
Environmental Advocacy Organizations	Climate action is top priority though emphasis on natural climate solutions varies	Federal climate legislation that includes natural climate solutions though approaches vary	Policies that might impact ecosystem sustainability negatively	Varying concerns about bioenergy; public lands management; varying views on wood products markets	Large-scale wetland, grassland and forest restoration; coastal wetlands restoration.
Conservation Organizations	Strong engagement on natural climate solutions	Conservation of grasslands, wetlands, forests; incentives to improve water quality; public lands restoration; coastal resilience.	Policies that might impact ecosystem sustainability negatively	Varying concerns about bioenergy; public lands management.	Large-scale wetland, grassland and forest restoration; coastal wetlands restoration.

III. WHAT CAN WE LEARN FROM STATE POLICY?

We are interested in state climate policy as it relates to natural climate solutions for three reasons. First, legislation that has passed in states—or that states are actively considering—provides significant insight into what policies can pass muster with rural and environmental stakeholders. Second, and particularly important for our analysis here, federal policy should be informed by the successes and failures of existing state policies. Third, many states are actively working on natural climate solutions policies now and those efforts provide some insight into the design of federal policy.

In the analysis below, we examine (1) renewable fuels, bioenergy, and fuel standards; (2) California's experience with cap and trade and the use of both offsets and allowance proceeds to finance natural climate solutions; (3) the Regional Greenhouse Gas Initiative's (RGGI) experience with offsets, and; (4) the work of the U.S. Climate Alliance states on natural working lands.

State Renewable Energy Standards, Renewable Fuel Standards and Bioenergy

Over the last two decades, states have been very active in passing policies to promote renewable energy and renewable fuel use. With respect to renewable energy standards and incentives, twenty states[35] have enacted mandatory renewable portfolio standards (RPS) that require electric generating utilities to deliver a certain amount of electricity from renewable or alternative energy sources,[36] the focus being on the renewable aspect of the electricity produced rather than carbon reductions. Regarding carbon reduction-focused standards, six states have enacted clean energy standards that require electric generating utilities to deliver a certain percentage of electricity from non- or low-emitting carbon sources.[37]

Renewable fuel standards, on the other hand, strive to increase the amount of renewables used in transportation fuel.[38] In addition to the Federal Renewable Fuel Standard (RFS),[39] eight states have enacted some form of a clean fuel standard, including California, Oregon, Hawaii, Washington, Minnesota, Missouri, Louisiana, and Pennsylvania.[40]

With respect to bioenergy or biofuels used to fuel the transportation sector,[41] the vast majority of states have enacted legislation to encourage the use of biofuels, and specifically the use of biodiesel and ethanol.[42] Biofuels legislation is not limited to states without a significant oil and natural gas industry. Louisiana, for example, has enacted a series of statutes that require the use of ethanol and biodiesel, that provide incentives for using biofuels, and that would provide incentives for developing infrastructure to support the biofuels industry.[43] Texas, Mississippi, and Alabama also have enacted similar legislation. Nor is biofuels legislation limited to states with significant agricultural and forestry resources. Nevada, a state with comparatively little agricultural and forestry land area, has enacted legislation to enable and encourage the use of biofuels.[44]

Renewable vs. Clean Fuel Standards[45]

In addition to California's Low Carbon Fuel Standard (LCFS), Oregon has adopted both an alternative fuel standard and low-carbon fuel standard. The alternative fuel standard requires that gasoline sold in the state contain at least 10 percent ethanol and that all diesel fuel sold in the state contain at least 5 percent biodiesel. Oregon's standard also creates tax credits and incentives for activities related to the production, collection, storage, and use of biomass and bioenergy. Oregon's low-carbon fuel standard requires a 10 percent reduction in average carbon intensity from 2015 levels by 2025, with a baseline of 10 percent ethanol blended with gasoline and 5 percent biodiesel blended with diesel.

The financial incentives created by these renewable fuel standards has prompted significant interest in renewable fuel development, particularly from the agriculture and renewable energy sectors. Of these, California's LCFS arguably has had the greatest influence on U.S. biogas development by dramatically increasing the value proposition for biogas projects.[46] Thanks to the high demand for biogas created by the LCFS, renewable natural gas produced by these projects can fetch in the realm of 15 times the price of conventional natural gas—and upward. The price signal sent by California has translated into a major boost in the number of anaerobic digester projects, from dairy and swine operations in particular, which score very favorably in terms of carbon reductions or carbon intensity.

California AB 32

In 2006, California passed the Global Warming Solutions Act (AB 32) which established a statewide cap and trade program that allowed for carbon offsets from the agriculture and forestry sectors to be used for compliance purposes. Up to eight percent of the California emissions cap could be met through offsets—a limit that was recently reduced to four percent under pressure from some environmentalists who oppose offsets.

Under the law, the California Air Resources Board has established protocols for forestry, livestock, rice, and grazing projects. The experience with AB 32 demonstrates both the potential and challenges of offsets. Forestry projects, for example, have produced millions of tons of offsets, but the projects have been limited by rules that require, among other things, a 100-year commitment by landowners. This is the inherent tension in all offset programs. That is, environmentalists tend to push for high standards for participation which then lowers the interest of potential landowners by raising the costs of participation.

Offsets from livestock methane projects has also produced substantial reductions. In this case, the accounting requirements are easier for producers to adhere to, in part because accounting issues are more straightforward for emissions reductions projects as opposed to sequestration projects. In the case of rice production, however, there has been no participation from landowners because carbon prices have been too low to justify investment despite the California Rice Commission's substantial efforts to develop an offset protocol.

In short, the experience with AB 32 suggests that continuing opposition to offsets, tension between environmental integrity and landowner participation in protocol development, and low carbon prices have limited the potential of offsets to generate GHG benefits.

In addition to offsets, AB 32 also auctioned permits under the cap and trade program and then invested those resource in a variety of climate-related projects including energy efficiency, clean vehicles, water energy projects, clean farm equipment, wildfire mitigation, and forest restoration. This is another useful lesson from California. That is, investments—in this case from allowance proceeds—in natural climate solutions can allow for conservation practices such as forest restoration to reduce the threat of wildfire that, for a variety of reasons, may not be a good fit under offset programs. An analysis by the state of California showed that GHG reductions from some agriculture and forestry activities were quite cost-effective relative to other investments.[47]

Regional Greenhouse Gas Initiative (RGGI)

RGGI is a cooperative effort among ten states—Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont—to cap and reduce electricity sector carbon emissions.[48] Each participating state has enacted and implemented its own carbon budget trading program based on the RGGI model. These programs limit carbon emissions from electric generating facilities, issue carbon allowances, and enables participation in regional carbon allowance auctions.

RGGI also allows for the use of offsets, including for projects that sequester carbon through forestry and reforestation and projects that capture and destroy livestock methane. However, the design of

RGGI and of the state implementation program limits the utility of offsets. RGGI caps offset use at 3.3 percent of a utility's reductions. This cap on offsets can increase as the demand for allowances and therefore offsets increases. However, RGGI's cap has not been stringent and so there has been almost no demand for offsets. One project has been approved involving landfill methane in Maryland. No agricultural or forestry offsets have been approved or used under RGGI.

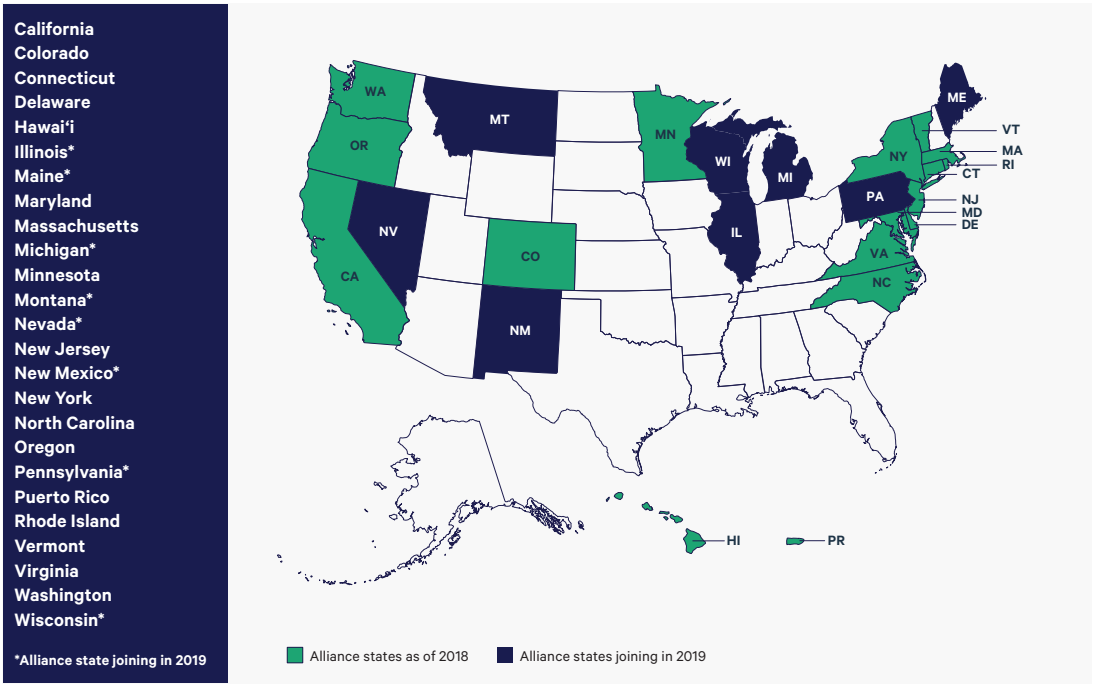
Notably, New Jersey which has recently rejoined RGGI is using revenue from auction of carbon allowances to fund, among other things, creation of stewardship plans for private forest owners.

U.S. Climate Alliance States

The U.S. Climate Alliance[49] is a bipartisan coalition of 25 governors who, after the Trump Administration signaled its intent to leave the Paris Agreement, committed their states to meeting the goals of the Agreement. Alliance states include California, Colorado, Connecticut, Delaware, Hawaii, Illinois, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nevada, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Puerto Rico, Rhode Island, Vermont, Virginia, Washington, and Wisconsin.

In the absence of federal leadership, the Alliance works with states to fill the climate action void. It does this by drawing from progress made in states which are leading on climate change and sharing and helping to scale best practices and successful strategies among state partners.

Figure 9. U.S. Climate Alliance States



While the Alliance works "across all sectors of the economy," it nevertheless has recognized that natural and working lands' capacity to sequester carbon must be activated in order to meet climate change goals. Thus, in 2018, the Alliance established the Natural and Working Lands Challenge ("#NWLChallenge").

The Natural and Working Lands Challenge aims to protect and enhance carbon sinks such as forests, farms, rangeland, and wetlands, while building greater ecosystem and community resilience against severe weather hazards. The NWL Challenge consists of a set of loose protocols,[50] data and analytical tools and other guidance mechanisms to help states in developing natural and working land carbon sequestration strategies. While many of the state's commitment levels are similar, the strategies can look very different depending on the composition of the state's agriculture and forestry sectors, land cover, geography, economic and political make up.

Over the last two years, the U.S. Climate Alliance's NWL Challenge has received pledges from 17 states, which are included in the chart below along with their specific natural and working land-focused progress. An example of concrete actions include California's release of a Draft 2030 Natural and Working Lands Climate Change Implementation Plan, which establishes a pathway for state-led conservation, restoration, and management activities.

In addition, Alliance states have assembled tools to help in conservation decision-making. For instance, Virginia established the ConserveVirginia tool in 2019, which includes a "smart map" to identify high priority lands for conservation. Importantly, the work the Alliance is catalyzing—to evaluate and model opportunities to increase natural and working land carbon reductions and uptake and to create strategies to implement these opportunities—is being validated with state funding, thus illustrating how investments in evaluation and planning can spur further investment or identify where investments are best made.

In 2018, North Carolina's governor issued an executive order committing the state to specific GHG reductions goal for the state, after which the state joined the NWL Challenge as part of its efforts to develop a strategy for meeting its climate targets. The NC NWL stakeholder group has produced modeling tools that have been used to identify priority areas for sequestration practices in North Carolina. These modeling tools have the potential to be transformed to programs that could help other states in ascertaining NWL sequestration opportunities.

With respect to how the NWL Challenge has spurred investments in natural climate solutions practices, the U.S. Climate Alliance reports that Rhode Island, which identified increasing the extent of urban forests statewide as one of its NWL goals, designated over $650,000 in grant funding for urban forestry projects. With respect to private forest land opportunities identified through New York's NWL Challenge effort, New York State established a new cost-share practice program to help private forest landowners overcome severe obstacles to establishing natural regeneration in stands of maturing forests located on most of New York's 15.6 million acres of privately-owned forests.

Perhaps the best lesson that can be taken from the U.S. Climate Alliance's NWL Challenge is the cooperative relationship it has built between itself and participating states. (The Appendix provides a complete list of the states and their corresponding NWL actions.) The Climate Alliance is succeeding by giving states the tools to ascertain their NWL carbon sequestration opportunities,

set their sequestration goals, and create plans based on their state's individual characteristics, politics and culture. In essence, states control where and how they will achieve sequestration goals, while the Alliance provides initial guidance to help them model opportunities and prioritize near, mid and long-term strategies.

One overarching question for Climate Alliance states is how to finance GHG reductions on agricultural and forest lands. California is already financing large scale natural climate solutions through both carbon offsets and expenditures of allowance proceeds. For other states (and for California, for that matter), the federal government could play an important role through a variety of policies to help fund land management practices. States, for their part, can provide expertise and a network of local organizations to work with farmers, ranchers, forest owners, and public land managers to put those funds to use. Federal policies and financing that allows for locally- or state-led projects could capture and leverage the extensive work being done by Climate Alliance states. Federal natural climate solutions policy could also provide improved data, science, and outreach to assist the efforts of states in meeting their climate goals.

IV. WHAT BELONGS ON THE NATURAL CLIMATE SOLUTIONS POLICY MENU?

This section of the report focuses on the menu of policies that can draw rural support while advancing significant investments in natural climate solutions. We first examine the existing federal policy landscape and then outline broad requirements for federal policy. We then turn to an extensive discussion of federal policies for climate mitigation and resilience on agricultural and forest lands. We end with a discussion of potential rural investment policies that support natural climate solutions while offering the potential to garner significant rural political support.

The Changing Policy Landscape

The policy landscape around agricultural and forest climate mitigation is changing rapidly. In the last several months, after a long hiatus Republicans have begun to step forward on climate change, particularly around agricultural and forestry incentives. Several members of Congress are actively working on bills addressing agricultural and forest climate mitigation and others are in the works. This activity is driven by two factors. First, there is growing urgency from Democrats and some Republicans about the need to act on climate change and a recognition that the land sector is vital. Secondly, there is still quite a lot of uncertainty in what the solution set looks like for agriculture and forestry, and members are seeking to fill the void.

Uncertainty around the policy mechanisms to address natural climate solutions is a relatively new phenomenon. As noted previously, since the late 1990s, cap and trade legislation has largely been in the center of conversations around comprehensive federal climate policy and carbon offsets were assumed to be the financial mechanism that would fund natural climate solutions through investments of private capital from companies subject to climate regulations.

Advocates for climate legislation have often viewed carbon offsets as a central bargaining chip that would help secure rural support for a broader climate package. Even if carbon offsets provided significant financial benefits to much of agriculture and forestry (which, as we point out earlier, is a questionable assumption), there will likely still be significant concern to broad climate

policy from agriculture and forestry because of concerns about impacts on the price of inputs such as fuel and fertilizer and a concern among those constituencies about federal environmental policy generally. The notion that offsets will win over broad support for a large climate package is probably tenuous at best.

That said, with the failure to enact cap and trade legislation in Congress in 2009–10, it's not clear that national climate legislation will be designed as an emissions trading program, if one were to even pass in the next few years. Because there is uncertainty about the form federal climate legislation will eventually take, there is corresponding lack of clarity about whether offsets are a viable tool to finance natural climate solutions.

Uncertainty about both the timing and the form of comprehensive federal climate legislation has important implications for agricultural and forestry climate mitigation policy. Most importantly, it means that advocates of natural climate solutions need to be agile and develop policies that can move as part of a broad climate package or as individual policies in budget, infrastructure, Farm Bill or other legislation.

The ability to be agile in finding venues for natural climate solution investments is made even more by the impact of COVID-19. As the country grapples with the effects of the outbreak, Congress is likely to consider both stimulus and economic recovery packages to help people and the economy recover. Natural climate solutions may have a role to play. Agricultural and forestry producers and landowners are already being impacted by the effects of the virus on markets for their products. At the same time, investments in agriculture and forestry have the potential to generate significant jobs and economic opportunity. If the stimulus and recovery packages from 2008 and 2009 are any indication, federal investments are more likely to draw support from Congress if they utilize existing authorities and have bipartisan support. Many of the policies discussed below fit those criteria.

Broad Requirements of Federal National Climate Solutions Policy

Based on where the tons are, where the stakeholders are and what the policies are, we consider a package of natural climate solutions policies, to produce the necessary climate benefits and pass muster with rural constituents, must:

- Rely on market- and incentive-based approaches, not regulation, to encourage adoption of climate beneficial practices on working lands while recognizing that different producers and/or landowners may have different needs in terms of policy design (i.e., conservation program incentives versus tax incentives).
- Rely on multiple policies and investments—rather than just a single approach—to address GHG mitigation, climate resilience, agricultural and forest productivity, and other rural needs.
- Allow for flexible, local- or state-driven projects that have low transaction costs and allow producers, landowners, agencies, and others to work collaboratively.
- Look for opportunities to integrate federal policies with ongoing and emerging efforts by the states.

- Encourage investment of private capital in mitigation and resilience, building on innovation that is already occurring in agriculture and forestry.
- Invest in the resources and staff (governmental and nongovernmental) to deliver incentives, technical assistance, and programs.
- Encourage sustainable, carbon beneficial bioenergy in both agriculture and forestry.
- Support research into agricultural and forest productivity and new bio-based products that can provide new sources of revenue and benefit the climate.
- Support research and delivery of science and technology that can assist producers, landowners, businesses and rural communities in climate mitigation and resilience.
- Invest in jobs and businesses that support climate mitigation and resilience activities on working lands and public lands.
- Ensure programs are delivered equitably to all producers and landowners.

Federal Policy Options for Natural Climate Solutions

What follows is a discussion of several approaches to natural climate solutions on agricultural and forest lands.

Compliance Offsets

Voluntary markets for offsets are relatively robust at the moment as many large companies increasingly take public pledges to reduce their GHG footprints. For many who won't be able to reduce operational GHGs to zero, purchase of offsets will be an important mechanism to achieve company targets. In addition to voluntary markets, the International Civil Aviation Organization has created a Carbon Offsetting and Reduction Scheme for International Aviation that has broad participation from many countries. This effort is slated to become mandatory in 2026.

Offsets—in both voluntary and compliance markets—have the strong advantage that they are designed to encourage private (not public) investment in natural climate solutions. In voluntary but especially compliance markets, it's critical to ensure that offsets in the land sector produce real, measurable, additional, and verifiable GHG benefits.[51]

A central challenge of offset programs is to overcome uncertainty from two different perspectives. First, some in the environmental community worry that ensuring measurable, additional, and permanent GHG gains from agricultural and forestry offsets is difficult.[52] Developing carbon accounting rules for many agricultural and forestry practices can be difficult and time-consuming. More rigorous accounting standards increase the probability of GHG gains but suppress producer and landowner participation by raising transaction costs. Likewise, more streamlined accounting protocols increase participation by lowering transaction costs but can raise concerns about the reliability of GHG gains from those practices, particularly from the environmental community. New technologies such as remote sensing or conservative calculation methods may significantly reduce monitoring costs. Still, any accounting standard will have to make judgements about additionality, leakage and/or permanence that can't be solved by technology alone.

A second type of uncertainty around offsets is raised by producers and landowners who are concerned that returns from offsets may be minimal or worse as a result of low carbon prices and/or high transaction costs associated with measurement and verification. Some GHG mitigation practices may be easily measurable and produce significant GHG benefits (e.g., methane digesters), however, many mitigation practices may produce modest annual GHG benefits per year per acre (e.g., agricultural soil sequestration, improved grazing practices). For this reason, offset programs will function better if landowners can be aggregated across large areas so that measurement costs can be broadly shared. In addition, farmers have developed tools (e.g., crop insurance) to address the risk of crop losses or low prices for other agricultural commodities. In the case of carbon markets, similar tools may be necessary to entice producer and landowner participation.

Using a Carbon Bank to De-risk Offsets and Guarantee Environmental Integrity

Is there a way to maintain the strongest attributes of offsets—encouraging private investment and tracking, measuring, and pricing GHG benefits—while addressing both forms of uncertainty discussed above: environmental and economic uncertainty? We think so.

A carbon bank could be established by the USDA to provide greater environmental certainty while guaranteeing producers and landowners a return from their investments. Such a bank could operate under the authority of the Commodity Credit Corporation at USDA. The CCC was developed to stabilize, support, and protect farm income and prices. Why not use the CCC to do exactly that for emerging carbon markets?

Using the CCC, the USDA could enter the carbon market as a buyer and operate a reverse auction—that is, USDA would offer to buy carbon reductions through agricultural and forestry activities and allow farmers, ranchers, and forest owners to bid the price at which they would sell. USDA could ask bidders to use existing third-party, carbon measurement protocols when submitting bids, thereby assuring that the carbon or GHG reductions meet rigorous standards. A competitive bidding process would lower the cost to the taxpayer while allowing farmers, ranchers, and forest owners to set a price at which they could be profitable.

Bids could come from farmers, ranchers, or forest landowners or, more likely, from producer groups, conservation organizations, businesses, and others who aggregate multiple landowners or producers into a single project bid—this would lower transaction costs. Measurement, accounting, and other costs would be capitalized into the cost of the bid.

Instead of buying carbon outright, if offsets are allowed for compliance with federal or state climate programs, the bank could serve as a buyer of last resort by guaranteeing a floor price for particular carbon practices. This would reduce uncertainty and spur investment from agricultural and forestry landowners and producers into climate beneficial practices.

Alternatively, the bank could be used to insure carbon credits produced through certain activities. For example, let's say a southern forest landowner wanted to convert lands from loblolly pine to longleaf pine and manage those new trees over longer rotations so as to increase carbon storage. While the landowner may produce an initial pulse of GHG emissions from harvest, over time the lands would sequester carbon on a net basis. A USDA bank could insure the long-term

performance of the project, thereby removing the risk of the landowner making an investment that may not provide remuneration for many years.

In addition to guaranteeing economic returns for landowners, a bank could also address environmental integrity of offsets if federal or state legislation creates a compliance market for land sector offsets. After having purchased GHG credits from producers and landowners, the USDA carbon bank could then later sell those GHG reduction credits into the compliance market. USDA would guarantee the environmental integrity of the credits by holding back some carbon tons to self-insure the credit sales. Thus, environmental advocates would have little to worry about regarding the integrity of the offsets. While the bank would likely lose money over time thereby requiring periodic infusions of federal dollars, it could use sale proceeds to replenish its funds and reinvest those dollars in other projects.

Another benefit of a carbon bank is that it would dramatically increase the speed at which farmers, ranchers, and forest owners could enter into GHG-reduction agreements. A bank would not have to wait for the development of offset protocols as it could use existing protocols from the voluntary market. Nor would it be subject to the same funding cycles and application requirements of existing incentive programs in the Farm Bill, for example, thereby reducing delays and paperwork.

As previously discussed, not all farm and forestry operations are capable of producing significant GHG reductions. A bank would create the option of funding those operations because it could choose to pay a higher cost for GHG reductions from them. For example, there may be some climate mitigation practices which have significant co-benefits (e.g., water quality, wildlife habitat). It may make sense for the bank to invest in such practices even if the carbon costs are above market rates. Even so, any system that pays producers and landowners for GHG reductions won't be a financial boon to all agricultural and forestry operations. In addition, early adopters of climate smart practices also likely won't be able to earn significant new revenue from a bank (or offsets program for that matter) that pays based on carbon storage because their soils, grasslands or forests are reaching saturation. This suggests that while a carbon bank may work well for a significant slice of agriculture and forestry, it should be paired with other policies that address climate resilience, enhanced productivity, or other potential opportunities.

Use of Existing Incentive Programs in the Farm Bill

Farm Bill programs already provide cost-share funding and technical assistance for GHG reduction activities on working farms, ranches, and forests, including conservation tillage, reforestation, manure management, nutrient-use efficiency, and others. One step Congress could take to promote natural climate solutions is simply to dramatically increase funding for existing Farm Bill programs such as the Conservation Reserve Program (CRP), the Environmental Quality Incentive Program (EQIP), the Agricultural Conservation Easement Program (ACEP), and the Conservation Stewardship Program (CSP).

Three benefits of this approach are the fact that there is no need to develop a new program out of whole cloth, agriculture and forest landowners are already familiar with these programs, and an infrastructure for implementation already exists. Programs, such as the Regional Conservation Partnership Program (RCPP), that fund locally developed and led projects, are particularly interesting as a vehicle because they enable the aggregation of many landowners into single

projects thereby reducing transactions costs. But leveraging existing programs also presents challenges: a focus on carbon reductions may compete with other program demands, existing programs may emphasize practices and not performance, existing program structures may not be compatible with a focus on carbon, and concerns may emerge about paperwork and delay.

Another challenge is that producers that have an adjusted gross income greater than $900,000 annually are excluded from participating in Farm Bill conservation programs. This will prevent large producers who may leave substantial GHG benefits from participating. While adjusting the AGI may be difficult, perhaps a system that requires substantial matching contributions from larger producers could ensure the public sees broad benefits from such climate projects.

Yet another issue with Farm Bill programs is that they have generally focused more on agricultural lands than on forest lands. Given the importance of privately owned working forests, implementation should ensure adequate forest landowner participation.

Several questions would need to be addressed to utilize existing Farm Bill programs so that they work for participants while also effectively incentivizing GHG reductions.

(a) Has Congress made climate mitigation a program priority? Farm Bill conservation programs support a wide range of activities, many of them critical (e.g., Great Lakes conservation, erosion control, water-use efficiency). If Congress simply adds dollars to these programs as a way to address climate change, climate practices would compete with other important resource priorities. Given the importance of quick action, policymakers might need to carve out specific dollars to devote to climate practices. It may also be the case that implementation should focus on specific high value practices that generate significant GHG and/or co-benefits. Targeting specific resources concerns or landscapes for Farm Bill dollars is not new. Over the last two decades, NRCS and the Farm Service Agency (which implements CRP) have developed a variety of mechanisms for targeting Farm Bill programs. Indeed, in 2015, USDA released its *Building Blocks for Climate Smart Agriculture and Forestry* which, among other steps, targeted Farm Bill conservation program dollars towards climate change activities on working lands.

(b) Should programs be changed to reward performance over practice? Generally speaking, Farm Bill programs provide cost-share payments for conservation practices, not performance. Practices are central. Changing programs to reward GHG performance would likely be a substantial undertaking. On the other hand, policymakers could focus programs on particular practices with the expectation that doing so would produce substantial GHG benefits.

(c) Which programs are a good fit for encouraging climate-beneficial practices?

(1) CRP has been enormously important in increasing carbon sequestration on working lands by restoring marginal croplands to grassland and forests. One study estimates 84 MMT CO2e per year.[53] This program could be improved in four ways to increase the carbon benefits, including expanding the size of the program beyond the current 27.5 million acres, allowing tree planting on

marginal pastureland, expanding the CRP grasslands program to allow for grazing while maintaining important grasslands, and increasing incentives for enrollments, especially those that target flood-prone lands, peatlands, or other areas where carbon gains could be substantial.

(2) **RCPP** could be an important climate change program because of its flexibility and adaptability to local conditions, as noted above. Further, this program would allow aggregators or other intermediaries to reduce the transaction costs of delivering programs. Like other Farm Bill programs, RCPP funds practices. But policymakers could consider focusing the program on carbon projects or amending it to allow for a performance-based approach.

(3) **EQIP** is very flexible and can fund virtually any conservation practice, with the exception of conservation easements and some capital expenses such as the installation of methane digesters. Policymakers could consider devoting a portion of EQIP to climate change practices. This approach would face two challenges. First, EQIP is practice-based; second, the program doesn't easily allow for the aggregation of multiple landowners into a single project.

(4) **CSP** rewards existing stewardship practices and creates incentives for producers to adopt additional conservation measures. The program is designed to encourage landowners to address multiple land-use concerns in designing conservation plans and developing CSP contracts. This may make it challenging to use CSP as a vehicle focused on GHG reductions. However, if policymakers decide to create a mechanism to reward early adopters of GHG beneficial practices, CSP would be a logical program to do that.

(5) **ACEP, Healthy Forest Reserve Program, and the Forest Legacy Program** could be used to encourage voluntary conservation easements. Such easements, for grasslands and especially for forests, could be very important in maintaining existing U.S. carbon sinks (by reducing losses to development) while keeping land in agriculture and forest production. Policymakers should consider dramatically increasing the Forest Legacy Program, which is implemented in partnership with state forestry agencies. Likewise, the Wetlands Reserve Easement program under ACEP can produce significant GHG benefits in restoring wetlands, especially forests and peatlands.

(d) Are there conservation practices that existing Farm Bill programs don't address?

Farm Bill conservation programs are flexible, but they generally haven't been used to fund significant capital investments such as methane digesters that could yield enormous GHG benefits. The Obama Administration sought to finance digesters through USDA Rural Development programs including the Renewable Energy for America Program (REAP) which provides both grants and loan guarantees. Policymakers should consider ways to reduce the financial risks of investing in methane digesters whether through REAP or other programs.

One other important benefit of Farm Bill programs is that they can fund climate resilience activities on working lands. Since funding resilience is both an important policy goal and likely necessary to broaden support for natural climate solutions, targeting Farm Bill programs to address the impacts of climate change on agriculture and forestry makes imminent sense.

Tax Incentives

Tax incentives are gaining significant interest in Congress as a viable option for encouraging GHG mitigation in the land sector. Section 45Q of the tax code creates a powerful incentive for the geologic storage and beneficial use of carbon captured from industrial facilities, power plants, and ambient air. Policymakers are already considering creating a new tax credit to provide incentives for agriculture and forestry sequestration activities. A benefit of this approach would be that it would reduce transaction costs while also reducing the potential for delay and paperwork requirements.

On the other hand, tax incentives for natural climate solutions are not without complications. Designing tax incentives for GHG activities on agricultural and forest lands requires deciding if policy should provide a tax credit based on the costs of practice implementation or based on the GHG gains. In the former case, a producer or landowner would receive a tax credit based on the amount of money spent on reforestation expenses, installation of a methane digester, or some other expenditure. This means the tax incentive would likely cover a narrower set of GHG activities that require some upfront investment. For example, lengthening timber rotations creates opportunity costs (i.e., delayed income from harvests) that would be difficult to finance through a tax incentive tied to expenditures.

Alternatively, a tax credit could be designed to provide a payment based on the amount of GHGs reduced as a result of installation of certain practices. This provides a purer incentive to reward producers and landowners based on the benefit to the environment. It does require choosing a carbon price in statute (or a means to select a carbon price) and, thus, unlike offsets or a carbon bank, the price of carbon would either be fixed or set as a result of some regulatory determination. This could create competition for voluntary or state-implemented compliance markets. A tax incentive based on GHG gains also requires some mechanism to ensure the carbon gains are real. Since the IRS isn't in the carbon measurement business, policy would have to develop some mechanism—for example, through USDA agencies and partners or by requiring third-party certification/auditing—to provide some guarantee as to GHG benefits.

Tax policy should also account for additionality issues. For example, large forest landowners already plant millions of acres in forest annually after harvest. Congress wouldn't want to design a tax incentive that simply covers practices that are already occurring. So, the tax benefit per landowner or producer should be capped or allowed only on lands where carbon gains meet some additionality requirement. A related issue is creating mechanism for recapture of tax benefits should the producer or landowner take steps to negate sequestration benefits through some change in land use or land practices.

One challenge with tax incentives is that institutional landowners, such as Timber Management Organizations (TIMOs) or Real Estate Investment Trusts (REITs) that own significant forest

acreage, would likely have difficulty taking advantage of tax incentives because of their corporate structure. Many farmers, ranchers and forest landowners also have limited or sporadic tax liabilities, meaning they may not be able to always take advantage of tax incentives. Allowing tax credits to be transferrable or marketable to other taxpayers could solve this challenge, though this can engender opposition from tax writing committees.

Lastly, it's worth noting that tax policy has provided a central motivation for many landowners to place land into conservation easements, thereby reducing the loss of forest and grassland and associated carbon losses. Given the importance of maintaining the current forest land base and grasslands, preserving existing incentives for conservation easement donations is important.

Crop Insurance

USDA provides federal subsidized insurance on some 90 percent of cropland in the United States with over $100 billion in liability protection for agriculture. Because the programs reach is so broad, there is substantial interest in looking to the program to spur climate beneficial agriculture across tens of millions of acres.

In addition to providing soil health and climate benefits, agricultural practices such as conservation tillage and cover crops also improve the resilience of cropland to drought and flood. There is growing interest, led by AGree Coalition and others, to create insurance products that reward farmers who implement these practices with lower insurance premiums.[54] While a few insurance products exist and new ones are in development, policymakers could speed this effort with new resources for research, data analysis, and product development. Doing so could be very effective in dramatically scaling up climate smart agricultural practices that also sequester GHGs. Other changes to crop insurance might include reducing the risk for producers who use cover crops, as is the subject now of pending legislation on the Senate.

Research, Technology, Carbon Measurement

Agricultural productivity matters for climate policy. Some have suggested creation of an ARPA-AG, modeled on the Department of Energy's Advanced Research Projects Agency – Energy, an agency tasked with funding research and development into innovative energy technologies. Another vehicle might be the Foundation for Food and Agriculture Research (FFAR), established in the 2014 Farm Bill. The purpose of FFAR is to increase investment in agricultural and food research through public-private partnerships.

Whatever form investment takes, the challenge of feeding more than nine billion people in 2050 while reducing GHGs in agricultural will require gains in productivity and efficiency of agriculture. In agriculture, precision farming techniques, nitrogen inhibitors, changes in livestock feed mixes, and many other new technologies can produce significant climate benefits. In addition, for commodities in agriculture which may not be able to produce significant amounts of GHG reductions, investments in productivity and resilience of those crops could be an important element of a climate package for agriculture.

As noted in the first section of the report, there is also considerable interest and some progress in developing new grain crops that are perennials and thus provide substantial carbon soil benefits.

This could be important research, but it is a long-term solution that will require additional research monies.

Forest productivity also matters, and, like agriculture, forestry is also faced with challenges related to a warming climate, including impacts from fire, disease, extreme weather and other factors. Forest research needs a similar investment of both private and public resources particularly given that Forest Service research budgets have dropped considerably in recent years. Genetic tree improvement, more efficient wood utilization, and improved silvicultural techniques can increase carbon storage in forests. Investing in technology—particularly new uses of wood—could be a key component in bolstering wood product markets and thereby expanding incentives for landowners to maintain and invest in forests.

A related area for public investment would be to bolster programs at USDA, specifically the Forest Service's Forest Inventory and Analysis and NRCS's Natural Resources Inventory, that provide critical baseline data on land-based carbon sequestration and emissions in the U.S. For example, investments could allow for more frequent carbon measurement at thousands of inventory plots across the country and increase the integration of new technologies into measurement. Doing so would provide benefits to farmers, ranchers, and forest owners who undertake carbon projects by providing more robust data for projecting carbon gains from conservation practices. More accurate and timely measurement of the GHG impacts of both forestry and agriculture is vital to ensuring the public's investment in natural climate solution is well spent.

Public Lands Management, Wildfire Management

Climate change mitigation and resilience is already a consideration in the management of federal lands. For example, the Forest Service developed a *Climate Change Roadmap* for the agency and then a scorecard to assess progress on climate-related work on the National Forests and Grasslands.

For the Forest Service, DOI's Bureau of Land Management and other federal agencies, the link of wildfire to climate change is a significant concern. Catastrophic wildfires, caused by decades of management practices that suppressed natural fires, and exacerbated by climate change, are a significant source of GHG emissions. These unnaturally destructive fires will continue to worsen unless steps are taken to restore more natural forest conditions on all forestlands. While the problem is often most acute on National Forest lands, these forests are often intermixed with state, private, and tribal lands. Restoration needs to occur across all ownership types to be successful. Both selective thinning of forests to restore more natural conditions (while also providing timber to local mills) and a significant increase in the use of prescribed fire are paramount.

Likewise, control of invasive species, such as cheat-grass, can substantially reduce the intensity of fires in rangeland. Landscape-scale forest restoration efforts, using collaborative approaches that bring industry, environmental advocates, agencies, and rural communities together, have demonstrated that well-conceived forest management practices can increase the resilience of forests to wildfire. But these efforts also cost money to support forest planning and, in many cases, to subsidize forestry treatments. In addition, substantial opportunities for reforestation exist on public lands, particularly in areas that have been subject to catastrophic fire.

However, the Forest Service spends well over half of its budget today on firefighting to the detriment of funding for forest management and restoration on its own lands. While Congress has passed legislation to allow the agency to draw on emergency funding for firefighting, this does little to replenish the funding that has been redirected over two decades from forest management to firefighting. In other words, Congress has stopped the bleeding, but the patient remains in critical condition. Substantial investments will be required to reduce the threat of catastrophic fire and related forest health challenges on public lands.

In addition to funding, policymakers could also look for ways to streamline well-designed, collaborative, landscape scale restoration projects to restore ecological health to these forests. These projects will typically include a mixture of thinning and re-introduction of low-intensity fires through the use of prescribed fires or managed wildfires. Reducing administrative and financial barriers to the use of prescribed fire will be particularly important for conserving many of the nation's forests.

Wildland firefighting itself could be an important area for investment as well. As noted above, forthcoming research from the Union of Concerned Scientists and Woods Hole Research Center suggests that the potential emissions from climate-induced fires in Alaska's boreal forests could be enormous and that enhanced fire management in these forests could produce substantial cost-effective carbon emissions reductions.[55] Thus, resources for firefighting equipment and people should be considered as part of any package of natural climate solutions.

Providing Assistance and Outreach to Farmers, Ranchers, Forest Owners

Conservation programs—whether for GHG reductions, wildlife conservation, watershed protection, or other purposes—require people backed by science to implement them. In the case of climate practices, farmers, ranchers and forest landowners will often need technical assistance to implement such activities. Federal policy already provides substantial technical assistance to landowners through implementation of the Farm Bill conservation programs.

USDA and the U.S. Department of Interior (DOI) have also created additional programs and staffing to provide technical assistance. USDA's climate hubs, established in 2014, provide usable, actionable data and land management recommendations on both climate mitigation and resilience to agricultural and forestry producers and landowners. DOI's U.S. Geological Survey also provides information to land managers on climate impacts to land, fish and wildlife, invasive species spread, and other natural resource issues. Boosting resources for these programs would have significant benefit.

That said, technical assistance doesn't need to be purely, or even primarily, government provided. While the U.S. Department of Agriculture's NRCS is a logical agency to provide this type of assistance, there is a significant network of other federal agencies; state natural resource, forestry, and agricultural agencies; land grant universities; conservation groups; farm and forest commodity organizations: business and crop consultants; rural cooperatives, and many others which could and should play a vital role in implementing GHG conservation practices on the ground. Policies that allow for these partners to underwrite a portion of their expenses or that provide grants to them would bolster flexible, locally driven climate mitigation and resilience projects.

Beginning, Minority, and Tribal Farmers and Forest Owners

Just as U.S. agricultural policy has considered ways to bolster outreach and program availability for beginning, minority, and tribal farmers and forest owners, climate policy should be no different. In the south, lands owned by African American farmers and forest owners often don't have clear title due to a legacy of racism and other factors. As a result, these lands are threatened with development. In addition, landowners often aren't able to capture the full value of their lands or even to enroll in USDA incentive programs.

Failing to recruit beginning, minority, and tribal farmers and forest landowners to the agriculture and forestry sectors has a very real cost not only to families but to the environment. Policy should carve out specific resources to reach these producers, to help them obtain clear titles, to provide them technical assistance, and to deliver incentives for continued stewardship.

Natural Climate Solutions Investment Policies to Build Rural Communities' Implementation Capacity

Many of the policy ideas listed above will result in significant co-benefits, including but not limited to economic benefits, for agriculture, forestry and rural communities in general. Still, the discussion thus far has largely focused on specific investments in and incentives for climate mitigation practices on U.S. farms, ranches, and forests. For both environmental and political reasons, policymakers should think more broadly about the range of policies needed to support GHG reductions in the land sector.

Regarding meeting the reduction and sequestration targets for agriculture and forestry, measures that will make it possible for high-level policy to spur actual on-the-ground implementation is a must. Regarding the political realities of climate policy making, federal natural climate solutions policy stands a much better chance of adoption if policymakers incorporate measures that invest in rural communities, such as new business opportunities, job training and creation, and reestablishment of manufacturing facilities that bring jobs and an increased tax base. In addition, investments in natural climate solutions can produce substantial economic opportunities as evidence in Figure 10 on the next page.

To that end, there are a series of policy mechanisms that could achieve meaningful climate benefits *and* bring significant economic opportunities to rural Americans. Many of these provide a necessary foundation on which to build and implement natural climate solutions. We focus on mechanisms related to three areas, including bioenergy, forestry, and agriculture. We believe in many cases more work needs to be done to determine the specific nature of the investment or the policy. The following section is intended to spur additional discussion around these ideas.

Figure 10. Job Creation per $1 Million Investment

INDUSTRY	DIRECT	INDIRECT	INDUCED	TOTAL
Reforestation, Land and Watershed Restoration, and Sustainable Forest Management	17.55	12.95	9.2	**39.7**
Crop Agriculture	9.8	6.5	6.5	**22.8**
Livestock	6.4	9.1	6.2	**21.7**
Gas (heavy and civil construction for pipelines - 50% new and 50% repair)	12.05	3.93	5.912	**21.888**
Mass transit and freight rail construction	13	3.70	5.038	**21.738**
Roads and bridges: repair	11.1	3.69	5.527	**20.317**
Conservation (Parks and Land and Water Conservation Fund)	11.45	4.15	4.7	**20.3**
Water infrastructure	9.96	4.38	5.427	**19.764**
Aviation	9.7	4.30	5.264	**19.266**
School buildings	8.65	5.38	5.233	**19.262**
Building retrofits	7.7	4.70	4.96	**17.36**
Roads and bridges: new	8.7	3.94	4.834	**14.474**
Solar	5.4	4.40	3.92	**13.72**
Biomass	7.4	5.00	4.96	**17.36**
Smart grid	4.3	4.60	3.56	**12.46**
Wind	4.6	4.90	3.8	**13.3**
Electricity generation, transmission, distribution	5.32	4.50	4.696	**14.512**
Coal	1.9	3.00	1.96	**6.86**
Financial Industry	3.22	2.34	1.668	**7.228**
Oil and gas	0.8	2.90	1.48	**5.18**
Nuclear	1.2	1.80	1.2	**4.2**

Source: Heidi Garrett-Peltier and Robert Pollin, University of Massachusetts Political Economy and Research Institute.

Note: Multipliers derived using IMPLAN 2.0 with 2007 data. Infrastructure multipliers and assumptions are presented in "How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth," Political Economy Research Institute, January 2009, http://www.peri.umass.edu/236/hash/efc9f7456a/publication/333/

Bioenergy

Facilitating development and market access for renewable natural gas (RNG) produced from dairies and hog farms (a.k.a., biogas or biomethane) could provide substantial GHG benefits while bringing significant economic benefits to rural communities. Currently, one federal and several state programs impose requirements on the transportation fuel sector to source a certain portion of their fuel from renewables. Supply, however, is very limited, primarily because it is difficult—from both a physical and regulatory perspective—to move biogas from its source to end users as RNG.

Dairy and swine producers, on the other hand, have significant amounts of biomethane that could fulfill demand from the transportation sector needs to comply with these mandates. Yet, it's currently very difficult for farmers to capture and move this gas to end users.[56] A well-designed natural climate solutions package could find ways to support the physical capture, processing, and transport of the biogas as well as ease regulatory and administrative burdens now placed on RNG transactors.

In addition, investments in biofuels—such as corn ethanol, biodiesel, and cellulosic ethanol—to improve the environmental and GHG footprint of these fuels could prove beneficial to the climate while providing significant economic opportunities. There is significant interest in electrifying the transportation sector as a GHG strategy. This is all the more reason to improve the environmental benefits of existing and future biofuels and to allow those fuels to compete on the basis of their environmental benefits.

Here are examples of enabling policies and mechanisms needed to ensure that big bioenergy policy can easily and efficiently be put into meaningful practice. Importantly, these mechanisms will bring additional economic benefits to rural communities:

Table 2. Bioenergy Investment Opportunities

High-Level Policy	Enabling Mechanism	Effect	Rural Benefits
Bioenergy Production Incentives	Money for biogas system construction & loan guarantees	Banks/lenders have funds to make loans to farmers; loan guarantees de-risk projects	Increases employment opportunities at local banks for loan officers; increase project implementation
	Coordination with state-regulated natural gas companies to ease transport restrictions and costs (via, e.g., renewable natural gas standard)	Eases administrative hurdles currently associated with injection and transport of RNG	Access to pipelines translates to more project implementation and increased training and job demand (i.e., construction, system O&M)
	Money for construction of CNG filling stations, incentives for fleet conversion to CNG and subsidies for renewable CNG use	RNG can be used locally because truck fleets need CNG	Creates jobs for mechanics to convert fleets; requires technical trainng at community colleges for mechanics and technicians capable of servicing CNG stations/fleets
	Ag- and forestry-related renewable energy tax incentives	Attracts private capital to renewable projects	
	Cost share for nutrient recovery add-ons to biogas systems	Helps farmers pay for aspects of waste management which bioenergy systems cannot address and/or where markets do not exist to make nutrient recovery cost effective	Decreased nutrient loading to waterways, job opportunities related to nutrient processing and provision of technical assistance to help farmers implement nutrient recovery practices
	Support research into, development of, and incentives for biofuels with better GHG and environmental footprint	Improve the GHG competitiveness of biofuels, sustains bioenergy markets	Maintain biofuel markets and jobs during a difficult agricultural economy in many regions

Forestry

Activating carbon sequestration at the levels necessary to meet 2050 climate goals will require swift uptake of carbon by forests across the U.S. To accomplish this uptake, a host of practices aimed at facilitating and sustaining the forest sector's support and participation will be required. Investments, for example, would need to be targeted toward ensuring rural communities have the capacity to process wood products (in order for forest owners to have the capacity to respond to wood product incentives), provide a workforce capable of implementing incentivized forest carbon uptake practices, and create payment mechanisms that easily reward forest owners for carbon-friendly practices.

These specific practices are not only essential for putting policy into practice, but also offer substantial upsides for rural communities. Examples include:

Table 3. Investments in the Forest Economy

High-Level Policy	Enabling Mechanism	Effect	Rural Benefits
Forest Economy Investments	Incentives for investments in mass-timber, cross-laminated timber and other manufacturing faciltiies accompanied with market incentives for use of carbon beneficial building materials.	Construction of new manufacturing facilities in rural areas near timber harvesting operations.	Near-term job opportunities related to facility construction; long-term job creation related to operation of new milling facilities; depending on the type of operation, training and education to develop skilled workforce.
	Bolster forest restoration through investments to support timber mills in the west that use small diameter timber from fire prone lands.	Support for forest mills that source wood off public lands in the west, where adequate milling capacity is necessary to reduce fuel and hence reduce emissions from catastrophic wildfires.	Near-term job opportunities related to facility construction; long-term job creation related to operation of new milling facilities; depending on the type of operation, training and education to develop skilled workforce.
	Support for bioenergy using responsibly sourced woody biomass.	Construction of plants to process woody biomass.	Near-term jobs for plant construction; long-term jobs for plant operation.
	Use of government purchasing power to procure power from wood energy (woody biomass) and to use manufactured wood products in building construction with sustainability criteria.	Requires increased wood material processing capacity for woody biomass production (for energy) an d milling plus conversion of facilities to accept wood-sourced fuel.	Increases job opportunities related to construction of processing facilities and operation of such facilities; requires construction/ engineering jobs to convert power and manufacturing plants to accept woody biomass-based fuel.
	Incentives to encourage workforce development related to low-impact logging, forest management, and forest restoration jobs.	Job training for loggers, and support for loggers and other woods workers, particularly in the west.	Rural communities most likely candidates for providing workforce to train loggers, as well as logging workforce.
	Incentives to support tree nursuries for reforestation in parts of the country with limited seedling/seed supplies.	Tree nurseries equipped to supply reforestration efforts and expansion of nursery operations to accommodate increased demand for seedlings/ saplings.	Increased job opportunities to open and operate new nurseries and/ or expand existing nurseries; need for technical assistance to help foresters/land owners appreciate value of planting species tied to cost share payments.
	Investments in firefighting crews and equipment, particularly in Alaska and western states.	Job training and recruitment.	Job opps to increase firefighters to combat forest fires, creating job opportunities in rural communities plus need for increased technical assistance/experts.

Agriculture

Similar to bioenergy and forestry, a variety of enabling policies and programs will need to be incorporated into any natural climate solutions package to activate agriculture-based carbon sequestration at the rate capable of meeting climate goals. For the purposes of this discussion, we focus on precision agriculture, increased farm productivity and composting, and the practical mechanisms that will deliver both these particular practices at scale and the anticipated effect on rural communities and economies.

Table 4. Investments in the Agricultural Economy

High-Level Policy	Enabling Mechanism	Effect	Rural Benefits
Investments in the Agricultural Economy	Broadband to support precision agriculture and smart grid technology.	Broadband could assist farmers in technology to reduce nitrous oxide emissions, incease water use effiency, and sequester carbon. Rural broadband could also enable rural utilities to implement smart grid technology to improve energy efficiency and lower GHGs.	Use of precision agriculture and new technologies could assist farmers in improved efficiency and profitability. Implementation of smart grid technology would save consumers money, create jobs, and reduce GHGs.
	Invest in seed technology to bolster use of cover crops and double cropping.	Reduce barriers to adoption of cover crops and double cropping systems that increase agricultural productivity for many producers and increase carbon sequestration.	Creates economic opportunties in agriculture and improves water quality.
	Support trials and development of biochar and composting facilities.	Biochar and composting can increase soil productivity, water retentation and nutrient use efficiency. But, adoption is not widespread and needs trials to determine landowner uptake and interest.	Rural communities can cite facilities and construct other infrastructure needed to produce biochar and process compost (e.g., collecting, sorting, distributing compost products).

Policy Matrix

The table on the next page summarizes the broad set of policies discussed in this report and the potential of those policies to win support from important constituencies while accomplishing climate goals.

Table 5. Policy Matrix: Positions and Effects of Specific Natural Climate Solution Policies

	Agriculture Views	Forestry Views	Env./Conservation Group Views	GHG Delivery	Federal vs. Private Investment
Compliance Offsets	Mixed. Dairy/hogs, corn/soybeans can do well, wheat, cotton, rice not clear. Transaction costs can deter adoption, esp. for small farmers.	Risk is a challenge without price guarantee. Transaction costs can deter adoption, esp. for small landowners.	Concern about offset integrity; want long commitments from forestry and agricultural sequestration.	Transaction costs and risks (that practices will not result in qualifying offsets) may limit participation.	Privately funded; federal investments in streamlining/ technical assistance/aggregation/ Insurance products could address slow uptake, some participant concerns.
Carbon Bank **(De-risk,** **Guarantee Env. Integrity of Offsets)**	A new idea to many. Price guarantee helps most producers and should de-risk participation in markets.	Flexibility allows for variety of contracts to improve management practices with low risk.	Less concern about integrity.	Provides significant potential to generate GHG reductions.	Substantial federal cost.
Use of Existing Farm Bill Incentive Programs	Familiarity. Can use existing networks.	Forestry is still a smaller participant in programs.	May have some competing priorities without substantial new money.	Integrating GHGs into existing programs may be a challenge.	Substantial federal cost.
Tax Incentives, Other Task Mechanisms	Will likely work for some practices only, many producers have low tax liability which may limit effectiveness.	Large landowners need transferability; reforestation tax incentives may be opposed by forest landowners without bolstering timber markets.	General support.	For some practices, GHG delivery will be strong; challenge will be in measuring, monitoring.	Substantial federal cost.
Crop Insurance	Increased products for ag will garner support if crop insurance program preserved.	N/A	Support likely.	Powerful tool to affect millions of acres.	Possible government savings.
Research, Tech Innovation, C Msmt	Strong support for productivity, resilience research.	Strong support for productivity, markets research.	May be some concerns about GMO, high input ag.	Hard to measure but important contribution.	Substantial federal cost.
Public Lands Mgmt	Impacted western ranchers, farmers will strongly support.	Strong support.	Some environmentalists will resist management of public lands.	Large potential gains from reduced fire emissions.	Substantial federal cost.
Increase Wildfire Suppression Expenditures	Strong support for impacted landowners.	Strong support for impacted landowners.	Little resistance, though will want increase use of natural fires and prescribed fires.	Could be substantial.	Substantial federal cost.
Bioenergy	Biofuel mandates a must-have for corn, soybeans; tax incentives for renewable fuel and energy; livestock producers like biogas, fear rising feed prices from ethanol mandates.	Markets for low value wood very attractive to forest landowners; forest-dependent industries.	Resistance from many groups; some groups may support with measures to ensure bioenergy production done responsibly.	Could be substantial, particularly with carbon storage.	Mostly, privately funded (mandates on non-land sectors for renewable transportation fuel, voluntary decarbonization commitments); gov. support needed for infrastructure
Beginning/Minority Farmers, Foresters	General support.	General support.	Strongly support; in line with EJ goals; see beginning farmers as more environmentally conscious.	Probably not substantial.	Federal $ required; may be delivered favorable cost share treatment or other incentives, outreach will be key.
Rural Investment Policies	Support for agricultural productivity, bioenergy, resilience likely strong.	Support for wood markets very strong; western mills and forestry will strongly support forest restoration, fire management.	Some investments will raise concern, but if policies bring rural support, that may be persuasive.	Essential for executing natural climate solutions swiftly and on broad scale.	Substantial federal investment; could be mitigated through matching requirements from private industry.

V. CONCLUSION

When considering agriculture and forestry in the context of the ongoing climate policy debate, two things are clear. First, meeting aggressive economy-wide decarbonization goals in the United States is extremely hard, if not impossible, without significant investment in the agricultural and forestry sectors. Second, generating the political support for that investment will require substantial support from not just the public at large but from rural voters and agricultural and forest interests, in particular.

For the past 25 years, climate policy for agriculture and forestry has largely assumed carbon offsets would be the tool of choice to finance conservation practices that reduce GHGs and sequester carbon on agricultural and forest lands. With no clear direction at present on what shape federal climate policy will take, carbon offsets may or may not be at the center of policy on natural climate solutions going forward.

Further, given that not all of agriculture and forestry will benefit substantially from policies that reward producers and landowners for GHGs avoided or sequestered, policymakers need to broaden the suite of policies under consideration for fully engaging agriculture and forestry in addressing climate change. Such a package should be designed as a rural investment package with broad benefits for agriculture and forestry, the conservation of ecosystems, and the climate. While climate mitigation goals would be central to such a package, other investments in climate resilience, bioenergy, wood markets, and rural job opportunities should and must be part of the package. Given the significant and potentially lengthy economic impacts from the coronavirus, investing in rural economic development makes even more sense.

A rural investment package need not be tied to a comprehensive climate package passed by some future Congress, though it certainly could. Advocates for natural climate solutions should be prepared for that eventuality but also for opportunities to advance a rural investment package through a standalone package, economic recovery legislation, opportunities in annual federal budgets, a potential national infrastructure package, and use of administrative policies and discretionary dollars at USDA.

Such a rural investment package must be designed based not just on where the tons are, but on where the stakeholders and where the votes—particularly those of rural voters—are.

APPENDIX. STATE RESPONSES TO THE U.S. CLIMATE ALLIANCE'S #NWLCHALLENGE

State	Response to #NWLChallenge
California	Natural and Working Lands California's Forest Health Program uses funds from California Climate Investments to implement projects that restore forest health, reduce GHG emissions, and protect upper watersheds where the state's water supply originates. Through 2018, the program awarded $110 million in grants. In January 2019, the state released its Draft 2030 Natural and Working Lands Climate Change Implementation Plan. The plan aims to increase state-led conservation, restoration, and management activities two to five times above current levels, to achieve a level of effort commensurate with that invested in other sectors of California's climate change portfolio.
Colorado	The state's Department of Agriculture is creating a state program to promote, coordinate, and monitor soil health activities and measure benefits for air quality, agricultural production, water quality and quantity, GHG reduction, watershed stability, and resistance to drought, as well as implementing a voluntary program that pays agricultural producers who demonstrate implementation of practices that offset corporate carbon emissions.
Connecticut	Connecticut released an updated version of its Comprehensive Open Space Acquisition Strategy to achieve its goal of protecting 21 percent (673,210 acres) of the state's land as open space by 2023, 10 percent of which is to be state-owned as additions to the system of parks, forests, and wildlife areas. As of 2017, 75 percent of the preserved acreage goal (over 500,000 acres) has been achieved.
Delaware	Natural and working lands strategies will be a component of the statewide climate plan currently in development. Delaware has committed GHG reduction funds to the Urban and Community Forestry Program, which offers grants for tree planting, tree care, and tree management projects on publicly owned lands. Since its passage, the Delaware Land Protection Act (1990) has protected 57,000 acres of land from development.
Hawaii	The Sustainable Hawaii Initiative sets the following goals for Hawaii: (a) double food production by 2020, (b) implement Hawaii's interagency biosecurity plan by 2026, (c) protect 30 percent of Hawaii's priority watersheds, (d) effectively manage 30 percent of Hawaii's marine areas, and (e) achieve 100 percent renewable energy by 2045. HB 1986 creates a framework for a carbon offset program that allows for carbon credits through global carbon sequestration protocols, which will address carbon sequestration through forest restoration. The Division of Forestry and Wildlife has launched a forest carbon sequestration program, which involves restoring the native forest of two areas—Kahikinui/Nakula Forest and Pu'u Mali Forest—while generating independently certified carbon offsets.
Illinois	The Illinois Department of Natural Resources has several conservation programs, including the Conservation Reserve Enhancement Program (CREP), the Coastal Management Program, Green Infrastructure Grants, and flood mitigation efforts. Illinois' forests have sequestered 343 million tons of carbon, and the state's 2018 Forest Action Plan includes considerations of climate change on its forests.
Maine	The Land for Maine's Future Program is Maine's primary funding vehicle for conserving land for its natural, recreational, and economic value. Since its inception in 1987, the program has helped conserve more than 600,000 acres of land, including working farms, forests, and waterfronts. The Maine Conservation Task Force's 2019 report on the next generation of land conservation recommends the state support projects that promote resilience and landscape connectivity to help ecosystems, wildlife, and natural resource-based economies adapt to a changing climate. The Governor's Climate Council Legislation sets up a specific "Working Lands" group to explore opportunities for increasing and preserving significant carbon sequestration through Maine's vast forest lands and soil practices.

Maryland	Maryland established the Maryland Healthy Soils Program to increase biological activity and carbon sequestration in the state's soils by promoting practices based on emerging soil science, through incentives, research, education, technical assistance, and financial assistance for farmers. Maryland is using sustainable forestry management practices to capture carbon in public and private Maryland forests. These programs aim to improve sustainable forest management on approximately 30,000 acres of private land annually and 100 percent of state-owned resource lands, and to ensure 100 percent of state forest lands will be third-party certified as sustainably managed.
Massachusetts	Over the last four years (FY15–FY18) Massachusetts permanently conserved 48,396 acres (75 square miles). In addition, EEA is investing $1 million annually in grants to improve local land use practices. Early in 2019, the Commonwealth published new land use/land cover data, which when combined with carbon profiles for land cover types and reiterated, enables the tracking of changes in terrestrial carbon stock. Governor Baker announced another $1.6 million in state and federal grant funding in April 2019 for Massachusetts towns to conduct projects relating to climate adaptation and river and wetland habitat restoration.
Michigan	The Michigan Wildlife Action Plan for 2015–2025 provides a framework to coordinate wildlife and habitat conservation and considers the climate vulnerability of focal species of greatest conservation need. In June 2019, the Michigan Department of Agriculture and Rural Development announced its decision to allow land currently enrolled in the Farmland and Open Space Preservation Program, which provides tax incentives to landowners who keep their land under agreements for agricultural use, to be used for commercial solar array purposes.
Minnesota	The Minnesota Pollution Control Agency issued the Greenhouse Gas Emissions in Minnesota: 1990–2016 report in January 2019, detailing Minnesota's progress on its GHG emissions reductions. The report noted that improving best management practices in forestry and agriculture can serve to reduce the state's emissions.
Montana	EO 8-2019 requires that the Climate Solutions Council include strategies for supporting "voluntary, incentive-driven tools and technologies for improving productivity, reducing emissions, and boosting soil health and carbon storage on farms and ranchlands, and in forests and wood products" in the Montana Climate Solutions Plan.
Nevada	Nevada's state Wildlife Action Plan was revised in 2012 to incorporate climate change impacts and analyze the vulnerability of habitats and species. The Nevada Division of Forestry is finalizing a statewide wildfire planning, mitigation, and restoration strategic plan that will incorporate climate change impacts.
New Jersey	Governor Murphy signed legislation banning offshore oil drilling in New Jersey state waters and prohibiting DEP from issuing any permits and approvals for the onshore development of offshore oil drilling infrastructure. Following the announcement in 2018 that the Trump Administration authorized air gun use in waters off the East Coast, Governor Murphy and a group of bipartisan governors from nine other states along the Atlantic coastline opposed the seismic testing and offshore drilling in the Atlantic Ocean. The governor announced his support for a full fracking ban in the Delaware River Basin and that proposed rules should be amended to ban all fracking activity, including the import, treatment, and discharge of fracking wastewater. New Jersey also has robust open space and farmland preservation programs that have preserved nearly 1.5 million acres of land.
North Carolina	The Division of Mitigation Services restores and protects wetlands and waterways through mitigation programs designed to assist private and public entities in complying with state and federal compensatory mitigation for streams, wetlands, riparian buffers, and nutrients. The DEQ Natural and Working Lands (NWL) stakeholder group is also exploring cost-effective opportunities in land conservation and management practices that provide co-benefits of improving ecosystem health and sequestering carbon and will be working to develop an NWL Action Plan to be published by January 2020.

Oregon	Oregon's Department of Forestry has developed a statewide inventory of forest carbon stocks and flows in Oregon's forested landscapes. Oregon also created the Ocean Acidification and Hypoxia (OAH) Council to evaluate the impacts of OAH on Oregon's resources and communities and recommend actions to the legislature and state leadership. The state also established and supports the work of the Oregon Climate Change Research Institute
Pennsylvania	The Pennsylvania Agricultural Conservation Easement Purchase Program strengthens the Commonwealth's agricultural economy and protects prime farmland. This program enables state and county governments to purchase conservation easements from farmers. Since 1988, 5,329 farms have been approved for easement purchases totaling 552,702 acres. Through its outreach programs, the Department of Conservation and Natural Resources provides leadership and technical assistance in conserving and managing Pennsylvania's important forest lands.
Rhode Island	Rhode Island's Department of Environmental Management (DEM), in conjunction with the U.S. Department of Agriculture (USDA) Forest Service, offers guidance on how landowners can properly manage forest areas and maintain healthy local ecosystems through its Forest Stewardship Program. DEM also works cooperatively with the USDA Forest Service on the Forest Legacy Program to preserve forests and stem the loss of the traditional values provided by forested lands through conservation easements or land purchases. Since its inception, the program has protected 3,583 acres in 22 parcels in Rhode Island. In April 2019, the state—in partnership with American Forests—received a $650,000 grant to develop strategies for advancing statewide urban and community forestry. The initiative builds staff capacity and targets urban forest projects that improve public health outcomes and mitigate climate change.
Vermont	The 2017 Vermont Forest Action Plan outlines goals and planned actions to meet desired future forest conditions, and advances ongoing management, conservation, and preservation efforts. These conservation efforts, along with promoting the growth of new forest, increases the state's carbon sequestration, biological diversity, and ecological productivity. Vermont is also working to supplement the existing 350,000 acres of recreation and conservation land with previously lost or damaged floodplain and wetland areas to help mitigate the impacts of future flooding events. Vermont's Working Lands Enterprise Initiative (WLEI) supports Vermont's entrepreneurs in the agriculture and forest product sectors through technical and financial assistance and has issued over $5.3 million in working lands funds since 2012.
Virginia	Governor Northam recently revealed his core land conservation initiative, which will use data and mapping tools to identify high-value lands for conservation purposes. The initiative aims to align conservation goals with the achievement of broader targets, including climate change and resiliency. In April 2019, Virginia launched a data-driven land conservation tool called ConserveVirginia, which maps high-value lands and conservation areas to help prioritize and inform projects.
Washington	The Washington Legislature has directed the Department of Natural Resources to launch a statewide carbon sequestration advisory group for natural and working lands, and to conduct carbon inventory studies for the state. This effort will culminate in recommendations to state policy makers in December 2020. The Ocean Acidification Policy and Management and the Washington Shellfish Initiative are both multi-group collaborations that inform ocean management in the interest of ocean habitats and the thriving shellfish industry. Inland, the Chehalis Basin Strategy, the Yakima Integrated Basin plan, and the state's Floodplains by Design programs each seeks to tackle both flooding issues and habitat loss through large-scale flood damage mitigation and restoration measures.
Wisconsin	A 1993 bill established a state goal of ensuring a future supply of wood fuel and reduce atmospheric carbon dioxide by increasing the forested areas of the state (1993 Wisconsin Act 414). Wisconsin's Managed Forest Law (MFL) program offers incentives to private landowners for engaging in sustainable forestry practices that improve water quality, wildlife management, harvesting, and recreation. Wisconsin's Working Lands Initiative (WLI) was established in 2009 and offers tax credits for land preservation to qualified landowners for farmland preservation and soil and water conservation.

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39. According to the Coalition for Renewable Natural Gas, RNG demand has "skyrocketed since 2014, when EPA included renewable natural gas on its list of cellulosic biofuels that can be used to meet the federal Renewable Fuel Standard." Lowrey, N. 2020. "California Energy Firm Will Turn S.D. Farm Wastes into Usable Natural Gas." South Dakota News Watch. https://www.sdnewswatch.org/stories/new-technology-will-turn-s-d-farm-wastes-into-usable-natural-gas/. In 2020, RFS is expected to require approximately 20 billion gallons of transportation fuel be acquired from renewable sources. Although corn ethanol, a cellulosic biofuel, was expected to meet a large portion of the RFS mandate, RNG is projected to satisfy "as much as 95 percent" of the cellulosic biofuel production standard. Lowrey, N. 2020. "California Energy Firm Will Turn S.D. Farm Wastes into Usable Natural Gas." South Dakota News Watch. https://www.sdnewswatch.org/stories/new-technology-will-turn-s-d-farm-wastes-into-usable-natural-gas/. The federal RFS program requires a portion of petroleum-based transportation fuel, heating oil or jet fuel consumption be replaced by renewable fuel. The RFS recognizes biomass-based diesel, cellulosic biofuel, advanced biofuel, and total renewable fuel as categories that qualify for the RFS. U.S. Environmental Protection Agency. n.d. "Overview for Renewable Fuel Standard." Accessed on May 3, 2020. https://www.epa.gov/renewable-fuel-standard-program/overview-renewable-fuel-standard; Greene, P. 2017. "101 for RINs." *BioCycle*. https://www.biocycle.net/2017/11/13/101-for-rins/. Congress authorized the Federal RFS pursuant to the Energy Policy Act of 2005 and expanded the program in the Energy Independence and Security Act of 2007, the purposes of which were to reduce GHG emissions, expand of the U.S. renewable fuels sector and reduce reliance on foreign oil. U.S. Environmental Protection Agency. n.d. "Renewable Fuel Standard Program." Accessed on May 3, 2020. https://www.epa.gov/renewable-fuel-standard-program. Of significance to livestock producers, in July 2014, EPA included biogas as a qualifying cellulosic and advanced biofuel under the RFS. U.S. Environmental Protection Agency. 2014. "EPA Issues Final Rule for Renewable Fuel Standard (RFS) Pathways II and Modifications to the RFS Program, Ultra Low Sulfur Diesel Requirements, and E15 Misfueling Mitigation Requirements." Regulatory Announcement EPA-420-F-14-045. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100JPPP.pdf.

40. C2ES. 2019. "Low Carbon and Alternative Fuel Standard." https://www.c2es.org/document/low-carbon-fuel-standard/.

41. Biofuels, a category of bioenergy, include ethanol, methanol, methane, biogas (a mixture of carbon dioxide and methane produced by the anaerobic digestion of organic matter), and biodiesel, all of which are converted to liquid or gaseous fuel forms (which in turn produce bioenergy). NREL. n.d. "Biomass Energy Basics." Accessed May 3, 2020. https://www.nrel.gov/research/re-biomass.html; US Biogas Potential: https://www.nrel.gov/docs/fy14osti/60178.pdf.

42. Center for Climate and Energy Solutions (C2ES). n.d. "Canadian Provincial Clean Vehicle Policies and Incentives." Accessed May 3, 2020. https://www.c2es.org/document/canadian-provincial-clean-vehicle-policies-and-incentives/. C2ES grouped U.S. and Canadian clean vehicle policies and incentives in the Canadian Provincial map.

43. See, e.g., La. Stat. Ann. §§ 3:4674, 3:4674.1, 3:3712; 39:364, 39:1646; 47:6037; Act 313 (H.B. 685) (2006).

44. See, e.g., Nev. Rev. Stat. §§ 366.022-.024, .068, .386; 701B.930-.995.

45. The Coalition for Renewable Natural Gas. n.d. "Federal, State & Provincial Polices." Accessed May 3, 2020. http://www.rngcoalition.com/policies-legislation. A complete list of renewable fuel standards can be found on the RNG Coalition's "Federal, State & Provincial Policies" webpage.

46. See *101 For Low Carbon Fuel Standard*, https://www.biocycle.net/2019/03/11/101-low-carbon-fuel-standard/. California's LCFS works by lowering the overall carbon intensity or CI of California's transportation fuels by allowing regulated entities within the transportation fuel sector to purchase or produce renewable fuel alternatives with lower CIs than conventional fossil fuels. The lower the CI of the fuel produced or purchased, the higher the value of the renewable fuel.

47. Legislative Analyst's Office. 2016. "Administrations Cap-and-Trade Report Provides New Information, Raises Issues for Consideration." https://lao.ca.gov/handouts/resources/2016/Cap-and-Trade-Report-Provides-New-Information-042016.pdf.

48. Note that by 2022, Pennsylvania and Virginia are likely to join RGGI, increasing the number of RGGI states to twelve. Clarcq, C. 2020. "Virginia set to join RGGI — A massive step forward for cap-and-invest." *Climate XChange*. https://climate-xchange.org/2020/02/19/virginia-set-to-join-rggi-a-massive-step-forward-for-cap-and-invest/; Office of Governor Tom Wolf. 2019. "Governor Wolf Takes Executive Action to Combat Climate Change, Carbon Emissions." https://www.governor.pa.gov/newsroom/governor-wolf-takes-executive-action-to-combat-climate-change-carbon-emissions/.

49. United States Climate Alliance. n.d. "About." Accessed May 3, 2020. http://www.usclimatealliance.org/alliance-principles.

50. The U.S. Climate Alliance's Natural and Working Lands Challenge commits Alliance states to a number of actions aimed at "maintain[ing] natural and working lands as a net sink of carbon and protect[ing] and increase[ing] carbon storage capacity, while balancing near- and long-term sequestration objectives" and helping states to "integrate priority actions and pathways into state GHG mitigation plans by 2020." United States Climate Alliance. 2020. "Natural and Working Lands Challenge." http://www.usclimatealliance.org/nwlchallenge.

51. Some agricultural offset projects—particularly projects to reduce livestock methane emissions by installation of methane digesters or caps on manure lagoons—don't present the same accounting challenges related to permanence, leakage, and additionality as land-based projects, including those to encourage forest carbon sequestration.

52. Some environmentalists also have moral objections to offsets, comparing them to indulgences. Emitters, they argue, should be forced to reduce GHGs from their own operations. In addition, a number of Environmental Justice organizations raise concerns about offsets on the grounds that offsets remove pressure on fossil fuel power plants to upgrade pollution control equipment or shut down altogether, thereby extending air pollutant emissions in the region immediately surrounding those facilities.

53. Food and Agricultural Policy Research Institute. 2007. "Estimating Water Quality, Air Quality, and Soil Carbon Benefits of the Conservation Reserve Program." FAPRI-UMC Report #01-07. Columbia, MO: FAPRI, p. 22. https://www.fsa.usda.gov/Internet/FSA_File/606586_hr.pdf.

54. The AGree Economic and Environmental Risk Coalition (AGree Coalition) "advocate[s] for common-sense policies that protect both natural resources and farmers' livelihoods" with a focus on supporting farmers in adopting conservation practices while preserving "a viable crop insurance program." Members include researchers, academics,

farmers, former USDA officials, and NGO leaders. The AGree Economic and Environmental Risk Coalition. n.d. "About." Accessed on May 6, 2020. https://foodandagpolicy.org/about-us/.

55. Phillips et al. 2020. (in review).

56. In addition to dairy and pork producers, biomethane, which can be processed into products like Renewable Natural Gas and renewable Compressed Natural Gas for energy production and transportation fuel, can be sourced from the anaerobic digestion of other organic waste and biomethane sources, like landfills, wastewater treatment facilities and crop residues. The Coalition for Renewable Natural Gas. n.d. "What is Renewable Natural Gas." Accessed May 3, 2020. http://www.rngcoalition.com/about-rng.

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