SENATOR BOB DOLE ▪ SENATOR TOM DASCHLE

21st CENTURY AGRICULTURE PROJECT

The Role of Agriculture in Reducing Greenhouse Gas Emissions: Recommendations for a National Cap-and-Trade Program

21st Century
Agriculture Policy Project

THE ROLE OF AGRICULTURE IN REDUCING GREENHOUSE GAS EMISSIONS:
Recommendations for a National Cap-and-Trade Program

Senator Bob Dole ▪ Senator Tom Daschle

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Disclaimer
The conclusions and recommendations presented in this report are solely those of Senators Tom Daschle and Bob Dole. They do not necessarily reflect the views of the Bipartisan Policy Center Board of Directors or its Advisory Board.

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and Recommendations

Two years ago we set out to examine the **state of American agriculture** *and make recommendations to Congress to help* **secure a prosperous future** *for our nation's farmers. This undertaking, which we chaired, is known as the* **21st Century Agriculture Policy Project**. *On May 30, 2007, we released a report entitled "Competing and Succeeding in the 21st Century; New Markets for American Agriculture," with detailed recommendations on a number of issues, including preserving the agricultural safety net, reducing the cost of the federal Farm Bill,* **promoting renewable energy development** *on agricultural lands, and* **creating a robust market** *for agricultural carbon credits.*

That report can be found at: www.21stcenturyag.org. On the topic of climate change, we stated that:

"Federal action to establish a mandatory program to limit greenhouse gas emissions is sensible and will provide agricultural producers with significant new market opportunities. The agriculture sector is in a unique position to lead in—and benefit from—efforts to address climate change. Expanded demand for biofuels is an obvious example, but ranch and farm lands are also well-suited for future development of renewable electricity sources (e.g., wind and solar power) and carbon sequestration."

Political leaders, members of the business community, and the general public increasingly expect that restrictions on emissions of greenhouse gases (GHGs) will be needed to address the problem of global warming. As Congress moves forward in the near future to draft and debate climate change legislation, American agriculture can play an important role in shaping the eventual policy outcome—and specifically, in ensuring that any future U.S. cap-and-trade program fairly credits farmers and ranchers for GHG reductions and allows them to participate in a new national market for carbon credits. The stakes are extremely high for America's agricultural producers. *Done well, a national GHG emissions control policy can provide a new multi-billion dollar per year market opportunity for farmers.*

In September, 2007 we convened an all-day meeting in Washington D.C. to develop further recommendations on these specific climate- and agriculture-related issues with representatives of state and national farm organizations and members of the Agricultural Carbon Market Working Group, a collection of industry leaders who have studied the issue of a national market for agricultural carbon credits for over a year. Based on that meeting and additional research and conversations with agriculture leaders, we offer the following recommendations for the development of a greenhouse gas emissions cap and trade program to appropriately reward carbon sequestration and other agriculture projects that reduce greenhouse gases in the atmosphere:

- U.S. farmers and ranchers should have the opportunity to participate in a national cap-and-trade program for GHG emissions.
- Within a cap-and-trade program, the agriculture sector should be fully rewarded for all verifiable GHG emission reductions.
- As in other sectors of the economy, energy-related GHG emissions from the agriculture sector should be regulated upstream, at the fuel supplier or distributor, electric utility, or large industrial facility.
- A cap-and-trade program that provides for both offset credits and set-aside allowances will give agricultural producers the flexibility to choose different levels of rigor in documenting emissions benefits and will help to deliver maximum economic and environmental benefits from low-cost mitigation opportunities in the agriculture sector.
- USDA, in collaboration with state and national agricultural producer organizations and the Consortium for Agricultural Soils Mitigation of Greenhouse Gases (CASMGS), should develop standardized, certified protocols for measuring, monitoring and verifying soil carbon changes that can be utilized by agricultural producers to facilitate their participation in carbon markets.
- Standardized, certified protocols and methodologies for the measurement and verification of soil carbon sinks should be clear, transparent, and

Done well, a national GHG emissions control policy can provide a new multi-billion dollar per year market opportunity for farmers.

practical in order to maximize the market's acceptance of and ability to value soil carbon emission reductions, while also maximizing agricultural producers' participation in carbon markets, and the resulting benefits to society.

- Additional provisions may be necessary to address the issue of permanence for biological (soil- or forestry-based) carbon sinks and to assure overall program integrity in the event that future actions or natural events cause unanticipated carbon losses.
- Projects begun prior to the initiation of a nationwide cap and trade program *at a minimum* should receive credit for all greenhouse gas benefits achieved beginning on the date of the implementation of the program.
- In addition to rewarding carbon sequestration projects for GHG reductions that occur beginning at the inception of the program, Congress should consider setting aside some allowances to reward early adopters that achieve emissions benefits prior to implementation of a mandatory policy.
- All domestic biological carbon offsets should be credited and rewarded prior to rewarding international projects.
- USDA should establish clear rules to allow any qualified person or organization to act as an aggregator for agriculture-based offset credits or allowances in future GHG markets. Ultimately, agricultural organizations may want to consider joining together to form a single national cooperative aggregation and carbon brokerage service to interact directly with regulated entities. Such an entity could allow agricultural organizations to maximize returns to the farm sector by avoiding the use of non-agricultural brokers and traders.
- USDA should provide verification services through its extension agents and should additionally certify private verification services.
- Congress should provide funding to assist key private sector adopters to offset the costs of developing and demonstrating new measurement, monitoring and verification methodologies for soil carbon sequestration.
- Congress should provide $15 million per year to the Consortium for Agricultural Soils Mitigation of Greenhouse Gases.

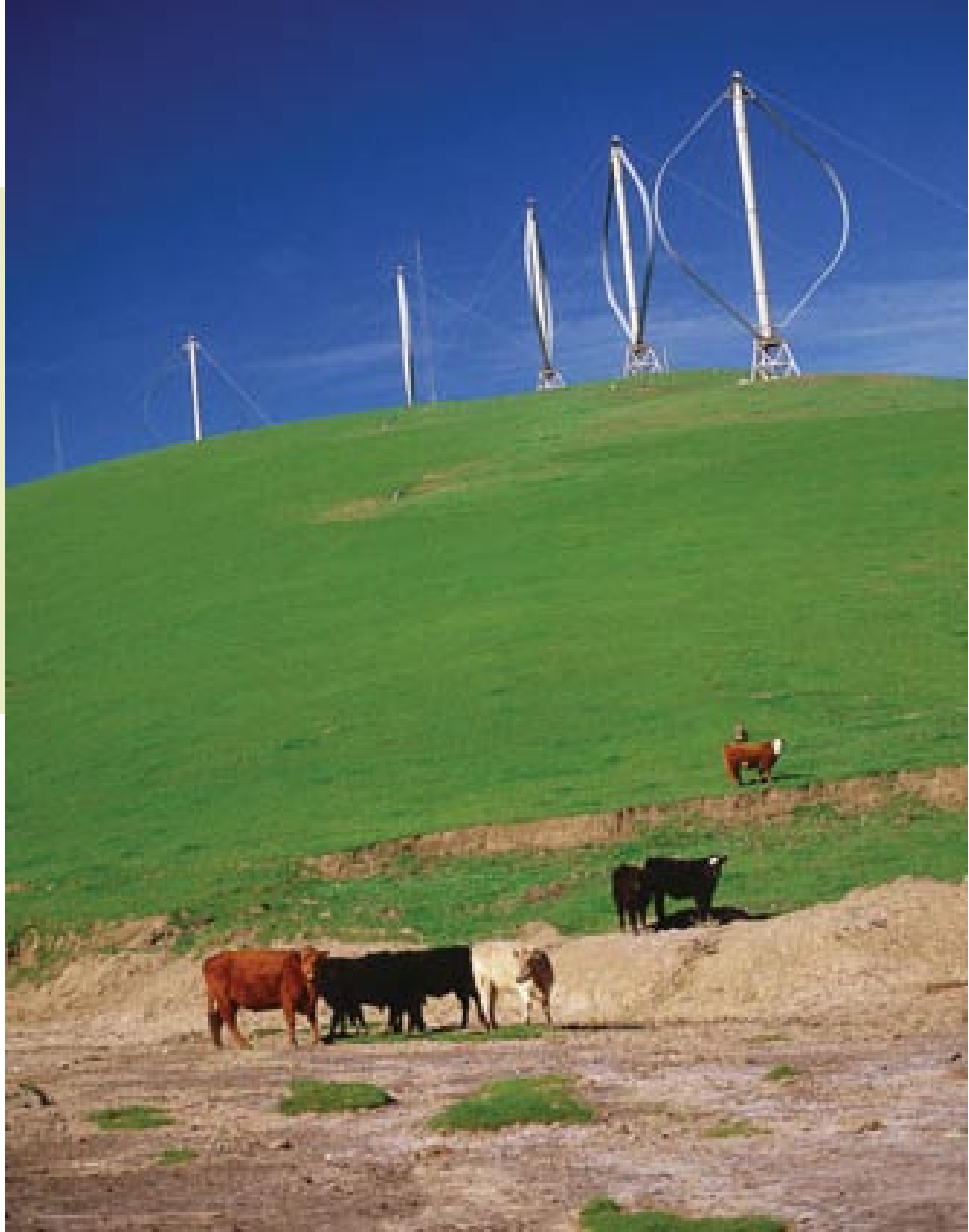
INTRODUCTION

Two years ago *we set out to examine the state of American agriculture and make recommendations to Congress to help secure a prosperous future for our nation's farmers. This undertaking, which we chaired, is known as the 21st Century Agriculture Policy Project. To develop our initial recommendations, we met throughout 2006 with* **farmers**, **conservationists**, *renewable energy experts, and others around the country to get their views on world trade,* **commodity prices**, *carbon sequestration markets,* **renewable fuels and electricity opportunities**, *conservation programs, and other issues that affect the* **profitability of America's agricultural producers**.

On May 30, 2007, we released a report with detailed recommendations on a number of issues, including preserving the agricultural safety net, reducing the cost of the federal Farm Bill, promoting renewable energy development on agricultural lands, and creating a robust market for agricultural carbon credits. On the topic of climate change, we stated that:

"Federal action to establish a mandatory program to limit greenhouse gas emissions is sensible and will provide agricultural producers with significant new market opportunities. The agriculture sector is in a unique position to lead in—and benefit from—efforts to address climate change. Expanded demand for biofuels is an obvious example, but ranch and farm lands are also well-suited for future development of renewable electricity sources (e.g., wind and solar power) and carbon sequestration."

Political leaders, members of the business community, and the general public increasingly expect that restrictions on emissions of greenhouse gases (GHGs) will be needed to address the problem of global warming. Numerous bipartisan bills have been introduced in Congress to establish a nationwide cap-and-trade system to achieve that goal. As Congress moves forward in the near future to draft and



The agriculture sector is in a unique position to lead in—and benefit from—efforts to address climate change.

debate climate change legislation, American agriculture can play an important role in shaping the eventual policy outcome—and specifically, in ensuring that any future U.S. cap-and-trade program fairly credits farmers and ranchers for GHG reductions and allows them to participate in a new national market for carbon credits. The stakes are extremely high for America's agricultural producers. Done well, a GHG emissions control policy can provide a multi-billion dollar per year market opportunity for farmers.

Achieving this outcome will not be a simple undertaking. Congress will need to resolve numerous complex issues associated with carbon sequestration and agricultural GHG emissions reductions. In September, 2007 the Dole-Daschle 21st Century Agriculture Project convened an all-day meeting in Washington D.C. to develop further recommendations on these specific climate- and agriculture-related issues with representatives of state and national farm organizations and members of the Agricultural Carbon Market Working Group, a collection of industry leaders who have studied the issue of a national market for agricultural carbon credits for over a year. This report is based on the input from the September meeting, conversations with other carbon market experts, and a review of other studies on this subject.

It is our hope that this report will achieve two primary goals: (1) provide Congress with recommendations for establishing a market for agricultural carbon credits as it moves forward to design national cap and trade legislation to reduce GHG emissions, and (2) encourage farmers and farm organizations to become active participants in the climate policy debate, particularly as it relates to the development of a new market for agricultural carbon credits.

Limiting CLIMATE CHANGE

Creating a Market for GHG Reductions

To date, **few financial incentives exist** *for reducing emissions of the gases that cause climate change that are* **associated with energy use** *and consumption in the United States. That is because, except for a few state and regional programs that are just beginning to be implemented, no effort has been made to require people or industries to pay a price for* **emitting carbon dioxide** *(CO_2) and other GHGs. Political momentum for a mandatory nationwide program to* **reduce GHG emissions** *is growing, however, and most parties to the climate policy debate now expect that* **major legislation** *towards that objective* **will be adopted** *within the next few years.*

The federal government could pursue a number of strategies to address global warming, including: (1) setting limits for every significant GHG emitter, as is done to achieve water quality objectives through the Clean Water Act; (2) establishing a national tax on carbon, as advocated by many economists; or (3) adopting a cap-and-trade system that allows regulated industries to trade emissions permits or allowances with each other, subject to a cap on overall emissions. Any of these approaches will raise the price of using fossil fuels, such as coal and oil, and of consuming goods and services that directly or indirectly produce GHG emissions. The impact of these price increases will be felt throughout the economy, but much of the ultimate cost of reducing emissions will eventually be passed along to end-use consumers.

Both a carbon tax and cap-and-trade program would reduce overall costs by eliciting the most cost-effective GHG mitigation measures. For a variety of reasons, however, the cap-and-trade option is widely viewed as the approach most likely to win Congressional and public support. In fact, all of the major GHG control programs that have been proposed or put in place to date—including several of the most prominent legislative proposals currently before Congress—have adopted this approach. For example, the European Union's Emissions Trading Scheme (EU ETS) uses a cap-and- trade system to limit GHG emissions from large industrial sources, as does the Regional Greenhouse Gas Initiative (RGGI) developed by several New England and Mid-Atlantic states to limit power sector emissions. The EU ETS was launched in 2004; RGGI is due to be implemented in 2009 across a 10-state region.

Designing an economy-wide GHG cap-and-trade program for the nation as a whole raises a number of complex and important issues. How those issues are resolved will have profound impacts, not only in terms of how the broader U.S. economy will be affected by emissions constraints, but also in terms of the specific costs and benefits likely to accrue to the nation's farmers and ranchers. In particular, a program designed to recognize the myriad low-cost mitigation options that exist within the agriculture sector could create substantial economic opportunities—including potentially large new sources of income—for rural communities and agricultural producers.

Fundamentals of a Cap-and-Trade Policy

Emissions trading and emissions taxes are often described as market-based forms of environmental regulation because—in contrast to traditional regulations that establish facility-specific pollution control requirements—they rely on financial incentives to elicit the lowest-cost emissions reductions. Under either system, every ton of emissions carries a cost and all major emissions sources face an equal incentive to avoid or reduce emissions. Sources that face lower mitigation or pollution-control costs will reduce their emissions more than sources that face higher costs. The chief difference between a cap-and-trade system and an emissions tax is that the former provides certainty about later emissions levels, without specifying a maximum cost, while the latter provides certainty about eventual costs without specifying a maximum emissions level. Hybrid systems that combine some elements of both approaches—notably a cap-and-trade program with a price cap—are also possible. As has already been noted, most current proposals for a mandatory U.S. program to reduce GHG emissions favor the cap-and-trade approach.

The mechanics of a cap-and-trade system are relatively straightforward. As a starting point, government establishes an overall cap or limit on emissions of the pollutant(s) in question from all sources covered by the system. A quantity of emissions permits or allowances consistent with this overall limit is issued and either auctioned or given away (or some combination of both). Once the program goes into effect, regulated

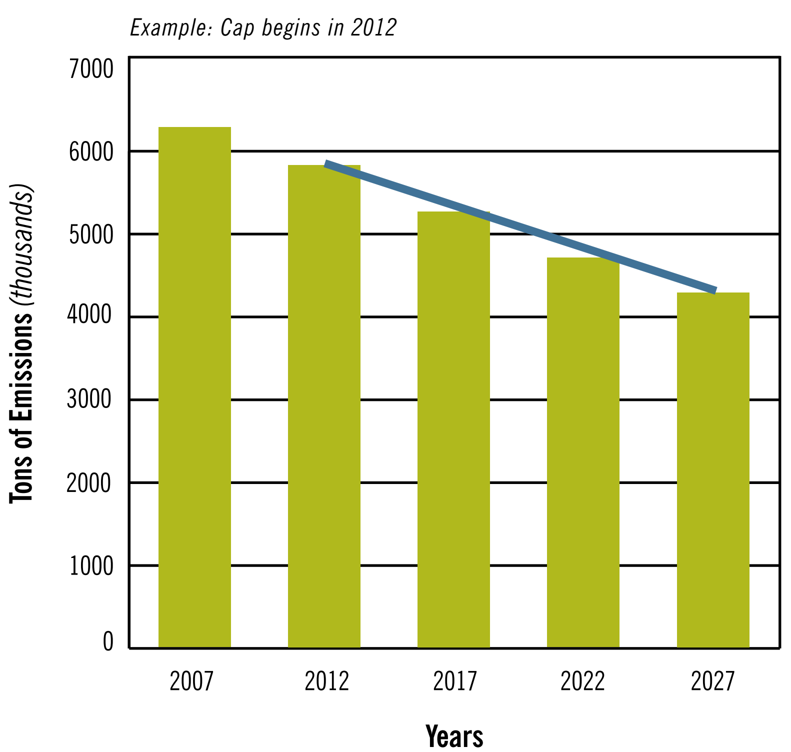
{ Political momentum for a mandatory nationwide program to reduce GHG emissions is growing. }

sources must track their emissions and surrender a permit or allowance for every ton they release to the atmosphere. (Note that in a system that regulates upstream producers or importers of fossil fuels, the compliance obligation would likely be based on the carbon content of fuels sold, rather than on direct emissions from the regulated entity.)

Once issued, permits or allowances themselves may be bought, sold, and traded to allow the market to establish their price or value. Entities that can reduce their emissions at a cost below the market price of permits will do so until the marginal cost of abatement—that is, the cost that must be incurred to achieve the next ton of reductions—rises to the level of the permit price. Accordingly, some sources may make very substantial reductions, while others—those with high abatement costs—will make only limited reductions. Most current domestic proposals call for the cap on overall U.S. GHG emissions to decline over time (see Figure 1). As this occurs, the market price of emissions permits or allowances would be expected to rise such that more aggressive abatement measures and deeper reductions become cost-effective.

For reasons of administrative simplicity, cost-effectiveness, and program integrity, most cap-and-trade proposals put forward to date do not attempt to cover all types of GHG emissions or emissions sources in the economy. Rather, they tend to focus on large suppliers and/or users of fossil fuels—that is, entities further up in the chain of energy production, distribution, and consumption, as illustrated by Figure 2. This approach makes sense because it efficiently captures the vast majority of GHG emissions in the economy while keeping administrative costs and compliance and enforcement requirements manageable. Trying to reduce or monitor emissions from multiple, smaller sources with fewer emissions—that is, entities at the 'downstream' end of Figure 2—would be more costly and would likely mean that a larger fraction of emissions could not be effectively covered by the trading system. Thus, the current expectation is that Congress will choose to regulate a smaller number of large "upstream" sources, rather than many diffuse "downstream" sources. In this type of system, energy end-users—including farmers and ranchers, as well as homeowners, most firms outside the energy sector (with the possible exception of very large industrial facilities), and car drivers—would not be directly regulated. That is, they would not be required to submit permits or allowances to cover their emissions. Rather the costs of regulation would be passed through to energy end-users in the form of higher prices for fossil fuels, intermediary forms of energy (like electricity), and goods and services that require the use of fossil fuels. In this way, the financial incentive to reduce emissions by reducing the consumption of carbon-intensive fuels and goods would be transmitted down the entire energy supply chain, and all energy-related emissions—including emissions from fossil-fuel use by agricultural producers—would be covered.

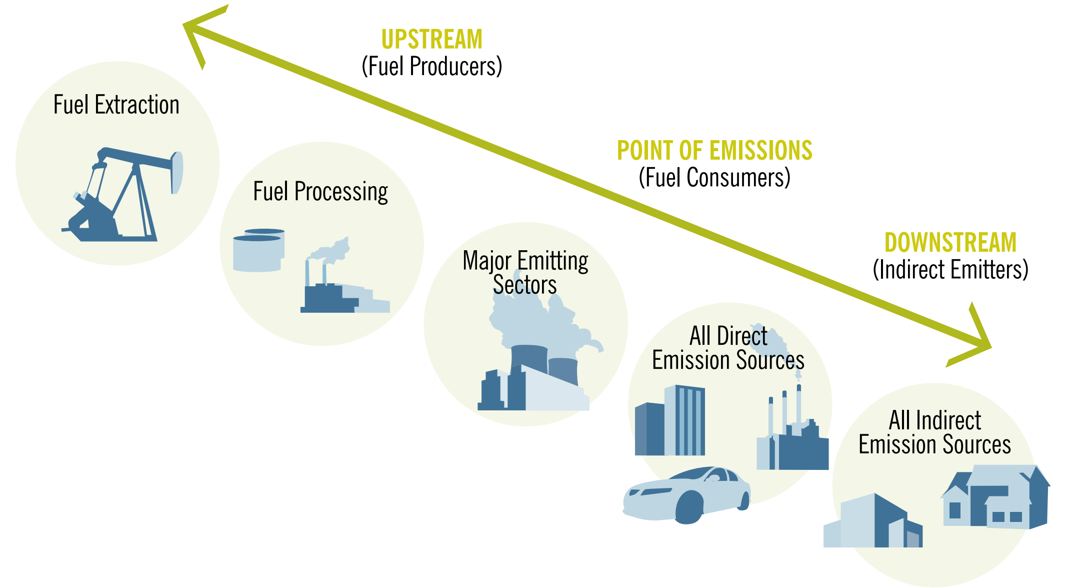
FIGURE 1: EMISSION CAP–TOTAL EMISSIONS ARE CAPPED AND REDUCED OVER TIME



The Economic Opportunity for Agriculture

Alongside its traditional role in providing the nation with an abundant supply of food and fiber, the agricultural sector is poised to be a major player in the development of clean and renewable domestic energy resources and in future efforts to reduce GHG emissions and mitigate global climate change. Although agriculture is a relatively small source of GHG emissions in the United States, it offers ample low-cost, high-value reductions opportunities. As noted in the previous section, a cap-and-trade program that regulates upstream producers or suppliers of fossil fuels would capture most energy-related agricultural CO_2 emissions, but would very likely miss other important sources of emissions and of cost-effective emissions-reduction opportunities in this sector. Examples include reducing nitrous oxide through nitrogen-use efficiency, reducing methane emissions from animal wastes and sequestering carbon in agricultural soils. A policy designed to recognize and reward these mitigation opportunities in the context of an economy-wide cap-

FIGURE 2: SCOPE AND POINT OF REGULATION



and-trade program for GHG emissions could generate substantial new revenue streams—potentially in the billions of dollars per year—for the nation's farmers and ranchers. It has been estimated, for example, that up to *168 million tons of CO_2* could be sequestered in U.S. agricultural soils *annually*.[1] The following figures give a sense of the total income opportunity associated with this estimate of carbon sequestration potential at three different price levels for CO_2:

- At \$10/ton CO_2 = \$1.7 billion/year
- At \$15/ton CO_2 = \$2.5 billion/year
- At \$20/ton CO_2 = \$3.4 Billion/year

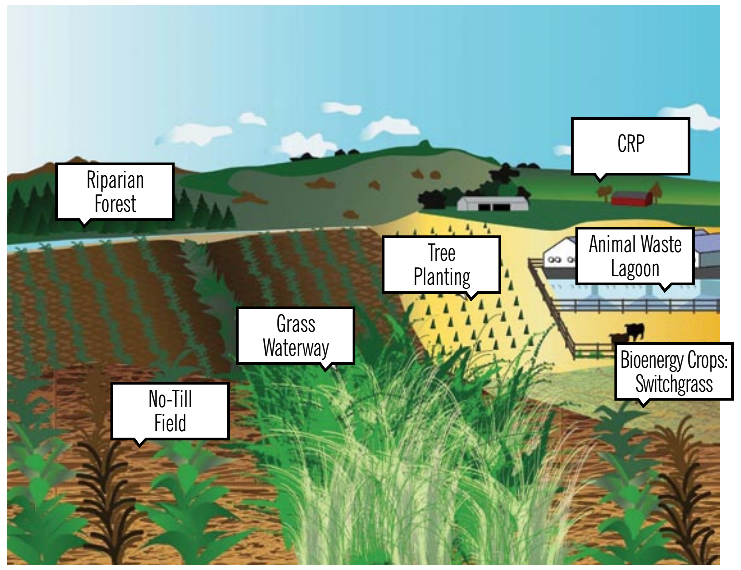
Notably, the \$10–\$20 per ton CO_2 price range shown above is roughly consistent with available modeling estimates of the carbon permit prices likely to emerge—at least over the first decade or so of program implementation—under several of the more prominent proposals that have recently been introduced in Congress. Currently, the U.S. Environmental Protection Agency (EPA), estimates that carbon sequestration by forests and agricultural lands offsets approximately 12 percent of annual GHG emissions from all sectors of the U.S. economy.[2] EPA estimates that most (approximately 90 percent) of this sequestration occurs on forest lands. With the financial incentives provided by a cap-and-trade system, it is likely that carbon sequestration opportunities on agricultural lands would be pursued more aggressively. For example, EPA has estimated that an amount of carbon equivalent to as much as 20 percent of all annual U.S. GHG emissions could be sequestered in soils and forests at a price of roughly \$15 per ton of CO_2.[3]

McCarl (2007) has looked specifically at how future climate-change policies could impact the agriculture sector, both in terms of imposing new costs and generating new income. His analysis concludes that such policies—provided they are implemented in a manner designed to take maximum advantage of agriculture's potential role in reducing and sequestering GHG emissions—could provide substantial net benefits to America's farmers and ranchers. Specifically, the sale of carbon credits by the agricultural sector could lead to a substantial rise in farm incomes.[4]

That said, designing a national cap-and-trade program to fully capture this upside potential while maintaining the environmental integrity of the trading program as a whole presents a number of

[1] USEPA, *Greenhouse Gas Mitigation Potential in Forestry and Agriculture,* November 2005, EPA Report 430-R-05-006, Washington, DC 20460.
[2] USEPA, *Greenhouse Gas Mitigation Potential in Forestry and Agriculture,* November 2005, EPA Report 430-R-05-006, Washington, DC 20460.
[3] Ibid.
[4] McCarl, Bruce, *Analysis of the Impacts of a Carbon Cap on Net Farm Income,* a modeling analysis prepared for the 21st Century Agriculture Policy Project, February 2007.

THE 21ST CENTURY FARM: CARBON CREDITS AND INCOME GENERATION



THE 21ST CENTURY FARM: POTENTIAL ANNUAL INCOME GENERATED FROM CARBON CREDITS ON A "MODEL" 1,000 ACRE FARM

Practice	Soil MT CO_2/a/y	Area (acres)*	Total Soil Credit	Value $4/Ton	Value $10/Ton	Value $20/Ton	Other Credits[1] CO_2/a/y	Value $10/Ton
Riparian Forest	NA	40					0.70?	
Grass Waterway	3.00	50	150	600	1500	3000		
Tree Planting[2]	0.45	100	45	180	450	900	0.70	700
CRP	3.00	100	300	1200	3000	6000		
Bioenergy grass crop	0.20	200	40	160	1600	3200	5.0	10000
No-till Field	0.75	500	375	1500	3750	7500		
Anaerobic Methane Digester for Animal Manure Treatment	NA	50*[3]		300	750	1500	1.5*[3]	750
Total ($)				**3,940**	**11,050**	**22,100**		

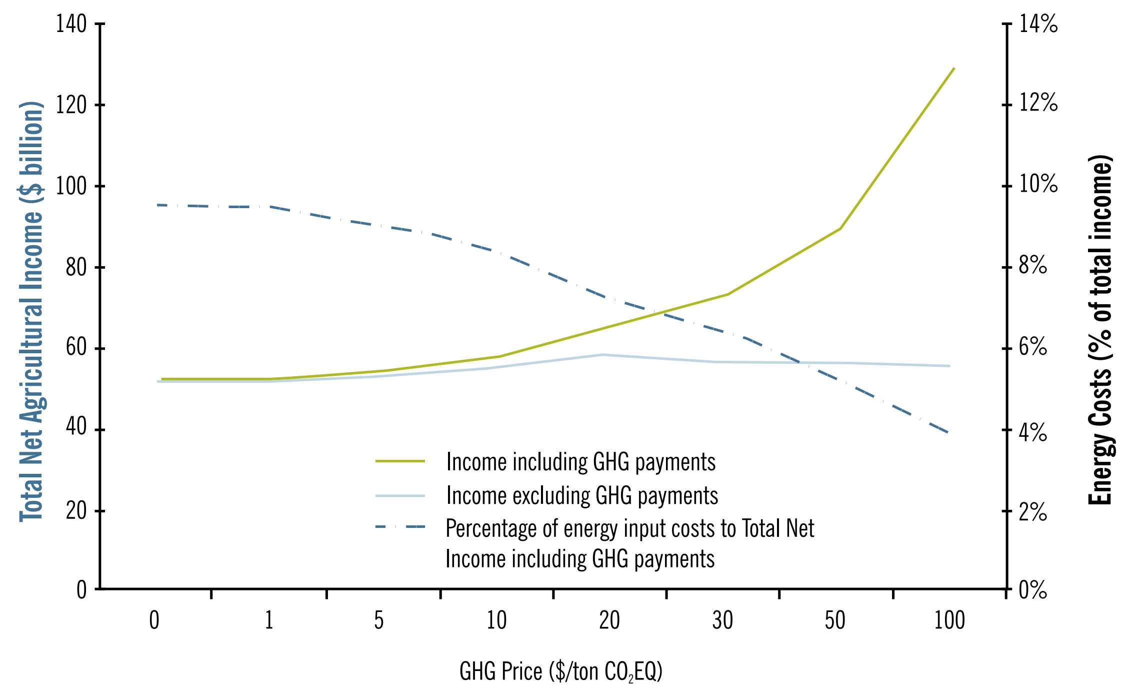
** Figure reported as head of cattle, rather than in acres*

[1] Other credits generated could include: carbon accumulation in woody biomass (Heath et al., 2003a) and from the use of perennial grasses for cellulosic ethanol production, with the ethanol substituting for fossil fuel use (Nelson personal communication), and methane credits (per head of cattle) from managing an animal waste lagoon, with the installation of an anaerobic methane digester.

[2] (Heath et al., 2003b)

[3] The amount of credits awarded by CCX in association with use of an anaerobic methane digester to handle cattle manure is approximately 1.5 MT CO_2/head/year (Personal communication with Dave Miller, Iowa Farm Bureau, 2007).

FIGURE 3: IMPACT OF CAP AND TRADE ON FARM INCOME

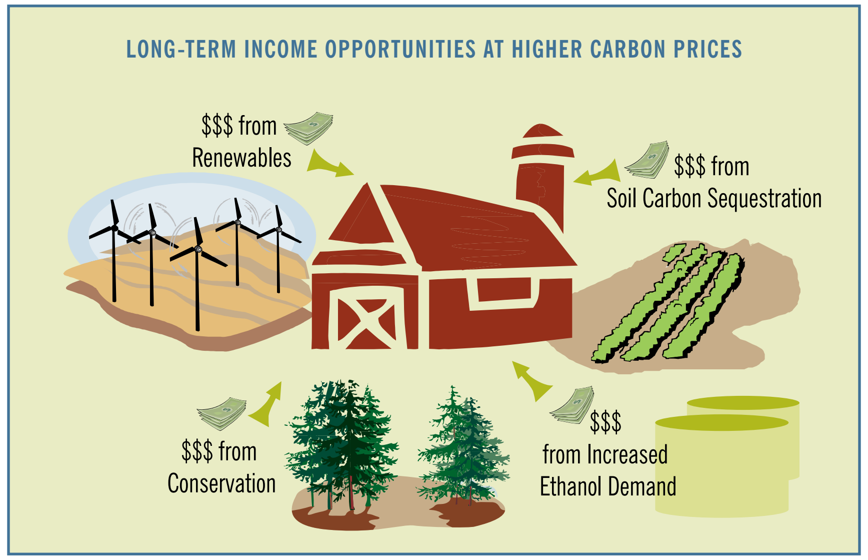


Source: McCarl 2007

policy challenges. Important issues remain to be resolved to ensure, first that farmers can obtain full market value for their contributions to reducing or offsetting GHG emissions, and second that the unique nature of biological carbon sequestration activities is fairly reflected in the accounting and verification processes. The stakes are high—not only for farm families, but for the nation as a whole, which stands to benefit from capturing the relatively low-cost, near-term mitigation opportunities available in the agriculture sector. Given these stakes, the agricultural community is actively engaged in current policy discussions to explore ways to address these program design challenges.

One of the most immediate and contentious issues that must be decided concerns the overall stringency of the policy. The more stringent the policy—that is, the greater the emissions reductions it aims to achieve over a given period of time—the higher the expected price signal that would be generated under a cap-and-trade system. On the one hand, it would be in agricultural producers' interest for GHG permit (or allowance) prices to be as high as possible, so as to maximize the potential income generated by the sale of credits from, for example, soil-based carbon sequestration. At the same time, a higher GHG permit price also means higher prices for gasoline and diesel fuel, home heating oil, natural gas, fossil-fuel generated electricity, and other farm inputs. A substantial rise in energy prices or in energy price volatility—particularly if it occurs so rapidly that energy users have little time to adjust—could adversely affect farmers and ranchers, consumers in general (especially those on low or fixed incomes), and the economy as a whole, which might grow more slowly as a result.

In response to these concerns, a number of current proposals for a GHG cap-and-trade program include some form of cost-containment mechanism. Legislation sponsored by Senators Jeff Bingaman and Arlen Specter, for example, contains a "safety valve"—essentially a cap or ceiling on the price of carbon permits—that rises over time in a gradual and predictable way. Another bill, sponsored by Senators Joseph Lieberman and John Warner provides for a federal board (akin to the existing Federal Reserve Board) to periodically review carbon prices and allow additional offsets to be generated or permits to be borrowed from future emissions budgets in the event that permit prices rise



too high or exhibit excessive volatility. Ultimately, it is likely that some type of cost-containment mechanism will be included in any mandatory national program to reduce GHG emissions in the United States.

We do not endorse one approach over another, nor do we take a position on the necessity of including a cost-control mechanism in the first place or on the optimal price of GHG permits. The point here is simply to highlight some of the trade-offs relevant for the agricultural community as Congress debates key issues such as overall policy stringency and options for managing cost impacts.

Near-Term Importance of Soil Carbon Sequestration

Results from recent scientific and economic analyses suggest that increasing the amount of carbon sequestered in agricultural soils represents an important low-cost GHG mitigation opportunity, particularly over the next quarter century as more dramatic, long-term transformations of the nation's energy systems are still in the early stages.[5,6] Changing investment decisions, commercializing new low-carbon technologies, retiring and replacing the existing capital stock of carbon-intensive equipment, and developing new infrastructure will take years and in some cases, decades. During this time, soil carbon sequestration and other widely deployable, 'low-tech' mitigation options are particularly valuable because they can help ensure that environmental targets (in terms of net GHG reductions) are reached, while keeping program costs and economic impacts to a manageable and politically supportable level. In addition, allowing 'off-sector' measures like soil-based carbon sequestration to qualify for offset credits within a broader cap-and-trade system for energy-related GHG emissions can improve the liquidity of GHG permit markets and dampen price volatility.

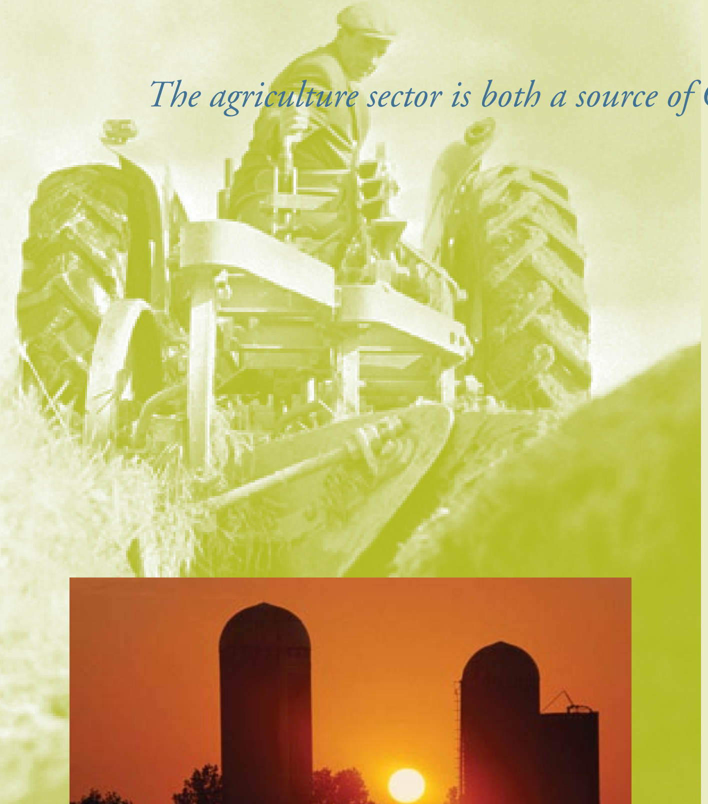
Over the next 30 to 50 years, as carbon prices increase, other mitigation options will become cost-effective, and reliance on soil carbon and forest management to achieve GHG reduction targets can be expected to diminish. In this longer time frame, measures such as afforestation, reforestation, and biofuels production would likely come to the fore of biologically-based mitigation options. These options have the potential to achieve larger long-term GHG reductions, but require the stronger financial incentives that would only come with higher carbon prices. Ironically, some analyses predict that the amount of carbon sequestered in agricultural soils could actually *decline* as tree planting and biofuels development become increasingly cost-effective under a carbon pricing regime and lead to large-scale land-use changes.[7]

Over the medium-term, other GHG mitigation options besides soil carbon sequestration, such as measures that reduce methane and nitrous oxide emissions from farm and ranch operations, will likely also become more important—provided that sufficient data on emissions fluxes and mitigation practices can be developed to support their full inclusion in emissions trading markets.

Many near-term mitigation opportunities available in the agriculture sector—besides offering substantial, readily available, and low-cost GHG reductions—would provide additional societal and environmental benefits. Agriculture-based measures that also reduce conventional air and water pollution, enhance soil quality and reduce erosion, and provide improved wildlife habitat could generate "charismatic carbon credits"—credits that are especially attractive because they address environmental concerns beyond climate change alone.

[5] Congress of the United States, Congressional Budget Office, September 2007, *The Potential for Carbon Sequestration in the United States.*
[6] See summary of Jae Edmonds' remarks, *Workshop on the Role of Biotechnology in Mitigating Greenhouse Gas Concentrations,* June 2001. Workshop Summary by Ken Nealson and J. Craig Ventner.
[7] Congress of the United States, Congressional Budget Office, September 2007, *The Potential for Carbon Sequestration in the United States.*

The Role of AGRICULTURE in Reducing GHGs



The agriculture sector is both a source of GHG emissions and a potential carbon reservoir, or "sink," that can **reduce GHG concentrations** *in the atmosphere. Agricultural activities are directly linked to* **three major types of GHGs***: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Accounting for the different warming potentials of these gases, the agriculture sector contributes approximately 7.4 percent of annual U.S. GHG emissions.*[8] *Most of these emissions originate from small,* **diffuse non-point sources**.[9,10,11]

In CO_2-equivalent terms, nitrous oxide and methane account for the largest share of agriculture sector emissions. A number of options exist for reducing GHG emissions from the agriculture sector.

Nitrous Oxide:

Agricultural sources of N_2O emissions include soils and fertilizers; in addition, the use of manure on croplands produces N_2O emissions. Options for reducing N_2O emissions include reducing nitrogen inputs (fertilizer use) on croplands and enhancing the uptake of nitrogen by plants (what is known as nitrogen-use efficiency).[12] The use of soil nitrogen tests to adjust fertilizer applications and minimize waste can help reduce N_2O emissions, as can changes in the timing of fertilizer applications to better coincide with the most active period of crop growth.

[8] United States Environmental Protection Agency, 2007. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005,* Washington, DC.

[9] No legislative approach or state or regional climate change policy considered or enacted to date proposes to directly regulate non-energy agricultural GHG emissions. Direct regulation of farm and ranch operations is widely regarded as impractical because the emissions involved are relatively small overall, compared to other sectors, and in many cases difficult to monitor, and because the sector encompasses virtually thousands of sources with low emissions.

[10] West, T.O., and Pena, N. 2003, Determining Thresholds for mandatory Reporting of Greenhouse Gas Emissions, *Environmental Science and Technology,* Vol. 37, No. 6: 1057-1060.

[11] Paustian, K., et al., 2006. Agriculture's Role in Greenhouse Gas Mitigation, Pew Center on Global Climate Change.

[12] Council for Agricultural Science and Technology, 2004, *Climate Change and Greenhouse Gas Mitigation: Challenges and Opportunities for Agriculture,* Ames, Iowa, Task Force Report No. 141.

The elimination of fallow periods and the use of cover crops can also promote the capture of nitrogen that might otherwise be lost as N_2O. Precision management and targeted applications of fertilizer can help boost nitrogen-use efficiency and reduce losses from N_2O. Robust data on N_2O fluxes from sources and sinks, and best management practices to reduce N_2O emissions, are still lacking, however.[13]

The development of nitrogen use efficiency (NUE) technology is a promising approach for significantly reducing GHG emissions without adversely affecting crop yields. The economic incentives for farmers to adopt NUE technology and its ease of implementation represent a significant opportunity for achieving GHG emissions reductions in the agriculture sector. Developing and implementing NUE technology should be a priority in climate change legislation, and cap and trade proposals should ensure that they reward such efforts appropriately. In addition, federal funding should be directed to accelerate commercial introduction of NUE technology.

Methane:

Agricultural CH_4 emissions largely come from livestock—specifically, from enteric fermentation in the digestive systems of ruminant animals such as cattle and from the anaerobic decomposition of organic matter (e.g. manure). Emissions from ruminant livestock can be reduced through genetic manipulation and by improving the quality of feed.[14] Covered lagoons or methane digesters are increasingly being used to capture CH_4 emissions from livestock manure and to generate energy for on-farm use.[15] Soils also produce some methane emissions, as does rice cultivation. Changes in water and fertilizer management can help reduce emissions from rice cultivation, as can the use of new rice cultivars. Finally, the burning of agricultural residues emits relatively small amounts of CH_4, N_2O, and CO_2.

{ A number of options exist for reducing GHG emissions from the agriculture sector. }

Carbon Dioxide:

In the United States, agriculture is both a source and sink for carbon emissions. The direct use of fossil fuels and electricity on farms and ranches generates CO_2 emissions, as does the use of inputs, like fertilizers and chemicals, whose production entails upstream energy use. Under a cap-and-trade system targeted primarily at energy-related emissions, energy prices will rise to reflect the cost of emission permits or allowances and as a result agricultural producers—like all other energy

Management practices that enhance agricultural soil sequestration:

- conservation tillage (no-till, strip-till, mulch-till, ridge-till)
- crop rotations
- cover crops and elimination of fallow periods
- organic solids management (including manure)
- land retirement programs (e.g. Conservation Reserve Program, Wetlands Reserve Program, Grasslands Reserve Program)
- rangeland management

Agriculture-based options for reducing GHG emissions beyond soil carbon sequestration:

- supplying sustainably managed feedstocks for the production of renewable biofuels
- methane capture and energy recovery from manure storage systems (e.g., using anaerobic methane digesters); changes in feed quality and formulation to reduce ruminant methane emissions
- reducing nitrous oxide emissions by reducing and optimizing fertilizer applications to ensure maximum nitrogen up-take by crops

[13] Lal, R. et al., 1998, *The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect,* Sleeping Bear Press, Inc.

[14] Council for Agricultural Science and Technology, 2004, *Climate Change and Greenhouse Gas Mitigation: Challenges and Opportunities for Agriculture,* Ames, Iowa, Task Force Report No. 141.

[15] Ibid.

Land conversion to forests or to biofuels production becomes more prevalent as carbon prices rise.

end-users—will face incentives to use energy more efficiently and/or to switch to lower-carbon energy alternatives. While CO_2 reductions from fuel switching and energy efficiency improvements could represent an important part of the agriculture sector's contribution to overall GHG mitigation, these reductions would be captured within the larger cap-and-trade system and thus would not be separately credited.

The incentives generated under a GHG trading regime would also be expected to drive increased demand for sustainable biofuels and renewable energy production, much of it well-suited for agricultural lands. Supplying the feedstocks needed to support a substantial expansion of biofuels production and hosting new wind and solar power projects (many of which are compatible with existing agricultural land uses) not only represents another important avenue for the agriculture sector's participation in GHG mitigation efforts—but will very likely also present significant new income opportunities for the nation's agricultural producers.[16] As with energy conservation and fuel switching, incentives for these forms of agriculture-based GHG mitigation are intrinsic to the cap-and-trade system. Thus, if stronger incentives for biofuels and renewable energy production are desired it is likely that they would be delivered through additional policies—such as a renewable portfolio standard and/or renewable fuels standard—rather than through a separate crediting mechanism within the cap-and-trade program itself.

The remaining major category of agriculture-based CO_2 mitigation options involves biological carbon sequestration. Prior to 1953, the large-scale conversion of forests, pasture, and rangeland to agricultural uses made the U.S. agriculture sector a net source of CO_2 emissions.[17] At present, however, agricultural soils and forests take up more carbon than they emit and thus represent a net sink. The historical loss of carbon from soils presents an opportunity to reverse past losses and enhance the current soil sink. It also presents perhaps the most important near-term opportunity for agricultural producers to reap direct benefits under a mandatory climate policy. Thus, the remainder of the discussion in this section focuses in some detail on the potential for agricultural soil and forestry-based carbon sequestration.

[16] Dole, B. and Daschle, T., 2007, Competing and Succeeding in the 21st Century: New Markets for American Agriculture, The 21st Century Agriculture Project.
[17] Kimble, J. et al., 2002. *Agricultural Practices and Policies for Carbon Sequestration in Soil,* Lewis Publishers.

Soil Sequestration:

Carbon sequestration in agricultural soils currently offsets about 10 percent of all GHG emissions from the agriculture sector as a whole; it offsets less than 1 percent of total U.S. emissions from all sectors. With proper management, however, the opportunity exists to significantly enhance carbon sequestration in agricultural soils. For example, scientists at the U.S. Department of Agriculture (USDA) and EPA estimate that agricultural soils have the potential to sequester enough carbon to offset 10–15 percent of annual U.S. GHG emissions.[18,19] Moreover, as has already been noted, many measures to increase soil carbon sequestration would have ancillary benefits in terms of air and water quality, improved soil tilth and fertility, enhanced crop productivity, and reduced nutrient leaching and run-off.

The uptake and storage of carbon by soils depends on soil type as well as on management practices, location, climate, and related factors. Not all soils absorb carbon at the same rate, and some soils have a greater carbon absorption capacity than others. It has been estimated that, on average, agricultural soils in the United States have the capacity to absorb 0.5 tons of carbon per acre, per year.[20] This potential can only be achieved if land management practices are adopted that maximize soil carbon sequestration. Whether this is likely depends largely on the opportunity costs faced by landowners. If farmers and landowners can participate in carbon markets and receive payment for stored carbon, it is more likely that they will undertake the management practices needed to maximize sequestration. Because soils have a finite capacity to absorb carbon, this mitigation option has limits: soils can reach the point where they are 'saturated' with carbon.

In general, soils that are more degraded and that have historically lost greater amounts of carbon—due to land conversion, for instance, or as the result of management practices that lead to carbon losses—have a greater capacity to sequester carbon, and at higher rates than soils that already have high levels of carbon. For this reason, farmers that have been engaged in no-till or carbon sequestering practices for years or decades likely have greater amounts of carbon already stored in their soils than those engaged in traditional tillage practices. As a result, their soils will likely absorb carbon at a slower rate than the soils of other landowners who have only recently converted to carbon-sequestering practices. As soils approach their carbon saturation potential, they tend to absorb carbon at a slower rate than more degraded soils, which have lower carbon content to start with.

POTENTIAL CO_2 REDUCTION OPTIONS

	Rapidly Deployable	Not Rapidly Deployable
Minor Contributor <0.2 PgC/y	Biomass co-fire electric generation Cogeneration and Hydropower Natural Gas Combined Cycle Niche options	Photovoltaics Ocean fertilization
Major Contributor >0.2 PgC/y	▪ C sequestration in agricultural soils ▪ Improved efficiency ▪ Industrial non-CO_2 gas abatement ▪ Ag non-CO_2 gas abatement (CH_4, N_2O) ▪ Reforestation	▪ Biomass to hydrogen ▪ Biomass to fuel ▪ Cessation of deforestation ▪ Energy-efficient transport ▪ Geologic storage ▪ High-efficiency coal technology ▪ Large-scale solar ▪ Next generation nuclear fission

Caldeira et al. 2004. A portfolio of carbon management options, p. 103-130, in C. B. Field and M. R. Raupach, eds. The Global Carbon Cycle. Island Press, Washington, DC.

How much of the theoretical carbon sequestration potential of agricultural soils would actually be realized under a future domestic climate policy depends on the aggressiveness of supporting policies and the market value of carbon. With highly supportive policies and strong financial incentives, landowners will adopt sequestration-maximizing soil management practices more quickly and more aggressively, resulting in higher rates of carbon uptake and shortening the time frame over which soils become 'carbon saturated'.

Forest Sequestration:

Forests also sequester carbon and offer substantial additional potential as a GHG mitigation option. In fact, forests can sequester roughly two to ten times the amount of carbon per acre that soils can—an estimated 0.9–4.6 tons of carbon per acre per year,

[18] The higher end of these estimates assume high carbon prices, and some land conversion, such as afforestation or reforestation of lands.
[19] US Environmental Protection Agency, 2005, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture, EPA* 430-R-05-006.
[20] West, T.O. and Post, W.M. (2002), Soil Organic Carbon Sequestration by Tillage and Crop Rotation: A Global Data Analysis, Soil Science Society of America Journal 66:1930-1946.

The agriculture sector is both a source of GHG emissions and a potential carbon reservoir.

according to a review of forest sequestration potential in the United States.[21] As with soils, the sequestration potential of different forests—both with respect to their maximum rate of carbon uptake and the total amount of carbon they can store—depends on many factors, such as tree species, geographic region, and the age of the forest.

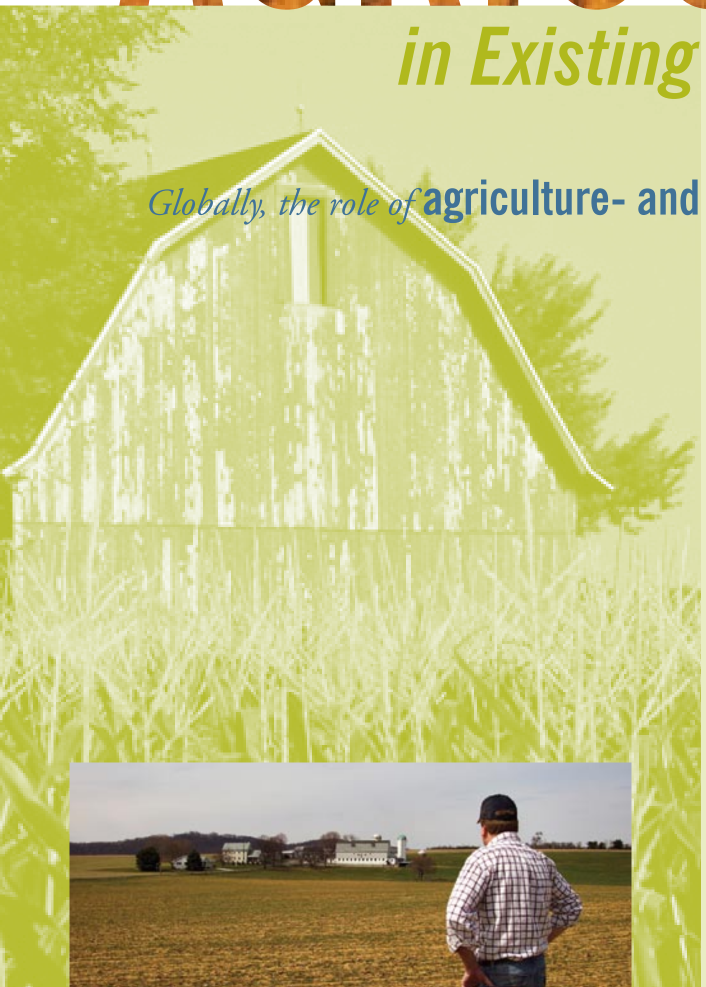
As has already been noted, different types of mitigation options are likely to dominate as carbon prices rise. Specifically, available modeling analyses by USDA, EPA, and others indicate that soil carbon sinks account for the bulk of carbon sequestered at lower carbon prices, whereas land conversion to forests or to biofuels production becomes more prevalent as carbon prices rise.

For example, USDA looked at the effect of a range of carbon prices on carbon sequestration practices over a 15-year period and estimated that—at $10 to $125 per metric ton of carbon—farmers will sequester up to 160 million metric tons of carbon per year (or up to 8 percent of U.S. emissions in 2001).[22] The USDA results suggest that carbon sequestration in soils would dominate at lower carbon prices (i.e., $10 per metric ton of carbon), but land conversion to forests would begin to dominate at higher prices (i.e., $25 per ton).

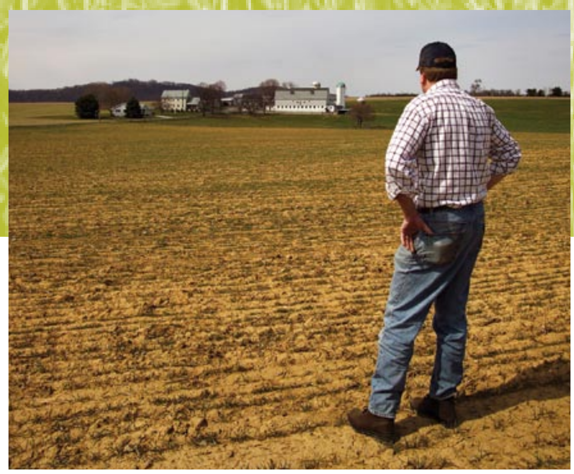
EPA, in a similar analysis, estimated that 40–270 million metric tons of carbon (or up to 14 percent of U.S. emissions in 2001) would be sequestered per year at carbon prices ranging from $20 to $110 per metric ton. Again, converting agricultural lands to forest became the most important sequestration option at higher carbon prices, while soil carbon sequestration was the sequestration practice of choice at lower prices.

[21] Stavins, R.N. and Richards, K.R., 2005, The Cost of U.S. Forest-based Carbon Sequestration, The Pew Center on Global Climate Change.
[22] Lewandrowski, J., et. al, *Economics of Sequestering Carbon in the U.S. Agricultural Sector,* USDA Economic Research Service, April 2004.

The Treatment of AGRICULTURE in Existing GHG Cap-and-Trade Programs



Globally, the role of **agriculture- and forestry-based biological sinks** *as important elements of a comprehensive* **GHG-reduction strategy** *has long been recognized. Because biological GHG reductions raise special issues related to* **monitoring**, **verification**, *and* **permanence**, *however, progress toward recognizing and crediting these types of measures in the context of mandatory GHG-reduction programs has been slow. Fortunately, efforts to* **devise appropriate policies** *for integrating biological sinks in broader emissions-reduction policies have recently begun to* **gain traction**.



The United Nations' Intergovernmental Panel on Climate Change (IPCC) issued a special report on terrestrial carbon sinks in 2000.[23] The report affirmed the potential of terrestrial carbon sinks and identified some of the unique definitional and accounting issues that need to be addressed to take advantage of that potential. These issues involve questions of measurement and monitoring, demonstrating that sequestration benefits are 'additional' to what would occur absent intervention, and striking the right balance between simplicity and accuracy in monitoring. The Marrakech Accords in 2001 further elucidated issues surrounding the inclusion of biological carbon sinks by describing accounting rules for soil carbon sequestration in croplands, grazing lands, managed forests, and lands subject to re-vegetation.[24]

The Fourth Assessment Report issued by the IPCC in 2007 goes further in identifying agricultural mitigation opportunities as key to reducing global GHG emissions over the short and medium term (that is, until 2030).[25] The report states, in part:

"Agricultural practices collectively can make a significant contribution at low cost to increasing soil carbon sinks, to GHG emission reductions, and by contributing biomass feedstocks for energy use…..A large proportion of the mitigation potential of agriculture (excluding bioenergy) arises from soil carbon sequestration, which has strong synergies with sustainable agriculture and generally reduces vulnerability to climate change."

As has already been noted in this report, the European Union's ETS (Emissions Trading Scheme) was launched in 2004 and is the first mandatory, broad-based GHG trading program of its kind.[26] The EU ETS does not currently allow emissions credits for agricultural or forestry sinks to be recognized or traded within the system.[27] This policy was reemphasized in January 2008, when the European Commission proposed changes to EU ETS for the program's third phase (2012-2020). In a Questions and Answers document that accompanied the proposal, the Commission stated that it would not allow credits from carbon sinks because "doing so could undermine the integrity of the EU ETS…" Nevertheless, the Commission did express support for using proceeds from EU ETS auctions to invest in biological sequestration "both inside and outside the EU…" [28] The EU also is conducting significant research on sinks, in part because of a determination that soil sinks provide an effective means of reducing net GHG emissions, can help countries meet mandatory emissions-reduction targets more flexibly and with lower costs, and also create additional environmental benefits.[29,30]

European countries have undertaken an Integrated Sink Enhancement Assessment (INSEA), with the explicit goal of implementing soil and forestry sink enhancement activities as part of the EU's obligations under the Kyoto Protocol "and beyond." A recent European Commission update on the INSEA states that:

"Sink enhancement measures could not only turn out to be instrumental to attain climate mitigation goals, but could simultaneously become a major driver of how our natural environment is managed."

The Canadian government is also working to establish a country-wide GHG cap-and-trade system, and has acknowledged it will include offset credits for

[23] Intergovernmental Panel on Climate Change, 2000, IPCC Special Report: *Land use, Land-use Change, and Forestry.*
[24] Smith, P. 2004. Soils as carbon sinks – the global context. *Soil Use and Management,* 20: 212-218.

[25] IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds), Cambridge University Press, Cambridge, united Kingdom and New York, NY, USA.
[26] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.
[27] Kyoto Protocol MEMO/03/154 Brussels, 23 July 2003, @ http://europa.eu.int/rapid/pressReleasesAction.do?reference=MEMO/03/154&format=HTML&aged=0&language=en&guiLanguage=en (accessed 5 October 2007).
[28] See European Commission, Questions and Answers on the Commission's proposal to revise the EU Emissions Trading System, Memo/08/35, 23/01/2008, accessed at: http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/35&format=HTML&aged=0&language=EN&guiLanguage=en.
[29] European Commission Joint Research Center, Integrated Sink Enhancement Assessment, 2007, @ www.eusoils.jrc.it/projects/insea/ (accessed 5 October 2007).
[30] Kraxner, F. et al., Integrated Sink Enhancement Assessment (INSEA): Main Achievements and Results, International Institute for Applied Systems Analysis, Laxenburg, Austria.

A large proportion of the mitigation potential of agriculture arises from soil carbon sequestration.

agricultural and biological emissions reductions from the start of its system, which is anticipated to take effect in 2008.[31]

In the United States, soil carbon sequestration is recognized within the voluntary Chicago Climate Exchange (CCX). Many states that have developed or are developing GHG reduction plans have acknowledged a potential role for agricultural emissions reductions, but few to date have explicitly opted to reward or provide incentives for soil carbon sequestration. One notable exception is the state of Pennsylvania, which aims to reduce GHG emissions to pre-2000 levels by 2025 (the state completed its *Climate Change Roadmap for Pennsylvania* in 2007). As part of its emissions reduction strategy, Pennsylvania is working to implement government policies and provide grants to promote soil carbon sequestration and climate-friendly animal waste management practices within the agricultural sector.

Other states that are developing climate change plans have explicitly identified the *potential* for agricultural- and/or forestry-based GHG reductions, including soil carbon sequestration (Colorado, Delaware, Massachusetts, Montana, New Mexico, New York, North Carolina, Oregon, and Rhode Island). Some state and regional climate plans have already identified animal manure methane digesters as an accepted means to achieve emissions reductions (California, Kentucky, Missouri), while others have listed this technology among potential mitigation options to be recognized in the future (Arizona, Colorado, Connecticut, Hawaii, Massachusetts, and New York). Other measures that have been identified in the context of state-level climate plans include limiting or avoiding deforestation (California Colorado, Delaware, and Utah), forest management practices, and forest-based carbon sequestration (California, Connecticut, Delaware, Montana, New Hampshire, New Mexico, Rhode Island, and Utah). The Northeast and Mid-Atlantic states' RGGI plan allows offset projects for reforestation and on-farm methane capture, but not for soil carbon sequestration.

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[31] Williams, T., 2005, *Climate Change: Credit Trading and the Kyoto Protocol,* Library of Parliament, Canada, PRB 05-47E.

Designing a

CAP AND TRADE

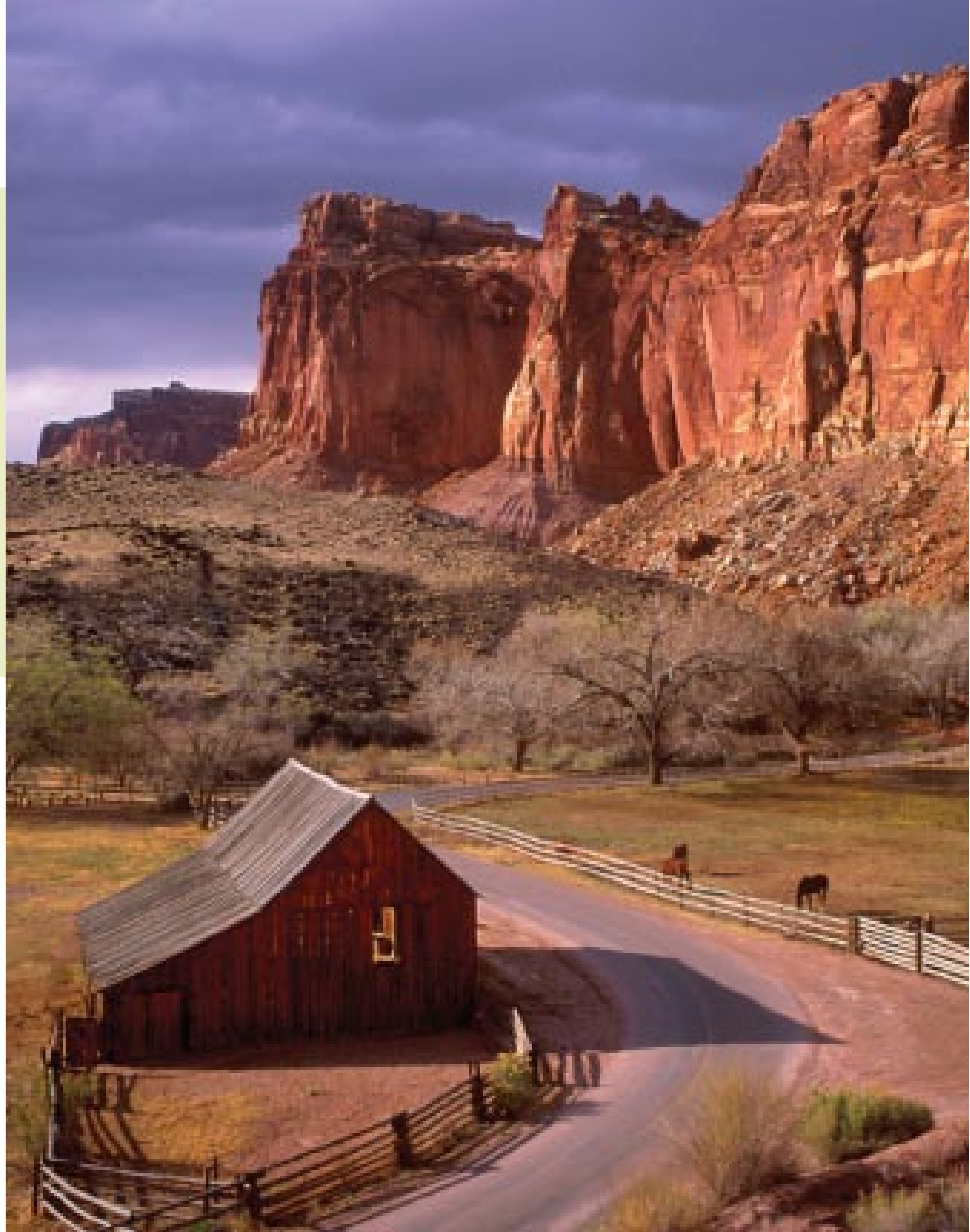
System that Works for American Agriculture

Although **biological carbon sinks** *are known to be an effective and potentially low-cost option for* **removing CO_2 from the atmosphere***, it cannot be assumed that soil sequestration and other emission reduction measures in the agriculture sector—such as* **methane capture** *and* **fertilizer management***— will be recognized or rewarded within a future cap-and-trade program for U.S. GHG emissions. Arguments for excluding such mitigation measures or limiting their use are generally grounded in concerns about overall program integrity.*

Specifically, some environmental groups and other stakeholders question whether it is possible to ensure the permanence and 'additionality'[32] of GHG emissions reductions achieved by soil carbon sequestration. The question is less whether reliably tracking and verifying emissions reductions is technically possible, but rather whether an acceptable level of certainty can be achieved at reasonable cost and without too much administrative complexity.

Significant thought has already gone into many of these issues and a number of creative policy responses have been suggested. As discussed below, we are confident that the issues associated with biological carbon sinks can be successfully managed while at the same time assuring overall program integrity and maintaining reasonable administrative requirements. Options toward that objective are worth exploring in some detail, because a well-designed program that recognizes soil carbon sequestration and other agriculture- and forestry-based GHG reduction measures can make it possible to tap significant, low-cost mitigation opportunities with commensurate benefits—not only for the nation's agricultural producers, but for the environment and for the broader economy as a whole.

[32] The term 'additionality' refers to the need to demonstrate that the emissions reductions or carbon sequestration achieved are additional to what would have happened anyway—that is, additional to any emissions reductions or carbon sequestration that would have occurred even in the absence of the project or activity being credited. Along with measurement, accuracy, and permanence, 'additionality' is traditionally among the criteria applied to offset credits in the context of a trading program.



Although economists and scientists have identified soil carbon sequestration as a near-term, high-value, cost-effective means of offsetting GHG emissions, there are issues unique to soil carbon sinks that will require unique policy solutions. For instance, soil carbon sinks cannot be considered permanent. Changes in the practices or activities that enhance such sinks can lead to soil carbon losses, as can natural factors such as weather or pests.

Thus, policies designed to recognize soil carbon sequestration and other types of agriculture-based mitigation options in the context of a broader cap–and-trade system will have to address issues of measurement, verification, and permanence in a way that maintains confidence in the overall integrity of the program, without creating undue administrative burdens or barriers to participation.

- **Measurement, monitoring, and verification.** Highly accurate technologies and techniques exist for measuring soil carbon content, but these methods can be expensive, invasive, and time-consuming (e.g. collecting soil samples from multiple points in a field and sending them for laboratory analysis). Sequestration benefits can also be estimated using scientific models, but the results are subject to greater uncertainty—potentially compromising the market value of associated credits or causing such credits to be issued only on a discounted basis. A cost-effective, yet accurate system of measuring and verifying soil carbon sequestration for market-based trading could combine estimates generated using a science-based model with results from random direct soil sampling. Alternatively, less-expensive in-situ technologies for measuring soil carbon may be utilized in a random sampling scheme, perhaps also linked to a model. Methodologies for estimating emissions reductions from agricultural sequestration have been developed and are available from a number of sources. The recently-released Duke Standard, for example, provides guidance on issues of measurement, monitoring, and verification.[33]

[33] Willey, Z. and Chameides, B. (eds.), 2007, Harnessing Farms and Forests in the Low-Carbon Economy: How to Create, Measure, and Verify Greenhouse Gas Offsets, Nicholas Institute for Environmental Policy Solutions, Duke University Press.

- **Defining a baseline.** GHG reduction benefits have to be estimated relative to a baseline or 'starting point.' The choice of a baseline will have an important effect on the amount of credit available for a given sequestration project. For agriculture, as for some other sectors, a baseline can be both *temporal*, in the sense that it establishes a date certain after which qualified emissions reductions are credited; and *geographic,* in the sense that it defines the boundaries within which emissions reduction or carbon storage will be "counted" or valued (e.g., a field).

  For example: A federal policy might state that all soil carbon sequestered after 2010 will qualify to receive carbon credits. To receive credit, agricultural producers would have to have a measurement or estimate of soil carbon content in 2010 (or at some later baseline date, if they are seeking credit for activities that begin after 2010) for the field or land parcel in question. Future credits would be based on the amount of additional soil carbon that accumulates after the established baseline date.

- **Demonstrating additionality.** As noted previously, it is generally accepted that a project or activity should receive credit in the context of a GHG cap-and-trade system only to the extent that it generates benefits *additional* to what would have occurred absent the project or activity. Rules or guidelines will need to be developed for demonstrating additionality for many agricultural offset projects. Such rules or guidelines could, for example, require that any emissions benefits that would have occurred due to a pre-existing law or regulation be *subtracted* from credited tons. This is referred to as regulatory additionality.[34]

  For example: A strict additionality provision might state that any GHG reductions attributed to a practice or activity prior to a date certain (e.g., the date the policy takes effect) do not qualify to receive credit, because the actions preceded the established policy, and thus do not represent additional reductions.

Other definitions of additionality have been proposed in the context of agricultural emissions reductions and soil carbon sequestration. For instance, if mitigation measures are common practice in a given geographic area or are deemed to represent "business as usual" in that area, they may not be considered as additional. In cases where practices like no-till farming have been going on for many years prior to the inception of a cap and trade program and are expected to continue in the future absent a specific carbon sequestration payment, it may make sense to reward them only with allowances taken from within the cap, so that there is awarding such carbon credits could never be construed as undermining the integrity of the cap.

- **Defining Permanence.** Biological sequestration is reversible and hence by nature not necessarily permanent: altering or abandoning a practice undertaken to enhance sequestration in agricultural soils or forests can result in the release of some or all of the stored carbon. Natural disturbances (e.g., fires, pests) can also lead to the release of stored carbon. The fact that benefits associated with a given project or activity may be temporary can be dealt with in part by establishing expiration dates on soil carbon credits, or by requiring re-verification of credits at established intervals, e.g., every 5 years. The government agencies charged with implementing a future program should be able to develop reasonable policies for managing risks and uncertainties related to the issue of permanence in ways that are workable and adequately address the concerns of affected stakeholders.

[34] Argus Air Daily, August 24, 2007, Offset standards compete to fill fed void, Vol. 14, No. 164, pp. 7-9.

- **Addressing the Potential for Leakage.** The term 'leakage' refers to the possibility that biological sequestration measures undertaken in one area may lead to increased GHG emissions elsewhere. For example, credit may be claimed for re-foresting an area of cleared land but if overall demand for land remains the same, the result may be that an equal area of existing forest is cleared somewhere else. Similarly, if a landowner reduces harvests in one forest stand to enhance carbon sequestration for credits, but harvests increase in another forest stand (since market demand for lumber is unchanged), "leakage" has occurred, thus limiting or negating the net sequestration impact.

> *Contractual issues with respect to ownership of the soil carbon credit should be resolved prior to the sale of the credits.*

- **Ownership/legal Issues.** Since biological sinks reside within the land resource, and land ownership or management may change over time, contractual issues with respect to ownership of the soil carbon credit should be resolved prior to the sale of the credits. These issues can be decided within the underlying policy or resolved contractually on a case-by-case basis between the buyers and sellers of credits.

  For example: If an agricultural producer receives payment for soil carbon sequestered on his/her land but then sells the land before the credit period is over, and the new owner tills that land, who is liable for the lost carbon—the buyer or the seller? A contract or policy should establish ownership of (and liability for the loss of) carbon credits before the sale occurs.

Rewarding Agricultural Soil Carbon Sequestration in a GHG Cap-and-Trade Program:

As discussed in previous sections of this report, a mandatory policy for limiting U.S. GHG emissions is likely to take the form of a cap-and-trade program that regulates upstream producers or distributors of fossil fuels and large mid-stream energy users (such as electric utilities, major industrial facilities, etc.). In such a scheme, agricultural producers would not be directly regulated—that is, they would not be required to surrender permits or allowances to cover their GHG emissions. Within the agriculture sector, energy-related emissions—such as emissions from the on-farm use of gasoline, diesel, heating oil, natural gas, and electricity—would be covered in the same way that they would be for all other sectors of the economy. Specifically, prices for different forms of energy and other inputs would rise commensurate with their embedded carbon content and farmers and ranchers, like all other energy end-users, would face new incentives to reduce consumption or switch to lower-carbon alternatives to reduce their exposure to these costs. Prices would also rise for other farm inputs, such as pesticides or fertilizers—particularly if they are energy-intensive or carbon-intensive. Again, higher prices will create incentives to reduce or substitute for these inputs.

Non-energy-related agricultural emissions, however—such as nitrous oxide emissions from fertilizer use and methane emissions from livestock—are unlikely to be covered by a nationwide cap-and-trade program. Nor would such a program, without additional provisions, deliver incentives for soil- and forestry-based carbon sequestration. If these potentially significant, relatively low-cost mitigation options are to be recognized and rewarded under a cap-and-trade system, additional provisions will need to be adopted. Several different approaches are possible. One is to allow agriculture emissions not covered under the cap, along with emissions reductions from soil carbon sequestration, to qualify for offset credits. Such credits could be used to offset regulated entities' allowance obligations. For example, a firm with 100 tons of emissions could meet its compliance obligation with 50 tons of program allowances and 50 tons of offset credits. An alternative is to "set aside" a certain quantity of allowances at the outset to be used to reward agricultural sequestration and other qualifying emissions reductions from sources not otherwise covered under the cap-and-trade program (these allowances would be, in effect, subtracted from the portion of allowances distributed for free or auctioned under the cap, and thus lower the actual level of emissions allowed under the program). These approaches differ in their implications for overall cost, for program flexibility and relative burden on regulated sources, and for managing the uncertainties inherent in many agriculture-based mitigation options, especially those that involve biological carbon sinks. A third, hybrid approach is also possible, in which both offset credits and a pool of set-aside allowances are available to qualified agriculture-based mitigation options. Each of the three approaches is described below.

Rewarding Soil Carbon Sequestration and Other Agriculture-Based Mitigation Options with Offset Credits:

As the term implies, offset credits can be used to offset the allowance obligations of regulated entities within a GHG cap-and-trade program. Offset credits represent emissions reductions, and are generated only after a measurable, verified emission reduction is achieved. Offset credits can be generated in addition to allowance credits in a cap-and-trade program. Their use would require emissions reductions to be achieved by uncapped sectors, such as agriculture, in exchange for the right of capped sectors, such as coal-fired power plants, to emit an equivalent amount of GHG above the cap. This allows sources covered under the trading program to emit GHGs at levels above the cap limit, because they offset those additional emissions by purchasing credits generated by entities such as farmers engaged in carbon sequestration. *The result is that*

the net impact on GHG levels in the atmosphere is the same as in the case where the cap is enforced without any provisions for offset credits.

Besides capturing emissions reductions from uncapped sources, the value of offset credits is that they reduce the costs of compliance for capped sectors. Under the offsets credits approach, agricultural offset credits would be technically equivalent to, and freely interchangeable with, emissions reductions from regulated sectors or sources. To the extent that carbon sequestration and other agriculture-based emission reductions prove cheaper to implement than emissions reductions elsewhere in the economy, the availability of offset credits for these activities would expand the pool of low-cost compliance options available to capped sectors. And, in turn, all sectors of the economy would benefit from lower allowance prices, improved liquidity in allowance markets, and increased compliance flexibility. Moreover, these benefits would be especially valuable in the early years of program implementation, when changes in energy infrastructure, capital stock turnover, and long-term investment patterns are just beginning to take hold.

In sum, a well-designed offsets program can deliver significant benefits for agricultural producers, the environment, and other market participants, as well as the broader economy. To maximize these benefits, however, it is critical that regulators, the public, markets and buyers all have confidence in the value of offset credits. This can be achieved by developing and implementing policies that take into account the unique features of biological carbon sinks, and that reflect the uncertainties inherent in these sinks. To provide this confidence, standardized, certified measurement and verification protocols need to be developed to address the unique issues associated with some agricultural GHG mitigation options (such as soil carbon sequestration and forest sequestration). Under this system, agricultural offset credits will likely be subjected to fairly rigorous measurement and verification standards in order to capture full market value, or credit. The underlying policy would need to address issues such as additionality and permanence so that buyers of offset credits are assured that they are getting the GHG reductions they pay for and regulators have confidence that the annual greenhouse gas emissions reduction goals are being met. By the same token, agricultural producers will need assurance that the GHG reductions from carbon sequestration and other mitigation activities they undertake will be fully recognized in the market. If farmers and ranchers face uncertainty about how or whether their emissions reductions will be valued, their response to the policy will be muted and the full potential of cost-effective carbon sequestration and other agriculture-based mitigation options will not be realized.

Several cap-and-trade proposals offered to date have addressed these issues. The current Lieberman-Warner proposal, which was introduced in Congress in October 2007 under the title "America's Climate Security Act," allows the use of domestic offset credits to 15 percent of any regulated entity's total compliance obligation in a given year (an additional 15 percent of the obligation can be met using international credits), and incorporates significant provisions to ensure that credits awarded for soil carbon and forestry sequestration emissions reductions are suitably measured, monitored, and verified.

Rewarding Soil Carbon Sequestration and Other Agriculture-Based Mitigation Options via an Allowance Set-Aside: As a complement to offering offset credits, policy makers can provide incentives for agricultural mitigation efforts by "setting aside" a portion of the total allowances available under the proposed emissions cap. This approach reduces the number of allowances that would otherwise be auctioned or distributed for free to capped sectors, and instead dedicates those allowances to agriculture for eligible projects that reduce GHG emissions. Presumably any allowances set aside for the agriculture sector would be transferred to an intermediary authority with relevant expertise, such as USDA, which would be responsible for determining the carbon value of soil sequestration and other GHG-reduction projects and awarding allowances to farmers based on those determinations. Agricultural producers who were awarded allowances could sell them on the open allowance market. Because allowances would have concrete monetary value in these markets, their distribution to agricultural producers would effectively encourage their undertaking eligible mitigation measures, provided the underlying policy would reward those mitigation measures adequately.

The crucial difference between offsets and allowance set-asides is illustrated in Figure 3, which shows that whereas offset credits are additional to the cap, set-aside allowances are taken from under the cap, and in effect, represent a redundant set of reductions. In other words, total emissions from regulated sources do not rise above the cap level under the set-aside approach. As a result, reductions obtained using soil carbon sequestration or other agriculture- and forestry-based mitigation measures would have the effect of reducing net emissions *below* the cap.

{ A well-designed offsets program can deliver significant benefits for agricultural producers, the environment, and other market participants. }

The advantage of this approach is that it would allow for a less rigorous demonstration of emissions reductions: while applicants for a share of the set-aside pool would still need to document emissions reductions commensurate with the quantity of allowances they wish to claim, there would be less pressure to precisely measure these reductions. Likewise, reliance on allowance set-asides rather than offset credits could allow for a less rigorous approach to issues like additionality and permanence. This is because allowances made available from within the cap can provide effective incentives for mitigation activities in uncapped sectors. In cases where farmers choose to obtain "allowance credits", rather than "offset credits," net greenhouse gas emissions allowed under the program actually will be below the annual cap. Put another way, because agricultural emissions reductions credited with "allowance credits" do not *offset* industrial emissions increases, but rather *supplement reductions* achieved

Both offset credits and allowance set-asides can provide effective incentives for soil carbon sequestration.

by industries, greenhouse gas emissions benefits from the program are greater overall. As a result, there is less pressure to ensure that greenhouse gas reductions achieved through soil carbon sequestration are vigorously measured. This approach is ideal for projects in which farmers engaged in no-till farming prior to the inception of a cap and trade program (i.e., prior to the baseline), which might not meet a strict additionality requirement in the cap-and-trade policy. Even if these emissions reductions are not strictly "additional," awarding them allowances will: 1) lock in the practice to ensure retention of past emissions reductions, and continuance of the practice for continued future reductions; and 2) ensures that the cap is not exceeded.

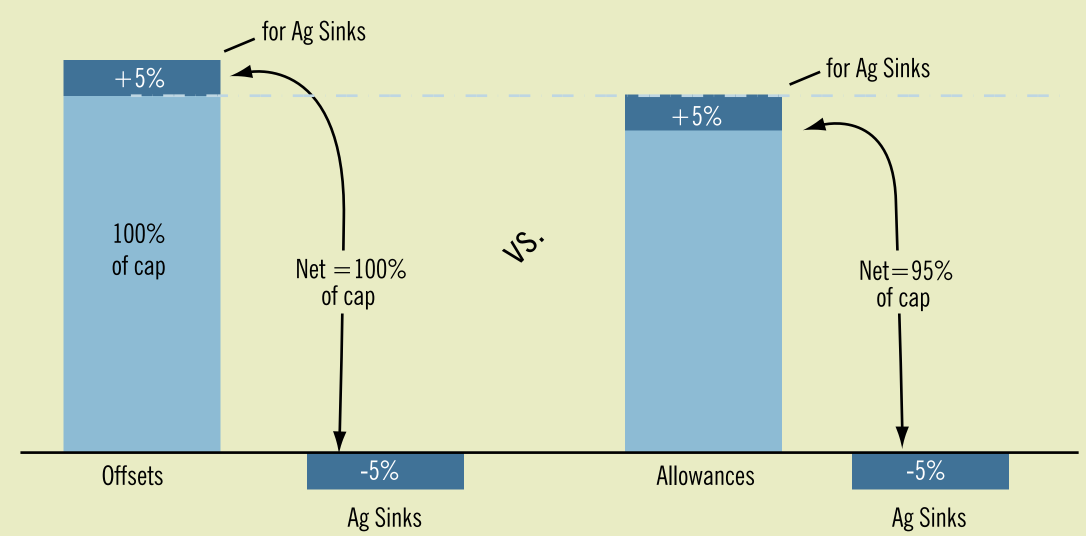
Allowance set-asides differ from offset credits in an important respect: they do not reduce the energy price impacts or provide economic benefits (i.e. flexibility or market liquidity) to the cap-and-trade program. Offset credits can reduce the cost of allowances by allowing regulated entities to substitute lower-cost emissions reduction options like soil carbon sequestration for other, more costly sources of emissions reductions. Reduced demand for allowances in turn leads to lower allowance prices and smaller price impacts. By contrast, in the case of an allowance set-aside, regulated sources as a group still need to meet the overall program cap. Thus, the market price of allowances will continue to reflect the marginal cost of the last ton of emissions reductions implemented to comply with the cap. Farmers who hold set-aside allowances because they undertake soil sequestration or other mitigation activities will sell their allowances at the prevailing market price. Thus, there would be no reduction in expected program costs or energy price impacts to the economy. This does not mean nothing is gained by awarding set-aside allowances—on the contrary, emissions reductions gained via this approach will achieve additional environmental mitigation for the same program cost.

Because an allowance set-aside would not reduce compliance costs, regulated industries are likely to be less supportive of this approach than they are of offset credits. More importantly, industries with a strong stake in the design of a federal GHG program might oppose set-asides—or at least seek to limit their scope—on the presumption that any quantity of allowances reserved for distribution to agriculture or for any other purposes would diminish the quantity of allowances that remain available for regulated entities. This concern reflects the fact that the economic effects of a set-aside program are primarily distributional. Because the pool of allowances is finite and has monetary value, setting some of it aside amounts to a transfer of funds from regulated entities—which will have to purchase any allowances they are not given for free—to uncapped sectors.

The figure below compares the offsets approach to the allowance set-aside approach, assuming (for illustrative purposes), that the total emissions cap in the cap-and-trade system is 100,000 tons of CO_2, and that the total pool of offset credits or set-aside allowances available for the agricultural sector is equivalent to 5,000 tons of CO_2.

The table below provides a side-by-side comparison of some aspects of these two options—offsets and allowance set-asides—for rewarding soil carbon sequestration in the context of a GHG cap-and-trade program.

NET GHG REDUCTIONS FROM USE OF OFFSETS VERSUS ALLOWANCES



A side-by-side depiction of an "offsets" system and an "allowance set-aside" system and the role of agricultural soil sinks within those systems, as described in this report. Note that the "offsets" system is neutral to the cap; and the "set-aside" system reduces the cap.

The first box defines those outcomes or impacts that are the same regardless of the approach used; and the second describes those impacts that are or may be different, including costs to society, costs to capped or regulated sectors, impact on net emissions, and risk (in terms of certainty about achieving intended emissions goals).

In sum, both offset credits and allowance set-asides can provide effective incentives for soil carbon sequestration and other agriculture-based GHG mitigation measures. Moreover, incorporating both of these approaches in a broad-based emissions trading program could generate substantial new income opportunities for American farmers and ranchers. Offsets have the advantage that they reduce allowance costs and energy price impacts and thus are likely to win greater support from other industry stakeholders. The chief disadvantage of an offsets mechanism is that it raises the stakes for accurate measurement and verification of agricultural reductions, and potentially necessitates additional provisions to address concerns about permanence and additionality, especially in the case of soil- or forest-based sequestration projects. Allowance set-asides, by contrast, do not reduce compliance costs for regulated sectors or lessen energy price impacts and may therefore garner significantly less support (or may even face opposition) from other industry stakeholders. On the other hand, the use of set-asides is likely to be compatible with a less demanding approach to measurement and verification and can produce emissions reductions additional to those achieved by the cap-and-trade program alone by lowering the actual cap. In light of these considerations, the most promising approach may involve a hybrid policy that *combines* offsets and set-asides to maximize the economic and environmental benefits that can be achieved by promoting a vigorous role for the agriculture sector in securing early GHG reductions.

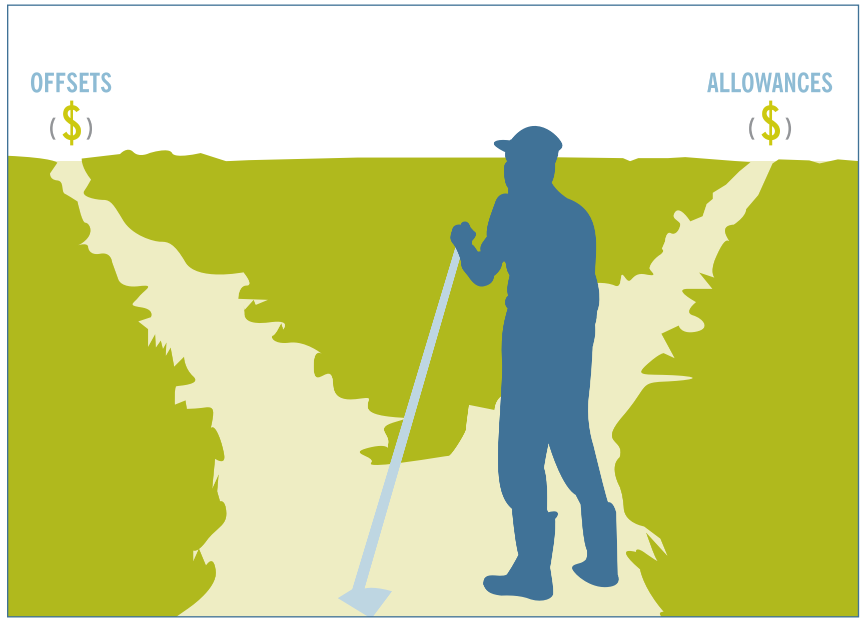
A Hybrid Approach:

The most prominent cap-and-trade proposal currently before Congress—the so-called Lieberman-Warner

OFFSETS VS. ALLOWANCE: WHAT IS DIFFERENT?

	Offsets	Allowance
Cost reduction for regulated entities?	Yes	No
Net emissions impact	Neutral	Positive
Emissions risk from measurement uncertainty, non-additionality or non-permanence?	Yes	No
Discount of market value to reflect risks?	Likely	Not Likely
More scrutiny?	Likely	Not Likely

bill—adopts a hybrid approach to reward soil carbon sequestration and other agriculture-based GHG mitigation measures. First, as already noted, covered entities under the program may meet as much as 15 percent of their compliance obligation through the use of domestic offsets, which would include offsets for soil carbon sequestration and for emissions reductions from sectors or sources, including agricultural sources, that are not otherwise covered by the cap-and-trade program. Responsibility for certifying offsets is given to EPA, which must apply standards and procedures spelled out in Subtitle D of the proposed legislation to ensure that offsets are granted only for activities that are verified, monitored, permanent, enforced, and additional. In addition, the Lieberman-Warner proposal sets aside 5 percent of each year's allowance pool specifically to reward farmers and foresters that adopt practices to increase the storage of carbon in soils or plants. USDA is charged with developing regulations to manage the distribution of set-aside allowances under this provision. Members of the agricultural community could determine which program (offsets or set-aside) they would like to participate in, but the legislation explicitly prohibits double-counting; that is, the same activity cannot *both* be certified as an offset *and* receive allowances.



For the reasons discussed in previous sections, it is reasonable to expect that the requirements for receiving allowances would be less rigorous than those applicable to offsets—perhaps making the former option more attractive to some producers who would prefer a 'streamlined' crediting process. In addition, allowances may be especially well suited to rewarding early actors in the agriculture sector for emissions reductions activities adopted prior to implementation of the mandatory policy. The rationale here is that it would be difficult to demonstrate "additionality" for these early reductions. At the same time, a compelling argument can be made for rewarding early actors and providing incentives for activities that begin before the actual start date of the cap-and-trade program, which will necessarily lag by some years the adoption of authorizing legislation. An additional benefit of using set-aside allowances for this purpose is that the pool of 'early action' tons would not grow over time, and thus would represent a finite number of credits to be allocated from the set-aside allotment each year. Absent this option, it is unlikely that "early action" tons will receive credits in a mandatory emissions reduction program.

Measuring, Monitoring, and Verifying Soil Carbon SEQUESTRATION and Other Agriculture-Based GHG Mitigation Options

To maximize the contribution of low-cost agriculture-based GHG mitigation options—including, in the near term, soil carbon sequestration and, over the longer term, **methane and nitrous oxide reductions** *from agricultural sources—more precise measurement, monitoring, and* **verification technologies** *are needed. These sources and sinks present unique measurement challenges, to be sure, but the* **challenges are not insurmountable**.

Nitrous oxide emissions from croplands, in particular, must be better understood to identify the most effective means of reducing emissions while simultaneously improving the efficiency and performance of chemical and organic fertilizers and improving farmers' bottom line. Meanwhile, further research to understand the mechanisms that influence methane and nitrous oxide emissions from farm operations, and practices to reduce them, is required. Better technologies for measuring and monitoring emissions of these gases in situ are also being developed. As the body of data on these trace gases grows, and management practices to reduce associated emissions can be better described, additional opportunities for environmental and economic gain—benefiting not only the agriculture sector in particular, but also society as a whole—will emerge.

Given that soil carbon sequestration is likely to play a major role in the early years of a mandatory, national GHG-reduction policy, developing improved and cost-effective methods for measuring and monitoring soil carbon changes is especially urgent; hence the remainder of this section focuses on specific opportunities for advancing the state of the science in this area.

Tools for Direct Measurement of Soil Carbon:

Accurate technologies for measuring soil carbon content are already available, but they are generally expensive, time-consuming, and invasive (i.e., they require numerous field measurements). Moreover, using these technologies may not be cost-effective in that the costs to measure and verify the results of a given project may exceed the market value of associated credits or allowances, especially at low carbon prices. Wide-scale utilization of direct carbon measurement technologies would also require an infrastructure to sample, transport, and test soil samples for market verification and trading.

Other technologies are commercially available now that provide less expensive, rapid, in-situ measures of soil carbon at the field and farm scale, but they are less accurate than direct measures of soil carbon content. If these methods have significant error rates, the market value of carbon credits measured using these methods might be discounted accordingly in future GHG markets.

Tools for Modeling Soil Carbon:

As an alternative or complement to direct measurement, models provide a good tool for estimating the carbon content of soils. At present the U.S. government utilizes the CENTURY model (Century Ecosystem Soil Organic Matter Computer Model) to estimate and report its national soil carbon inventory on an annual basis. The CENTURY model is a land-based ecosystem model that simulates nutrient dynamics, including carbon and nitrogen uptake, on cropland, grasslands, forest, and savanna ecosystems, as well as the effect of land-use changes between these different systems.[35] It was collaboratively developed by Colorado State University (CSU) and the Agricultural Research Service of USDA.

A hybrid measurement approach that links science-based models with direct soil carbon measurement could help to close the gap that currently exists between practical and affordable direct measurement techniques and the needs of a crediting system that requires reasonably accurate and reliable estimates of the soil carbon impacts associated with specific projects or activities. While the CENTURY model was not developed to measure soil carbon changes at the field or farm level, it could be linked to real-time, direct measurements across a representative range of the U.S. landscapes in such a manner that it could provide robust estimates of soil carbon changes at the field and farm scale for market-based applications (such as a cap-and-trade policy.) CSU, which houses and maintains the CENTURY model, has tested this hybrid application. Together, the Natural Resources Conservation Service (NRCS) of USDA and CSU have devised a scientifically-based random soil sampling scheme that would take approximately 5,000 direct soil samples across the continental United States every five years (approximately 1,000 samples per year, in a 5-year rotation) and link data from those samples to the CENTURY model. Over time, these data would significantly enhance the robustness of the CENTURY model for estimating soil carbon and changes in soil carbon across the nation. Funding to institute this system permanently would not only add to the public database of information on U.S. soil carbon and soil quality, but would also help prepare the agriculture sector to participate in future carbon markets.

The Consortium for Soil Carbon Sequestration and Greenhouse Gas Mitigation (CASMGS):

This Consortium was established by Congress in 2000 to advance scientific understanding of soil carbon sequestration and its potential application as a GHG mitigation option. It brings together scientific expertise from U.S. land-grant universities and the national laboratories administered by the U.S. Department of

[35] Natural Resources Ecology Laboratory, Colorado State University, CENTURY Model, http://www.nrel.colostate.edu/projects/century/ (accessed 2-21-2008)

Energy (DOE). The Consortium has concentrated on five research tasks since its formation:

- documenting the science behind soil carbon sinks
- defining best agricultural management practices to enhance soil sinks
- predicting and assessing GHG flux from soils, and methods to increase net GHG reductions
- measurement, monitoring and verification technologies for soil carbon
- outreach and educational programs for the agricultural sector

{ Accurate technologies for measuring soil carbon content are already available, but they are generally expensive, time-consuming, and invasive. }

Work by the Consortium over the last several years has bolstered the scientific basis for using soil carbon sequestration as a GHG mitigation option. In particular, it has helped develop the tools and knowledge base for measuring and verifying changes in soil carbon content. The Consortium collaborates and consults with federal agencies, including USDA, EPA, and DOE, and with other parties in the agriculture sector, industry, non-governmental organizations, and state agencies. It also collaborates with the U.S. Department of State in international outreach and exchange efforts, including with countries like Argentina, Australia, Brazil, Canada, Mexico, and New Zealand.

During 2007, the Consortium increased the scope of its efforts by expanding its range of collaborators to include additional university and laboratory partners in a position to add critical expertise. Its continued efforts will be critical as the United States moves closer to enacting federal GHG-reduction policies that can take advantage of the mitigation opportunities available from the agriculture sector. Both the House and the Senate versions of the 2007 Farm Bill have identified reauthorization of the Consortium as a priority policy objective; funding for its continued work will also be necessary, and is recommended.

The Need for Standardized Soil Carbon Measurement Protocols:

The agriculture sector's ability to participate in future GHG markets would be substantially enhanced if USDA collaborated with CASMGS to establish a suite of certified, standardized protocols for use by agricultural producers for soil carbon measurement, monitoring, and verification. Such protocols would lend transparency and credibility to agricultural producers' ability to create robust, verified offset credits or set-aside allowances and provide assurances to both sellers and buyers about the degree of accuracy reflected in a particular measurement protocol.

USDA could establish a single standardized protocol or multiple protocols with different, but explicitly stated levels of accuracy. Such protocols could be updated regularly or as the science dictates to ensure that the most accurate technologies and methodologies available are being utilized and that agricultural producers are awarded the maximum credit for their efforts. In the case of multiple protocols with varying degrees of accuracy, agricultural producers could decide themselves which protocol to utilize, knowing in advance how the market would value credits issued with different levels of certification (for example, the market might apply a standard discount to credits issued using a measurement protocol with a higher degree of uncertainty). To help agricultural producers prepare for the GHG markets that are likely to emerge in the next several years, certified, standardized measurement and verification protocols should be established within the next two years, if possible, but certainly prior to the emergence of a mandatory national market and active GHG trading.

Policy RECOMMENDATIONS

Recommendation #1: U.S. farmers and ranchers should have the opportunity to participate in a national cap-and-trade program for GHG emissions. The world scientific community has warned that action to reduce global GHG emissions must begin soon if some of the most serious consequences of global warming are to be avoided. In its Fourth Assessment Report, issued in 2007, the IPCC states that "mitigation efforts and investments over the next two to three decades will have a large impact on opportunities to achieve lower stabilisation levels." At the same time, the IPPC warns that "[d]elayed emission reductions significantly constrain the opportunities to achieve lower stabilisation levels and increase the risk of more severe climate change impacts" (IPPC, 2007). The agriculture sector offers a range of opportunities to achieve significant, near-term, low-cost mitigation. Any mandatory GHG cap-and-trade program adopted by the United States over the next several years should be designed to maximize these opportunities by explicitly rewarding and encouraging soil carbon sequestration along with other cost-effective GHG-reduction measures from agricultural emissions sources not otherwise covered by the cap.

Recommendation #2: Within a cap-and-trade program, the agriculture sector should be fully rewarded for all verifiable GHG emission reductions. Provided projects can meet robust standards of measurement and verification (including satisfying applicable criteria with respect to permanence, additionality, enforceability, etc.), policy makers should avoid placing artificial limits on the use of offset credits and other mechanisms designed to recognize and reward agriculture-based mitigation efforts. Such efforts can yield significant benefits for the economy and for the environment, making it possible to meet emissions reductions goals at the lowest possible cost and as expeditiously as possible. Concerns about program integrity can be addressed in the policy construct, and can achieve the requisite certainty regarding biological emissions reductions of GHG without erecting unnecessary barriers to full participation by the agriculture sector.

Policy Recommendation #3: As in other sectors of the economy, energy-related GHG emissions from the agriculture sector should be regulated upstream, at the fuel supplier or distributor, electric utility, or large industrial facility. Other, non-energy GHG emissions from farm and ranch operations are generally too small and diffuse to lend themselves to direct regulation under a broad-based cap-and-trade system. Well-designed offset credit and allowance set-aside provisions can deliver effective incentives for tapping promising mitigation opportunities in the agriculture sector. Because the cost and administrative difficulty of regulating millions of small emissions sources would be prohibitive, no GHG cap-and-trade program proposed to date would directly regulate small energy end-users, including farmers and ranchers or individuals, households, or most businesses (with the possible exception of large industrial facilities). The current Lieberman-Warner draft legislation is typical in that it proposes to regulate only entities that emit CO_2 at a rate of 10,000 tons per year or more. According to the authors of one study on this issue, "thresholds below 10,000 Mg (tons of CO_2 equivalents) per year may bring in relatively large numbers of facilities while minimally increasing the percentage of reported (or, for our purposes, regulated) emissions."[36] The same study found that nearly 20,000 farm operations in the United States are estimated to produce more than 1,000 tons of CO_2-equivalent emissions annually, but none meet or exceed the 10,000 ton threshold. Regulating large upstream energy suppliers and users will effectively capture the great majority of GHG emissions and deliver consistent incentives for reducing emissions throughout the

{ *The agriculture sector offers a range of opportunities to achieve significant, near-term, low-cost mitigation.* }

[36] West, T.O., and Pena, N. 2003, Determining Thresholds for mandatory Reporting of Greenhouse Gas Emissions, *Environmental Science and Technology*, Vol. 37, No. 6: 1057-1060.

economy. Higher prices for energy to reflect the cost of GHG regulations will prompt all energy users, including agricultural producers, to reduce their energy consumption and switch to lower carbon alternatives.

Policy Recommendation #4: **A cap-and-trade program that provides for both offset credits and set-aside allowances will give agricultural producers the flexibility to choose different levels of rigor in documenting emissions benefits and will help to deliver maximum economic and environmental benefits from low-cost mitigation opportunities in the agriculture sector.** Offset credits should be available for agriculture-based mitigation projects—including soil carbon sequestration projects—that can meet rigorous standards for assuring measurement, additionality, and permanence. Set-aside allowances taken from under the cap provide a particularly effective mechanism for rewarding projects that provide important carbon benefits, but that may have more difficulty meeting these tests, such as no-till practices undertaken before the cap-and-trade program goes into effect (so-called 'early action' projects). A hybrid approach can respond effectively to the twin imperatives of (a) ensuring overall program integrity and (b) allowing for maximum participation by the agricultural sector.

Policy Recommendation #5: **USDA, in collaboration with state and national agricultural producer organizations and the Consortium for Agricultural Soils Mitigation of Greenhouse Gases (CASMGS), should develop standardized protocols for measuring, monitoring and verifying soil carbon changes that can be utilized by agricultural producers to facilitate their participation in carbon markets.** Prior to the implementation of a mandatory federal cap-and-trade program for GHG emissions, USDA should collaborate with CASMGS (which has a critical mass of expertise, scientific data, and experience with this issue) to establish standardized protocols for measuring and monitoring soil carbon for credit in GHG markets. Optimally, farmers or aggregators should be able to choose from a suite of standardized protocols that offer varying levels of cost and accuracy (since the trade-off for more accurate measurement technologies tends to be higher cost).

Each standardized protocol should, at a minimum, describe the pros and cons of the measurement methodology in question, as well as the minimum criteria to be applied when certifying carbon credits according to that standard, the costs involved, the relative availability and accessibility of the technology or instrument being used, the estimated time investment required to implement the protocol, and the degree of accuracy associated with resulting measurement estimates , including, if appropriate, the associated discount rate that would be applied to credits based on those estimates. That way every agricultural producer, aggregator, or third party verifier knows the rules, options, criteria, costs, and benefits associated with different measurement protocols, up front, before determining which methodology to utilize. USDA should revise and update the standardized protocols on a regular basis, or as improvements in the science or in measurement technologies warrant.

Finally, USDA should establish appropriate standardized protocols and certification criteria for the suite of additional activities—besides soil carbon sequestration—that could generate emissions reductions credits from the agriculture sector. Examples include activities that generate methane and nitrous oxides reductions, as well as GHG benefits from biofuels production and other options. All of these standards should be developed as far as possible in advance of carbon markets so that the agriculture sector can be optimally prepared to participate in those markets once they are established.

Policy Recommendation #6: **Standardized, certified protocols and methodologies to measure and verify soil carbon sinks should be clear, transparent, and practical in order to maximize the market's acceptance of and ability to value soil sink projects, while also maximizing agricultural producers' participation in carbon markets, and the resulting benefits to society.** Substantial research and thinking has already been invested in understanding the potential for biological carbon sequestration and in devising practical policy responses to concerns about additionality, measurement, monitoring, permanence, leakage, and verification. The

Rewarding emissions reductions from the domestic agricultural sector will enhance economic opportunities for U.S. farmers.

agricultural (and forestry) sector clearly presents some unique issues such that standardized methodologies for measuring GHG benefits in other sectors—for example, defining a 'business-as-usual' baseline against which to measure emissions—may not apply. Work by organizations such as the Consortium for Agricultural Soils Mitigation of Greenhouse Gases and Duke University's Nicholas Institute for Environmental Policy Solutions can be invaluable as government agencies such as USDA seek to develop guidelines and protocols for documenting and recognizing carbon sequestration benefits from agriculture- and forestry-based projects.

Policy Recommendation #7: **Additional provisions may be necessary to address the issue of permanence for biological (soil- or forestry-based) carbon sinks and to assure overall program integrity in the event that future actions or natural events cause unanticipated carbon losses.** For example, a future program may establish expiration dates on soil carbon credits and/or require re-verification of credits at established intervals (e.g., every 5 years. The government agencies charged with administering these programs will need to develop clear rules and guidelines for managing project risks and associated liability issues, especially

with respect to the trade and use of offset credits (for reasons discussed in the main text, the problem of permanence is somewhat less concerning in the case of allowance set-asides). In doing so, it will be important to strive for a balance between assuring program integrity and avoiding administrative requirements that are so burdensome they hinder the deployment of cost-effective carbon sequestration options.

Policy Recommendation #8: **Projects begun prior to the initiation of a nationwide cap and trade program *at a minimum* should receive credit for all greenhouse gas benefits achieved beginning on the date of the implementation of the program.** For example, if a farmer undertakes no-till practices prior to the implementation of the program, he or she should still receive credit for carbon sequestration or emissions reductions achieved after implementation of a new cap-and-trade program. Reward for such practices should be limited to allowance credits, since questions may be raised about whether they may meet strict tests of additionality. To receive an allowance credit, a farmer would be required to establish the baseline soil carbon content at the start of the program, for a field or fields within specified geographic boundaries, and would receive credit for greenhouse gas benefits achieved.

Policy Recommendation #9: **In addition to rewarding carbon sequestration projects for GHG reductions that occur beginning at the inception of the program, Congress should consider setting aside some allowances to reward early adopters that achieve emissions benefits prior to implementation of a mandatory policy.** Activities and management practices that have resulted in GHG reductions and increased carbon sequestration should be rewarded as early as possible. To that end, provisions aimed at recognizing and rewarding early action should be included in the design of an emissions trading program. Set-aside allowances are especially well-suited for this purpose, and we recommend that practices like no-till farming begun in advance of implementation of a cap and trade program be eligible exclusively for these types of credits. The failure to recognize early reductions could generate perverse incentives to inflate baseline emissions and minimize baseline soil carbon content in advance of a cap-and-trade program taking effect.

Policy Recommendation #10: **All domestic biological carbon offsets should be credited and rewarded prior to rewarding international projects.** Rewarding emissions reductions from the domestic agricultural sector will enhance economic opportunities for U.S. farmers. In addition, it will be easier to assure effective measurement and enforcement for projects located within the country. International projects should only be credited and rewarded to the extent that all qualifying domestic and agricultural emissions reductions activities are first recognized and rewarded.

Policy Recommendation #11: **USDA should establish clear rules to allow any qualified person or organization to act as an aggregator for agriculture-based offset credits or allowances in future GHG markets.** Many early programs have provided valuable learning experience on the question of how aggregators can and should operate in carbon markets on behalf of the agricultural sector. The Chicago Climate Exchange, the Iowa Farm Bureau, the National Farmers Union, and the Pacific Northwest Direct Seed Association are examples of organizations that have already acquired experience as aggregators in established voluntary carbon markets.

Based on this experience, we believe the role of aggregator should be available to any interested party that qualifies, including but not limited to commodity groups, state governments, universities, private carbon trading companies, and other interested parties. Ultimately, agricultural organizations may want to consider joining together to form a single national cooperative aggregation and carbon brokerage service to interact directly with regulated entities. Such an entity could allow agricultural organizations to maximize returns to the farm sector by avoiding the use of non-agricultural brokers and traders.

Policy Recommendation #12: **USDA should provide verification services through its extension agents and should additionally certify private verification services.** This will provide farmers with a choice of using either private or governmental verification services.

Policy Recommendation #13: **Congress should provide funding to assist key private sector adopters to offset the costs of developing and demonstrating new measurement, monitoring and verification methodologies for soil carbon sequestration.** Because costs will be highest in the early years of a national offset program, funding to enable groups to develop their own methodologies for potential inclusion within federally-established standards, will be critical to help private aggregators and technology developers address the need for robust measurement, monitoring, and verification tools.

Policy Recommendation #14: **Congress should provide $15 million per year to the Consortium for Agricultural Soils Mitigation of Greenhouse Gases.** Continued federal funding for the Consortium is imperative to retain the critical mass of scientific and institutional expertise it has developed in its ongoing efforts to expand the scientific basis for soil carbon sequestration and improve related measurement and monitoring technologies.

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