Agriculture and Forestry in a Reduced Carbon Economy:

Solutions from the Land

A Discussion Guide

25x'25

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Overview

Background

The 25x'25 Steering Committee in 2008 appointed a Carbon Work Group to analyze agriculture and forestry's role in a reduced carbon economy and develop recommendations for how each sector can capitalize on efforts to reduce and capture carbon and greenhouse gas emissions. The Carbon Work Group, comprised of select Steering Committee members and additional volunteer leaders from carbon market stakeholder groups, is circulating this report. It is a working document intended to facilitate discussion. Feedback is requested and should be addressed to staff members Ernie Shea (eshea@25x25.org) or Jeffrey Frost (jfrost@25x25.org).

Climate Change Policy Perspectives

There is a wide consensus among scientists that global warming is occurring and can be attributed to increased emissions of greenhouse gases (GHG). The increased emissions are a consequence of human activities, with the majority of GHG increases occurring since 1970. Impacts from global warming include a rise in sea level, increased frequency of severe weather, and changes in precipitation – all of which will have a significant impact on the agriculture and forestry sectors.

To minimize the warming, emissions must be reduced. The question is which policy option can achieve GHG reductions in a manner that is cost-effective and socially equitable. In this document we further ask: What will be the impact of a given climate policy on the agriculture and forestry sectors? Macro-economic consequences on the sectors from climate policy and offset revenue potentials and associated costs are examined. The focus here is on how the agriculture and forestry sectors can anticipate national policy actions and plan their participation.

As described within this Guide, agriculture and forestry can and will deliver substantial emissions reductions, including sequestration, under any national climate change policy. All of the high-likelihood national climate change policies being discussed will result in a price for carbon emissions[1]. A price for carbon emissions is an incentive to create emissions reductions, reductions that the agriculture and forestry sectors can deliver.

We know that our sectors can deliver reductions. The bulk of this document describes the conditions under which we can best deliver these carbon reduction services. The reductions must be produced cost effectively, while simultaneously addressing the realities of sector financial viability and land stewardship.

National climate change policy, under any high-likelihood form, will powerfully reverberate across the energy, economic, and social landscape. Since other sectors are expected to look to the agriculture and forestry sectors to voluntarily deliver substantial emissions reductions, there are agriculture and forestry sector-specific imperatives which must be part of the detailed development of a national policy.

This Guide describes the climate change principles and imperatives specific to the agriculture and forestry sectors. Since the current political consensus points toward a cap and trade policy, cap and trade policy receives the lion's share of attention herein. In the event that an alternative

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[1] Greenhouse gas (GHG) emissions are often referred to as just "carbon emissions" even though there are six greenhouse gasses generally covered, including carbon dioxide (CO_2). Thus a "carbon price" is inclusive of all greenhouse gas emissions.

policy such as a carbon tax was to emerge the agriculture and forestry sectors will still be able to deliver carbon reduction services. For this reason, additional sections herein examine and discuss a carbon tax and reductions via the Clean Air Act as described by the EPA notice of proposed rulemaking (EPA, 2008a).

Structure of this Discussion Guide

This Guide is intended to build capacity in the agriculture and forestry sectors around climate change solutions and to lay the foundation for consensus-based policy recommendations.

> **Note on use of the electronic hyperlinks in this PDF document**. When you see a highlighted word such as this on Emissions Trading, click on it to go immediately to the topic for more detail. When you are done, right click your mouse and select "previous view" to return to the starting point where you clicked on the hyperlink. Try it now if you like.

The following are the key Guide sections and their content:

Executive Summary

This section provides a summary of the Guide. For more substantive content please refer to the Guide.

Introduction to Policy Options

This section describes three major national policy options being contemplated: cap and trade, a carbon tax, and climate change action under the Clean Air Act.

Agriculture and Forestry Offsets

This section defines the sectors, establishes common offset reductions language, and quantifies the size of each potential reduction type.

Recommendations

This section outlines principles and policy imperatives for the consideration of 25x'25 Alliance members, climate stakeholders and policy makers.

Appendices

Appendix A: 25x'25 Organizational Background.

This section describes the national 25x'25 coalition, its objectives, and mission.

Appendix B: 25x'25 Carbon Work Group Members.

This section lists group members and describes the work process employed to produce this Guide.

Appendix C: Acronyms and Abbreviations.

A quick checklist is provided for convenience.

Appendix D: Organizations Engaged in Allied Action.

Organizations engaged in allied work are identified.

Appendix E: Q&A (living) Document.

Appendix F: Ag & Forestry Vulnerabilities to a Changing Climate.
A brief review of how a changing climate will cause known types of disruptions to business as usual for the agriculture and forestry sectors.

Appendix G: References.
A comprehensive list is included.

Executive Summary

National policymakers have made clear their intention to address global warming and a national climate change policy is expected soon. In anticipation of this policy debate, the 25x'25 Steering Committee convened a select Carbon Work Group, a panel of nationally recognized producers, economists, conservationists, and academic and business leaders charged with examining opportunities available to the agriculture and forestry sectors to participate in a reduced carbon economy.

After twelve months of analysis and deliberation, the Carbon Work Group concluded that there are a number of ways in which agriculture and forestry may join in the fight against climate change through greenhouse gas (GHG) emission reductions, terrestrial sequestration and avoided emissions via the use of biomass for biofuels and power. (see Table ES1). Many of the operational changes that create emission reductions also yield high-value sustainability co-benefits such as soil and forest health, improved water quality, and even operational efficiency co-benefits. Anaerobic digestion of livestock waste creates energy and helps reduce runoff into waterways. Where no-till practice is a viable option, significant soil loss reductions and fossil fuel reductions can be achieved. Advance collaborative planning can increase the likelihood of these win-win outcomes.

Table ES1: Source of Reduction Opportunities

Sources of Important Agricultural and Forestry "Reduction" Opportunities
Emissions Reductions
Agricultural CH_4 Emissions Reductions
Manure Management Enteric Fermentation
Agricultural N_2O Emissions Reductions
Fertilizer Practices Manure Management
Biological Sequestration Fluxes
Agricultural CO_2 in Soils
Tillage, Crop Rotations, Cover Crops, Grazing Practices
Forestry CO_2 in Forests and Wood Products
Afforestation, Reforestation, Deforestation, Avoided Deforestation, Forest Management, Wood Products
Avoided Fossil Fuel Emissions
Emissions Avoided from Substitution for Fossil Fuel Combustion
Liquid Transportation Biofuels (ethanol, biodiesel, other renewable fuels) Thermal Biopower/Bioheat (biogas, wood, grasses, other cellulose) Renewable Electrical Power (biogas, wood, grasses, other cellulose)
Emissions Avoided from Efficiency Improvements
Agricultural and Forestry Operations Efficiency for Fuels and Electricity

Source: AgRefresh (2008)

The U.S. EPA has concluded that agriculture, including forestry, is responsible for 7 percent of total U.S. GHG emissions. While this is a small source of GHG emissions compared to the electric power, transportation, and industrial sectors, the agriculture and forestry sectors have an important role to play in significantly reducing overall emissions. EPA estimates that these sectors have the potential to reduce 10-25 percent of total annual U.S. GHG emissions because of their large biological sequestration potential - a fact that creates both opportunities and challenges for farmers, ranchers and forest land managers.

Current policy debates indicate that in all likelihood most agriculture and forestry operations will not be regulated. However, the expected impacts of climate change on U.S. ecosystems include significant consequences for farming and forestry, including the extended range and lifetime of pests and stress; higher temperatures and/or decreased precipitation; increased drought stress; decreased water availability; reduced animal production of meat and dairy products in the summer; and increased fire hazards, among others.

The Carbon Work Group has concluded that the agriculture and forestry sectors are well positioned to offer solutions to counter climate change and that farm, ranch and forestland owners have much to gain by helping reduce GHG emissions.

The Work Group also has concluded that no single policy will by itself create the entire set of fundamental changes needed to transition to a low carbon future. In fact, an effective transition strategy will entail a collection of actions such as cap and trade and/or a carbon tax, liquid biofuel incentives (including the Renewable Fuels Standard), improved average vehicular mileage requirements, energy efficient building standards, renewable electricity objectives and technology advancement incentives. In addition, in the absence of a national climate change policy, there is every indication that EPA would move forward with a system to regulate GHGs under the Clean Air Act.

The core climate change policy options being considered by 25x’25 and the national community have generally been a cap and trade program or a carbon tax. The agriculture and forestry sectors, however, expect to have the opportunity to voluntarily deliver emissions reductions, regardless of the policy mixes adopted.

Policy Options

Policy makers are considering a variety of mechanisms to reduce the nation’s carbon footprint. A synopsis of those under consideration follows.

Cap and Trade

A cap and trade system sets a national cap, or limit, on how many greenhouse gas emissions are allowed. The government then creates allowances (legal permits to emit) for those emissions. The government may decide to give allowances away for free or raise revenues by auctioning them to capped, or regulated, entities. "Offsets" in a cap-and-trade system are generated from either reductions in emissions or increases in sequestration by uncapped sectors. They are generally measured in metric tons of carbon dioxide equivalent emissions (MTCO_2e).

Even though the agriculture and forestry sectors are expected to be uncapped, they have the ability to produce a significant quantity of reductions at lower cost than capped sectors. Capped entities, that need more permits to emit, could purchase offsets, from the agriculture and forestry sectors when their cost is lower than the cost incurred by reducing on-site emissions. By providing offsets that reduce the overall costs of compliance for capped sectors, the agriculture and forestry sectors simultaneously help reduce the overall cost of the cap and trade program and are rewarded in the marketplace.

Offsets could provide a significant revenue stream for the agriculture and forestry sectors. A study by the EPA (2005) suggests that an estimated 2,100 MMT CO_2e could be reduced per year over the next 100 years. By way of reference, 2,100 MMT is about 30 percent of total current U.S. GHG emissions. Using EPA's high end estimate for the average price of carbon ($50 MT CO_2e.), the agriculture and forestry sectors could realize over $100 billion in additional annual *gross* revenue. To put this into perspective, the total value of U.S. agriculture in 2002 was $200 billion.

Table ES2: National Agriculture and Forestry Mitigation
Total 2010-2110, MMT CO2e, Annualized Averages by Activity

Activity		$ per MT CO2e				
		$1	$5	$15	$30	$50
Emissions Reductions	Agricultural CH_4 / Agricultural N_2O	9	15	32	67	110
Biological Sequestration Fluxes	Agricultural Soil Carbon Sequestration	62	123	168	162	131
	Forestation (afforestation)	0	2	137	435	823
	Forest Management	25	105	219	314	385
Avoided Fossil Fuel Emissions	Emissions Avoided from Substitution For Fossil Fuels	0	0	57	375	561
	Emissions Avoided from Efficiency	21	32	53	78	96
Total from all Activities		**117**	**227**	**666**	**1,431**	**2,106**

Source: Adapted from EPA (2005)

With this unprecedented opportunity to generate new revenues, the net gains will depend on associated costs, including those required to change operating practices such as sequestration with a vegetative buffer; track and sell offsets; and from the increased costs for inputs such as fuel and fertilizer. Although studies have estimated some of these costs, the net gains for the sectors are still unknown. Agricultural and forestry leaders should also be aware, however, that revenue gains will not be uniform across the country. Soil sequestration opportunities and forest resources are not universal. Even where there is an opportunity, the revenue generated from carbon reduction services must be substantial enough to cover all costs.

Until final policy details are crafted, there is no guarantee that commercial carbon markets will provide sufficient incentives to maximize agriculture and forestry mitigation potential. Currently, market prices fluctuate depending upon a variety of factors including quality of offsets, artificial supply and demand pressures, general economic conditions, carbon price expectations, and policy specifics, among others. To gain the full participation of agriculture and forestry, any new climate change regulatory system adopted by Congress must create a market that can sustain robust prices.

Carbon Tax

A carbon tax is similar to a cap and trade program in that economic incentives are used to reduce emissions. However, unlike a cap and trade system, there is no emission limit set with a carbon tax. Instead, a dollar price is set per ton of CO_2e as a tax on GHG emissions. Taxing upstream sources such as petroleum refineries and coal power plants would be the easiest and most efficient way to implement the tax.

Among the benefits of a carbon tax is simpler administration and market stability. However, the main criticism of a carbon tax is that it cannot ensure specific emissions targets are met.

The Clean Air Act

An April 2007 Supreme Court ruling determined that all of the primary greenhouse gases qualify as air pollutants, and therefore can be regulated by the EPA under the Clean Air Act (CAA). While the ruling did not mandate regulation, it directed EPA to assess the danger that new motor vehicle emissions posed to public health. If greenhouse gasses meet the endangerment test, then EPA will be obligated to set standards for new motor vehicles.

The EPA has also been petitioned to set standards for non-road vehicles, including those used for construction, shipping, and farming equipment. Legal challenges also have been brought to try to control emissions from coal power plants and diesel engines. So, while the Supreme Court ruling narrowly focused on motor vehicles, it is likely that stationary sources would also be regulated.

In 2008, the EPA issued a proposal for controlling emissions under the Clean Air Act, while also noting that the CAA was not designed to regulate GHGs. Using the Act to regulate GHGs could create a layer of complexity that could be avoided with the passage by Congress of comprehensive climate legislation. The EPA says the CAA will be used “unless and until” other legislation is put in place by Congress. Therefore, the longer Congress takes to implement climate legislation, the more likely the CAA will be used to control emissions.

While there has been some concern that EPA enforcement of the CAA to regulate GHGs might impose stringent limits on individual farms, it appears likely that only very large livestock operations - estimated by EPA to include less than one hundred dairy, swine and cattle farms - will be required to report emissions, a possible prelude to regulated limits.

Potential Opportunities for Agriculture

Methane and Nitrous Oxide Emission Reductions

Although enteric fermentation is the main source of methane emissions, a second source of methane emissions, manure management, offers biogas recovery systems as a more proven process for eliminating emissions. Anaerobic digestion creates biogas from manure, which can be used for electrical generation or thermal energy production. Biodigestors provide a significant opportunity in the agriculture sector to reduce fossil fuel emissions of carbon dioxide and emissions of manure methane that would otherwise be released. While EPA estimates there were only 111 commercial livestock digesters operating in 2007, the potential for anaerobic digesters to provide financial and environmental benefits to U.S. farms has prompted acceleration in the construction of digesters in recent years.

The development of new fertilizer application techniques to reduce nitrous oxide emissions is another potential opportunity to mitigate climate change, including more efficient use of manure and nitrogen fertilizers.

Biological Sequestration

Increasing soil carbon sequestration is the most viable mitigation strategy at very low carbon prices. EPA reports that at $5 per MT CO_2e, soil carbon sequestration activities could reduce 123 MMT CO_2e per year over the next 100 years. Another study shows that if prices were $125 per ton, 72 to 160 MMT CO_2e per year of soil sequestration is available through various management practices such as conservation tillage or no-till; manure injection; planting winter cover crops; improving water and nutrient use; adopting rotational grazing systems; and conversion of marginal or underutilized lands to grasslands, riparian buffers, forests and wetlands.

Avoided Fossil Fuel Emissions

Substituting renewable fuels for fossil fuels in transportation or electrical power applications also reduces emissions. Biomass from agriculture and forestry can be converted into liquid fuels, co-fired in conventional power plants, or directly combusted. In addition, efficiency improvements should be used throughout the economy, including in farming and forestry operations. Energy efficiency is important in the aggregate and also provides valuable ways to reduce on-farm energy costs.

Potential Opportunities for Forestry

Carbon Dioxide Reductions

U.S. forests store about 150,000 MMT CO_2e, which accounts for 2 percent of global terrestrial carbon stores. Unlike many countries where deforestation rates exceed regeneration rates, forests in the United States currently sequester more carbon than they emit, resulting in a carbon sink. Annual incremental forestry sequestration in the United States is equal to about 10 percent of annual U.S. CO_2 emissions. Some research suggests that with the right policies, up to 36 percent of U.S. CO_2 emissions could be sequestered, although high costs would pose a barrier to reaching that level.

Biological Sequestration
Afforestation, planting trees on lands that have not contained forests, and reforestation, the re-establishment of forest on land recently devoted to forestry, provide carbon sequestration services that are the most easily documented means of boosting forest carbon and are also the most common forestry transactions in the voluntary offset marketplace.

Carbon sequestration can also be enhanced through management practices such as selecting specific species, varying harvesting rotations, and managing for pests and fires. Carbon sequestration through changes in forest management also can preserve a host of other ecosystem services.

Deforestation occurs when forests are harvested for timber or converted to pasture land, crop land, or other managed uses. Forest degradation occurs when unsustainable harvesting practices are used or changes negatively affect a forest's production capacity. Incentives should be created to preserve forests and encourage better management in order to cut land-based emissions from deforestation and degradation.

Durable wood products can serve as carbon reservoirs as well, and could be considered for carbon offsets. The amount of carbon sequestered in products depends on the amount of wood harvested, practices used to harvest the wood, what the products are harvested for, and the half-life of wood in the products.

Avoided Fossil Fuel Emissions
Short-rotation woody crops (SRWC), along with other woody biomass feedstocks, can play a significant role in reducing fossil fuel emissions by substituting for fossil fuels in direct combustion applications or indirectly through cellulosic biofuels production. Forest slash, the residual material left after timber harvest or thinning, presents an opportunity to utilize additional forest biomass.

Policy Impacts
Assuming that cap and trade is the leading contender for a national policy, what macroeconomic impacts should be expected from such a policy? Regulation of GHG emissions will create behavior changes away from carbon-intensive activities. While this is the goal for climate stabilization, it will also incur costs. How great will these costs be to firms and individuals? Several economic models have examined the impact of a domestic cap and trade policy on energy prices, Gross Domestic Product, employment, and distribution of those costs. Independent reviews of these models conclude that the long-term economic impact of a cap and trade policy on the U.S. economy would be moderate. Short-term costs and impacts could be significant, however, especially for the most energy-intensive agricultural operations.

Climate change policy will have a greater economic impact on some sectors than others. Higher prices as a result of a cap could adversely affect firms in the energy and energy-intensive goods and services sectors. Manufacturing, the most energy-intensive industry, is likely to feel the greatest impact. Agriculture and forestry, however, are the only sectors on the production side of the economy that are expected to experience a positive output as a result of mitigation.

Basic economic theory dictates that businesses and individuals will respond to increased prices by investing in development of technologies and management techniques to reduce costs. This will provide new job opportunities. History shows that the engine of progress in America is technological innovation. Over the centuries, new industries have developed and adapted quickly to changing economies. The industrial revolution, the space age and the Internet offer solid examples of this economic evolution. Innovative industries typically do not develop on their own; rather they grow through economic incentives that induce firms to invest in research and development. A cap and trade policy has the potential to provide this incentive and usher in a new economic era for the U.S.

Policy Principles and Imperatives

Guided by discussions and input from a wide cross-section of 25x’25 partners, the Carbon Work Group has developed the following principles and policy imperatives to aid stakeholders and policy makers in the nation’s transition to a reduced carbon economy. The result is an evolving collection of recommendations regarding climate change policy, its implementation, and what must happen for the agriculture and forestry sectors to deliver maximum greenhouse gas emissions reductions.

Overarching Principles

The following overarching principles should be considered in the formulation of climate change policy:

- The environmental impacts (e.g. increasing frequency of wildfires, insect outbreaks and rising sea levels) and economic cost of inaction warrant action.
- Sufficient science and political momentum exist to warrant action now.
- Adaptation and mitigation must be pursued simultaneously.
- Sustainability must be considered in all policy decisions.
- The requirements of the global as well as national communities must be considered.

General Policy Principles

Any climate change policy to be considered:

- Should include emissions reductions, biological sequestration (removals), and avoided emissions.
- Should be designed to cover a term long enough to allow effective planning by both capped and uncapped sectors.
- Should recognize “early actors” under all policy options.

- Should be developed in a process that is outcome-oriented and technology-neutral, as well as neutral regarding the choice of the transactions marketplace.
- Must be enforceable.

Agriculture and Forestry Climate Change Principles
Any climate change policy encompassing agriculture and forestry:

- Must allow the sectors, which represent primarily diffuse emissions sources and/or sequestration opportunities, to deliver reductions.
- Must include a well-specified project qualification process that allows quick inclusion of new project types (e.g. enteric fermentation) that meet eligibility requirements.
- Must engage sector participation to the fullest available extent, given the sectors' potential to reduce hundreds of millions of tones of emissions per year.
- Must acknowledge and count climate change benefits in programs that reward landowners for other ecosystem services.
- Must recognize that the agriculture and forestry sectors will strive to produce emissions reductions that are complementary to their role as stewards of the land, protecting and enhancing the economic value of their land assets.
- Must include significant investment in research and development and education to actualize emissions reduction opportunities.

Overarching Cap & Trade Imperatives
If cap and trade is the ultimate policy vehicle, compliance with the following specific imperatives must occur for the delivery of real reductions by the agriculture and forestry sectors:

- Agriculture and forestry should be identified explicitly as uncapped sectors capable of generating significant quantities of GHG reductions.
- While offsets must be allowed, only qualified offsets will be acceptable. Qualified offsets must be real, additional to reductions that would have occurred without the offset credits verifiable, registered, substitutable at par for allowances, and permanent (or of a contracted duration).
- If allowances are auctioned under a cap and trade system, the funds generated could be beneficially used for a wide variety of program requirements, including conducting needed research and financing government carbon sequestration programs.
- Cap and trade program rules must balance environmental rigor and accounting precision against operational practicality.
- Offsets must be registered based upon reductions verified after the fact; no forward crediting based upon future expectations will be allowed.
- Under cap and trade, there must be recognition of both “early actors” in uncapped sectors and "credit for early action" within capped sectors.
- Under cap and trade, the system design must identify and guard against potential perverse outcomes, such as the temporary cessation of a practice in order to restart the same practice as a qualified additional project earning offsets.

- Cap and trade system design must guard against unintended collateral consequences such as water quantity or quality degradation.
- While there may be challenges relative to whether an offset project would have happened under a business as usual scenario, payments for other ecosystem services such as water quality improvements should not be precluded by participation in the carbon offsets markets. Rather, participation in multiple ecosystem service marketplaces should be allowed and the benefits should be "stackable."
- International offsets should be allowed into a U.S. domestic cap and trade system under requirements that ensure compliance with domestic offset rules. They should be subject to the special requirements of trade agreements, reasonable quantitative limits, and reciprocal linkage to other broad-based programs such as the United Nations Framework Convention on Climate Change (UNFCCC) and international agreements, such as the Kyoto Protocol.
- Cap and trade program rules must clarify ownership and prevent double counting.
- Existing and proposed policies ancillary to, or parallel with, a federal cap and trade system must not conflict with cap and trade rules.
- While the Environmental Protection Agency should be the administrator of a cap and trade program, the USDA should be the administering agency with respect to agriculture and forestry offset project rules.

1. Policy Options

1.1. Introduction

Given that a national climate change policy is expected in the near future, every economic sector must examine its potential role under each of the potential policy option outcomes. The 25x’25 Steering Committee has convened a 25x’25 Carbon Work Group to determine how the agricultural and forestry sectors may contribute to the policy solution in a manner beneficial to the national and global need, while simultaneously searching for positive economic opportunities.

The 25x’25 Carbon Work Group has concluded that on balance the agriculture and forestry sectors have much to gain from helping to reduce greenhouse gas (GHG) emissions. The opportunities for farm and forestry action under a carbon-constrained future – expected to be discretionary in nature – are described in subsequent sections. The policy conditions that will support the delivery of emissions reductions by our sectors are also described herein.

The expected effects on U.S. ecosystems from climate change include significant effects on farming and forestry. Forest ecosystems and agricultural systems are intrinsically linked to climate. Ecosystems will be impacted which means humans will be affected as well.

The longer-term effects of climate change on agriculture and forests are less well known than short-term effects. For example, in the short term forest productivity is expected to increase, while in the long term changes in drought, fires, and disease may decrease forest productivity. Some of the effects of climate change on agriculture and forest sectors include: extended range and lifetime of pests and stress; higher temperatures and/or decreased precipitation; increasing drought stress; decreased water availability; reduced animal production of meat and dairy products in the summer; and increased fire hazards, among others as discussed in the following.

The important issue of sector vulnerabilities is the topic of Appendix F – Ag and Forestry Vulnerabilities to a Changing Climate.

1.2. Policy Alternatives in Perspective

No single policy will by itself create the entire set of fundamental changes that a low carbon future will require. An effective transition strategy will entail a collection of actions such as cap and trade and/or a carbon tax, liquid biofuels mandates regarding both fuel volumes and fuel carbon content limits, improved average vehicular mileage requirements, energy efficient building standards, renewable electricity objectives, and technology advancement incentives.

The core climate change policy option being considered by 25x’25 and the national community has generally been either cap and trade or a carbon tax. The current political leaning appears to be support for a cap and trade system as the preferred core option. The agriculture and forestry sectors, however, expect to have the option to productively deliver emissions reductions under whichever policy mix emerges.

This section therefore, describes three prominent alternatives: cap and trade, carbon tax, and reductions under the Clean Air Act.

1.2.1 Cap & Trade

A cap and trade system sets a national cap, or limit, on how many greenhouse gas emissions are allowed. The government then creates allowances (legal permits to emit) for that amount of emissions. The government may decide to give allowances away for free or raise revenues by auctioning them to capped entities. Entities that reduce their emissions to a level below their owned allowances generate 'surplus' allowances that can then be traded among capped entities.

A national cap is subdivided into caps for the individual entities in the capped sectors. Capped entities must match all of their emissions with a combination of allowances or their functional equivalents, "offsets". Offsets are generated from either reductions in emissions or increases in sequestration by uncapped sectors.

Offsets are generally equal to an allowance and both are generally denominated in metric tonnes of carbon dioxide equivalent emissions ($MTCO_2e$).[2]

> $MTCO_2e$
>
> Different gases vary in their impact on the earth's energy balance and hence their contribution to global warming. The global warming potential (GWP) of a gas is a measure of its warming effect, over a specified timescale (generally 100 years), relative to CO_2. Thus carbon dioxide equivalence provides a common denominator that covers all of the relevant greenhouse gasses. For example, the global warming potential for methane over 100 years is 25 and for nitrous oxide 298. This means that a metric tonne of methane and nitrous oxide respectively is equivalent to emissions of 25 and 298 metric tonnes of carbon dioxide. A tonne of methane emissions is thus 25 $MTCO_2e$ and a tonne of nitrous oxide emissions is 298 $MTCO_2e$.
>
> Note: These GWPs are from the *IPCC Fourth Assessment Report* (2006). International GHG reporting guidelines are still based on 1996 *IPCC Second Assessment Report*.

Allowing offsets from uncapped sectors in a cap and trade system provides significant cost and flexibility benefits. Agriculture and forestry, two sectors expected to be uncapped, may choose to produce a significant quantity of reductions[3] at lower expected cost than capped sectors. Thus agriculture and forestry offsets will reduce the overall costs of compliance for capped sectors, while simultaneously benefiting the agriculture and forestry sectors. The capped entities – if they need to own more allowances or offsets to cover their emissions - will purchase the offsets when available for a cost lower than that of reducing emissions via their own on-site actions.

The cap and trade policy option provides a relatively precise control of total emissions and also allows low-cost offsets from uncapped sectors to help reduce the total program costs. Cap and trade systems face a genuine challenge to remain administratively simple. The market prices for allowances and equivalent offsets will vary as supply and demand shifts work through the system.

Based upon the national conversation, existing legislative proposals, and the position of President Obama, it appears that a greenhouse gas cap and trade system is likely to play a major role in the

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[2] The exception is the Regional Greenhouse Gas Initiative (RGGI) market, which uses short tons. One short ton = .9 metric tonnes.

[3] The term "reductions" is used within this Primer to represent all allowable forms of improvement including reductions, sequestration, and avoided emissions.

yet-to-emerge national suite of solutions. Section 2, Agriculture and Forestry Offsets, of this Guide describes how the agriculture and forestry sectors can contribute to the cap and trade solution and earn monetary rewards, while simultaneously advancing land stewardship objectives such as sustainability.

If the allowances under a cap and trade system are auctioned or sold to capped entities in some form, a cap and trade system may be designed to have the same revenue affects as a carbon tax. This allows, as described within the carbon tax section, a choice to productively employ those revenues in a beneficial manner (Orszag, 2008; Goulder et al., 2008).

1.2.2 Carbon Tax

A carbon tax is another policy option which can be employed to control the emissions of greenhouse gasses. A carbon tax is similar to a cap and trade program in that economic incentives are being used to reduce emissions. However, there are fundamental differences between the two.

Unlike a cap and trade system, there is no emission limit set with a carbon tax. Rather, a dollar price per tonne is set as a tax on GHG emissions. Taxing upstream sources such as petroleum refineries and coal power plants would be the easiest and most efficient way to implement the tax.

There are several benefits of a carbon tax. Because a carbon tax is often touted as simpler to administer, the administration and transactions costs may be less than with a cap and trade system. A carbon tax is also lauded for fixing the cost of emissions in a more stable fashion. This is because with a carbon tax, the market, which is subject to volatile prices, is not left to determine the carbon price. Instead the government sets the tax rate, which should be gradually increased overtime.

It is important that a carbon tax be phased in gradually so as to not destroy the value of existing long-lived investments. If a carbon tax was introduced and the tax was set too high, there could be significant reduction in the value of investments (e.g. housing, cars, heating and cooling systems etc.), disrupt the economy, and could be viewed as inequitable (Burtraw, 2004).

In order for a carbon tax to be equitable, it should be revenue-neutral. That is, little if any tax revenue raised by the carbon tax should go to the government. Instead the proceeds from the tax should go back to the public to lessen the damage on the economy. By returning the tax dividends to low-income energy users, a carbon tax could also be designed to be equitable and possibly even “progressive”.

A carbon tax would reduce emissions. By placing a price on carbon emissions, the cost of pollution is internalized into business decisions. This, in turn, stimulates investment in new technologies that will result in reduced emissions. However, because total emissions are not fixed by the policy, a carbon tax cannot ensure specific emissions targets are met. Not being able to guarantee a specific reduction target is a limitation of a carbon tax.

A carbon tax will also have a different impact on agriculture and forestry sectors than a cap and trade program. Under a carbon tax, the agricultural and forestry sectors could expect to be subject to a tax like all other sectors. A hybrid system is possible where an offset program could be wed to a carbon tax system, allowing sectors such as agriculture and forestry to contribute low-cost offsets according to their abilities.

1.2.3 Clean Air Act

In April 2007, the Supreme Court ruled on *Massachusetts v. EPA* that all six greenhouse gases qualified as air pollutants and therefore could be regulated by the EPA under the Clean Air Act (CAA). This ruling did not mandate regulation, however, but rather directed EPA to assess the danger that new motor vehicle emissions posed to public health. If greenhouse gasses meet the endangerment test, then EPA will be obligated to set standards for new motor vehicles. The EPA has also been petitioned to set standards for nonroad vehicles, including for construction, shipping, and farming equipment, and legal challenges have been brought to try to control emissions from coal power plants. So even though the Supreme Court case ruled on motor vehicles, it is likely that stationary sources would also be addressed.

The EPA could use a variety of regulations to control both mobile and stationary sources. For example, the EPA could mandate that aircraft change engine design or flight speed to reduce emissions. For stationary sources, the EPA could use National Ambient Air Quality Standards (NAAQS), New Source Performance Standards (NSPS), and/or designation of Hazardous Air Pollutants (HAP).

Designation of greenhouse gases as HAPs, however, may subject agriculture to regulations as fugitive emissions are included. HAPs are set at even lower thresholds—10 tons for any single HAP or 25 tons for any combination of pollutants (EPA, 2008b). Using the HAP authority would create an enormous administrative burden on EPA, so it is unlikely the agency would exercise this authority.

EPA in 2008 issued its Advanced Notice of Proposed Rulemaking (ANPR) to describe how emissions would be controlled under the Clean Air Act (CCA), while also noting that the CCA was not designed to regulate GHGs. Using it could create a layer of complexity that comprehensive climate legislation passed by Congress could avoid. While the EPA could try to create a cap and trade regime, it would not be nearly as efficient a system as one created with Congressional approval. It would also be much more complicated to create an offsets market under the CAA. The EPA has stated that the CAA will be used “unless and until” other legislation is put in place by Congress (EPA, 2008b). Thus, the longer Congress takes to implement climate legislation, the more likely the CAA will be used to control emissions.

1.2.4 Other Policy Options

Other policies can and will be used in the mix also. For example the CAFE (average corporate fuel economy) standard and the biofuels Renewable Fuels Standard (RFS) are already in place and subject to continuous adjustment and revision at the will of Congress. The CAFE standard revisions, a product of the Energy Independence and Security Act of 2007 (EISA), mandates a 35 mpg target by 2020. The revised RFS sets a target of 36 billion gallons of transportation biofuels by 2022. These latest RFS targets were also set via EISA.

Among the existing and potential other policies, the biofuels standards are probably the most directly significant for the farm and forestry sectors. The farm and forestry producers of biofuels feedstocks such as corn and corn stover, soybeans, perennial grasses, woody biomass, etc. stand to enjoy increased incomes from the biofuels energy demand source. Since the existing RFS is in place and has been revised as recently as the end of 2007, this Guide will not address biofuels policy.

2. Agriculture and Forestry Offsets

Within the context of the expected highest-likelihood policy outcome, a cap and trade system, the focus of this Guide is to:

- describe how the agriculture and forestry sectors can contribute to greenhouse gas reduction objectives,
- elaborate on extensive cap and trade policy technical implementation details, and
- delineate specific policy details that will allow the agriculture and forestry sectors to contribute to their full potential (Principles & Imperatives).

2.1. *Offsets Represent an Opportunity*

Capping GHG emissions creates potential new market opportunities for the agriculture and forestry sectors. Most of the climate change bills introduced into the United States Congress explicitly identify agriculture and forestry as uncapped sectors. They are also identified as being capable of generating significant quantities of GHG reductions, which could make them major players in the offset market. By proactively planning how the sectors can generate significant emissions reductions, the sectors demonstrate how they become part of the solution.[4]

Creating a carbon market places a dollar value on reductions in GHG emissions. Offset providers can thus be paid for their reductions. All sectors of the U.S. economy will need to reduce their greenhouse gas emissions. The opportunity to voluntarily participate in the offset markets as an uncapped sector being paid for reductions has distinct advantages. Agriculture and forestry stakeholders can capitalize on the opportunity by documenting their willingness and ability to produce emissions reductions under the necessarily stringent requirements of cap and trade. By voluntarily providing offsets for other industries, they will be increasing their own economic stability while providing additional benefits to the nation. A cap and trade policy represents an annual multi-billion dollar revenue opportunity for the agriculture and forestry sectors.

Revenue gains in the agriculture and forestry sectors will not be uniform across the country. For example feedlots, dairies, regions where soil sequestration can be accomplished, and forest locations all represent opportunities not uniformly distributed across the country. The revenue opportunity must also be substantial enough to cover all of the costs. At least three types of costs will be incurred by the farmers and foresters: 1) the costs to make the operating practice changes needed to generate offsets; 2) the transaction costs to track and sell carbon offsets; and 3) the increased costs for farm inputs tied to the price of fossil fuels, prices expected to rise under a carbon policy implementation.

There are a number of ways in which agriculture and forestry may join in the fight against climate change through emissions reductions (see Table 2 – Sources of Reduction Opportunities). Many of the operational changes which create emissions reductions also yield high-value sustainability co-benefits such as soil and forest health, improved water impacts, and even operational efficiency co-benefits. Anaerobic digestion of livestock waste creates energy and helps reduce runoff into waterways. Where no-till practice is a viable option, significant soil loss reductions and fossil fuel reductions can be achieved. The 25x'25 Carbon Work Group believes that advance collaborative planning can increase the likelihood of these double win outcomes.

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[4] The term "reductions" is used within this Primer to represent all allowable forms of improvement including reductions, sequestration, and avoided emissions.

2.2. Agriculture & Forestry Sectors Defined

Throughout this Discussion Guide reference is made to the agriculture and forestry sectors. A description of the make-up of these sectors is presented in Table 1, which categorizes the sectors using the North American Industry Classification System (NAICS). The data presented in Table 1 is from 1997 NAICS statistics. While specific statistics have changed over the last decade, the classifications and industry profiles remain valid and are included here for a clear characterization of the subcomponents of the sectors (NASS, 2002). Current values for farm and forestry owner counts, acres estimates, and dollar amounts based upon this classification were not available.

Table 1: North American Industry Classification System Sector Statistics (1997)

NAICS Code & Type of Establishment	Sector	Land Area	Value of Sector
111 – Crop Production • 1111 – Oilseed & grain • 1112 – Vegetables & melons • 1113 – Fruits & tree nuts • 1114 – Greenhouses/Nurseries & Floriculture • 1119 – Other crops	47% (902,372) of farms were classified as NAICS code 111.	46% (429 million acres) of agriculture land use in the U.S. was cropland.	Crop production value was $97.7 billion, which was 49.6 % of total agricultural products sold.
112 – Animal Production • 1121 – Cattle ranching & dairy farming • 1122 – Hog & pig farming • 1123 – Poultry & egg production • 1124 – Sheep & goat farming • 1125 – Animal aquaculture • 1129 – Other animal production	53% (1,009,487) of farms were classified as NAICS code 112.	43% (401 million acres) of agriculture land use in U.S. was pastureland/rangeland.	Animal production value was $99.3 billion, which is 50.4% of total agricultural products sold.
113 – Forestry and Logging • 1131 – Timber tract operations • 1132 – Forest nurseries and gathering of forest products • 1133 – Logging	57% of all productive forest land in the U.S. was owned by 9.3 million non-industrial private landowners.	Total U.S. forest land was 736.6 million acres. 33.8% (249.1 million acres) of forest land was owned by federal government.	Annual sales for commercial timber and nontimber forests products were $3.8 billion. The value of U.S. manufactured solid wood shipments in 1997 was $127 billion (USDA FASonline).

Sources: (EPA, 2000) (USDA -FASonline, 2008)

More general sector definitions are also provided by USDA and US Forest Service.

Agriculture Definition by USDA: The official definition of a farm for statistical purposes is "any place from which $1,000 or more of agricultural products (crops and livestock) were produced and sold or normally would have been sold during the year".

Forestry Definition by U.S. Forest Service: The U.S. Forest Service defines forested area as "forest land" if it is at least one acre in size and at least 10 percent occupied by forest trees of any size or formerly having had tree cover and not currently developed for non-forest use.

2.3. Offset Definitions and Discussion

This section introduces cap and trade offset terms such as additionality, baselines, permanence, leakage, and verification and discusses what is necessary for the agriculture and forestry sectors to produce qualified offsets.

Emissions Trading.[5] Entities regulated under an emissions cap may use either allowances or purchased offset credits to meet GHG emission obligations. Capped entities must match their emissions with a corresponding quantity of these permits. A capped entity may reduce its own emissions or use the available trading markets to acquire allowances and offsets from other holders whenever it finds itself in danger of having emissions exceeding the permits it has previously acquired.

Program administrators and the government originally issue only a limited number of allowances consistent with the desired level of emissions. This is the cap. At any time, the owners of the allowance and offset permits may keep them and release the emissions, or reduce their emissions and sell the permits. The fact that the permits have value as an item to be sold or traded gives the owner an incentive to reduce their emissions.

Qualified Offsets. Qualified offsets must be the final result of a well constructed cap and trade program and its associated offset credits rules. Qualified offsets must be real, additional, verified, registered, fungible, and permanent (or of contracted duration).

- Real means measured and quantified in a rigorous and approved manner.
- Additional or surplus means that that they are beyond business as usual.
- Verified means confirmed by approved independent third-party experts as in compliance.
- Registered means to be included in a transparent and public fashion in a comprehensive registry listing.
- Fungible means that an offset from a project is the same as an allowance.
    - An offset and an allowance will have the same price and same character (e.g. $10 per metric tonne of carbon dioxide equivalent) and be exchangeable one for the other in an undifferentiated fashion.
- Permanent refers to the character of sequestration which may be more precisely defined as meeting the contracted duration of sequestration (whether for one or fifty years).

> ***Additionality** tests assess whether an offset project would have happened under a "business as usual" scenario.*

Additionality. Because offsets are used to compensate for emission reductions that a capped entity would otherwise have to make itself, the reductions resulting from offset projects must be shown to be "in addition to" reductions that would have occurred without the offset credits. Establishing why a project was implemented is difficult; thus, practitioners and regulators generally rely on a series of tests to determine a project's additionality. These tests often assess whether the activity is required under law, already common practice, or faced with financial, technical, institutional, and/or other barriers. No single approach is the best for all projects or project types, and generally a combination of tests is best. In some cases all projects of a particular type might be defined as additional by program rules.

> *A **baseline** represents forecasted emission levels in the absence of the offset project.*

Baseline. A GHG emission baseline must be established in order to quantify an offset project's GHG reductions. The baseline is sometimes referred to as the business as usual scenario, or the "without-project" case. The difference between the baseline and the actual emissions after the offset project is implemented represents the reductions achieved by the project, and this amount is available to be credited as an offset. Offsets are only as credible as their baselines.

Performance-Standards and Technology-Benchmarks. Operationally, the screening procedures and project monitoring and verification rules must accept some imperfection in order

[5] Bold highlights in this section identify key terms.

to avoid unacceptably high offset program costs. In general terms, this can be in the form of acceptance of individual project-type protocols employing performance-standards and technology-benchmarks in lieu of mandating project-specific data, monitoring, and accounting where arguably unnecessary.

Crediting Period. Several factors relate to the determination of the appropriate length of the crediting period. The appropriate crediting period must relate to the natural cycle of sequestration projects that produce results over many years. In order to incentivize investment in reduction projects, the crediting period also should consider economic costs and necessary cost-recovery terms. Finally, the crediting period rules must factor in the reality that as new technologies penetrate the sectors, an action that is additional today and is compared to a particular baseline today may not be additional ten years from now as it evolves into the business as usual case.

The ***crediting period*** *is the number of successive years a project will be allowed to quantify and sell offset credits.*

There is a long-term value to an early and rapid ramp-up of emissions reductions project investments. A generous crediting period will draw more farm and forestry projects into the mix and allow the sectors to deliver maximum quantities of qualified offsets.

Fungible Credits. The agriculture and forestry sectors benefit from a system where each offset, once issued and registered by the program, is indistinguishable from every other offset and all offsets are fully fungible (fully substitutable) with allowances.

Permanence or Duration. Permanence is a type of project risk most often associated with biological and geologic sequestration of emissions. If fully fungible, an offset sourced from a biological sequestration project will be indistinguishable from a farm methane reduction, which involves no questions of permanence. This means that the permanence or duration issue for biological sequestration must be addressed at the project and program level in a way that ensures that individual offset credits, once issued and registered by the program, carry no risk-adjusted price discount and no price differential in the marketplace.

Permanence *refers to the length of time that carbon will remain stored after being sequestered in vegetation.*

Agriculture and forestry entities understand that biological sequestration projects such as soil carbon, afforestation, or reforestation, possess inherent uncertainty and risk regarding the duration of the sequestration. These projects must account for this uncertainty, the issue commonly referred to as “permanence”.

A project that produces fully fungible offsets must employ a program design that accounts for the risk and uncertainty behind the registry and before offset credits are issued. The practical results are that offset buyers are fully protected from uncertainty, so that fungibility results. The risk and uncertainty are managed by the project owner and the cap and trade program itself, with the costs inevitably borne by the owners of sequestration projects.

Given the requirement for all offsets to be fungible post-registration, and given the duration uncertainty for sequestration projects, there are a number of tools that a cap and trade offset program may employ to accomplish the desired outcomes. Agriculture and forestry understand that individual sequestration projects face significant challenges to bring offsets to market, no matter which system is used. A system with fungibility, as recommended here, keeps the risk corralled behind the registry and away from the offset trading markets. An alternative cap and trade system approach could allow risk-adjusted offset prices as the means to accommodate sequestration uncertainty.[6]

A cap and trade system designed around fungible offsets, must manage the uncertainty associated with sequestration duration behind the registry. It is possible to manage the uncertainty using a combination of tools. For example, risk-adjusted crediting rates can be employed. By crediting all afforestation projects of a given species in a given geographic realm at only a portion of the expected ex-post sequestration rate, the program and project can account for uncertainty such as forest fires.

Although full discussion of such details is beyond the scope here, agriculture and forestry prefer solutions for sequestration projects that use fixed, project-type factors for the discounted crediting-rates, the risk-adjusted crediting rates. While new protocols such as California Climate Action Registry may allow for more efficient project-specific risk ratings, it could be too administratively burdensome to require that unique discount crediting rates be computed for each project. Similarly, agriculture and forestry prefer limited-life risk exposure for project owners via buffering mechanisms such as risk pools, insurance premiums, and other means administered at the central cap and trade offset program level.

Leakage. Leakage is similar in some ways to the issue of sequestration duration in that unintended GHG emissions may occur. Leakage means that the planned rate of reductions might not materialize ex-post because they are increased elsewhere. Unintended emissions within a project's boundary require the project owner to solve the problem. However, leakage is often outside the project boundary and beyond the control of the project owner. For example, avoiding deforestation through an offset project in one area could simply shift the land demand, causing deforestation at a different location.

> ***Leakage** is defined as an increase in emissions outside of the project's emissions boundary that occurs as a result of the project's implementation.*

Recognizing that leakage is a shared problem, one solution is a program design that accounts for leakage using adjustment factors developed for specific activities and applied at the regional or national scales.

> *An **allowance** is an authorization to emit a fixed amount of greenhouse gases, commonly denominated in metric tonnes of CO_2e per year.*

Allowance Distribution. The distribution of allowances via auctions or some other payment mechanism is an opportunity to fund the cap and trade program. Plus, there are important ways these funds - or allowance set-asides - could be utilized to produce additional emissions reductions.

Funds could support the development of emissions reductions that do not readily fit into the conventional cap and trade program via the offset model. Promising new project types and methodologies with significant offset volume potential could be supported. The use of program funds for high potential opportunities could be directed to improving scientific understanding or developing new methodologies for project types. Both activities would benefit stakeholders. Auction revenues, commensurate with the ability of the sectors to deliver reductions, could be dedicated to funding leading-edge agriculture and forestry GHG reductions. An allowance set-aside program could empower less scientifically certain reductions while simultaneously reducing emissions below the cap.

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[6] An alternative is a system which brings sequestration offsets to market still bearing the risks of unknown duration. This latter system incorporates the risk adjustment for sequestration projects via market price discounts. These price discounts are the means for a market to account for the uncertainty. There is no fungibility between individual offsets and between offsets and allowances in this latter type of system. The discounted prices for offsets from sequestration projects means that project owners receive reduced revenue per offset.

Verification and Registration. Offsets should be verified by an independent, qualified, third-party verifier according to approved methodologies and regulations. Verifiers should be entities whose compensation is not in any way dependent on the outcomes of their decisions. Regulatory regimes should have an approved list of offset project verifiers and should have procedures in place to ensure that conflicts of interest are avoided. Ex-post monitoring and verification reports should be used as the basis for issuing offset credits.

> ***Verification*** *is an ex-post confirmation that the project was implemented and is performing according to the approved standard.*

Projects are generally required to be "registered" at the time of implementation to ensure against double counting. Registries record and track all offset credits once program authorities have issued them to registered projects based upon verified reductions.

Program Rules and Protocols. A cap and trade program will require several layers of operating rules. For offsets, there will need to be general rules and rules specific to each project-type which qualifies to earn offset credits. Examples of recommended general rules and guidelines include World Resources Institute's Greenhouse Gas Protocol for Project Accounting and the International Standards Organization 14064-Part 2. Examples of current voluntary market offset project rules include the Voluntary Carbon Standard and the Gold Standard. Examples of project types (e.g. biogas recovery and afforestation/reforestation) for which there are well developed protocols include the Clean Development Mechanism Methodologies and California Climate Action Registry. Ultimately every qualified type of offset activity will require its own detailed project protocol rules.

Ownership and Double Counting. Cap and trade policy must clarify ownership issues for situations where more than one party is involved or where a reduction from a single project would qualify under multiple policy options. It is not acceptable for a single reduction to be claimed twice and therefore quantification methodologies and protocols for offsets must define ownership rules too.

For example, if a ranching operation places a wind turbine in service to produce and use electricity on its site and the ranch thus reduces its draw of electricity from the grid, there is a reduction in emissions because grid electricity is produced from a variety of sources, including coal plants that do not now need to run as much. A comprehensive policy will need to clarify whether the owner of the coal plant or the wind turbine ranch owner may claim the emissions reductions. Similarly, when both cap and trade offset markets and renewable electricity credit (REC) markets are in operation, carbon reductions from a renewable electricity project should be qualified for inclusion under only one or the other.

Here is the second example where ownership and double-counting rules must be precise. Assume that if a farm converts from a row crop to switchgrass, it will improve soil sequestration of CO_2 via less tillage and it will reduce N_2O via reduced nitrogen fertilizer application. Assume that these are approved ways for the farm to create and sell offset reductions under a cap and trade system. Simultaneously, however, the new switch grass crop is sold to a biorefinery for the production of cellulosic ethanol to meet the advanced biofuel definition under the Renewable Fuel Standard. If the life cycle analysis of the advanced biofuel pathway demonstrates emissions reductions in a way that provides for a carbon credit under the separate markets for RFS credits, there will be double-counting. Cap and trade policy implementation details must address the full range of ways in which ownership claims are uncertain and double-counting could result.

There are still other types of activities where clarifying ownership and avoiding double-counting will prove challenging if these activities become accepted program areas within a cap and trade system. For example, if accounting for the long-duration of carbon sequestration in wood products, quantification rules and the timing and ownership of offset credits will present unique challenges. Similarly, if allowed under a cap and trade system, substitution of low carbon wood products for high embedded-energy and emissions materials such as concrete and steel will present unique challenges for the development of program rules that address quantification, timing, and ownership.

Stackable Benefits. A related issue is stackability, which refers to the ability to simultaneously benefit from multiple governmental policies. For example, if you receive Conservation Reserve Program (CRP) payments and also earn carbon offset credits for the increased soil carbon from the same land, the benefits are stackable. Stackable benefits arise when an action earns benefits in two or more different programs. Other programs where carbon offset projects might qualify for credits while receiving other, stackable, benefits are the USDA EQIP program and Conservation Security Program (CSP).

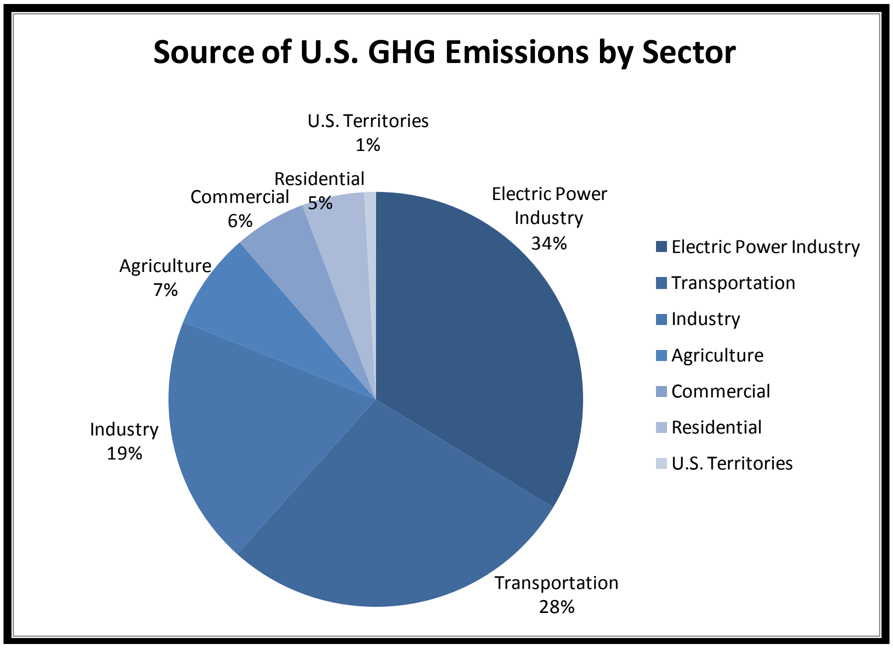
Ancillary and Parallel Policies. In all cases the federal cap and trade system program rules must explicitly co-opt or coordinate with related policies. Ancillary and parallel polices include, for example, the federal Renewable Fuel Standard, the California Low Carbon Fuel Standard, regional cap and trade systems such as the Regional Greenhouse Gas Initiative (RGGI) and the Western Climate Initiative (WCI), and other potential legislation.

While the Environmental Protection Agency (EPA) will be the administrator of a cap and trade program, the **USDA role** should be to administer agriculture and forestry offset project rules. The USDA has the working knowledge of relevant technical issues surrounding offsets from these sectors as a consequence of its experience with past climate change regulations, including Section 2709 of the 2008 Farm Bill. The USDA has previously developed metrics, including qualified forestry and agricultural quantification methodologies for the Department of Energy (DOE) 1605b program. Such existing work should be included in a cap and trade program, to the greatest reasonable extent.

2.4. Quantified Offset Services Opportunities

2.4.1. Overview of Potential Reductions

Figure 1: Source of U.S. GHG Emissions by Sector



Source: (EPA, 2007a)

Agriculture is responsible for 7 percent of total U.S. GHG emissions. The primary source of U.S. emissions is the electric power industry (34 percent), followed by the transportation sector (28 percent) and industrial sector (19 percent). Agriculture exceeds the commercial sector (6 percent) and the residential sector (5 percent) in total emissions (Figure 1). While the agriculture sector is a small percentage of total CO_2 emissions, it contributes 77 percent of total nitrous oxide emissions and 30 percent of total methane emissions (EPA, 2007a)

Agriculture and forestry can contribute to emissions reductions. It is estimated these sectors have the potential to offset 10-25 percent of total annual U.S. GHG emissions (EPA, 2005). Agriculture and forestry have the potential to deliver reductions equal to 10-25 percent, even though they are the source of just 7 percent, because of the large biological sequestration potential. The forest-related carbon sink is actually increasing (0.4 percent a year) in the U.S.

The offset activities fall into three categories: emission reductions, biological sequestration fluxes, and avoided fossil fuel emissions (Table 2).

Table 2: Source of Reduction Opportunities

Sources of Important Agricultural and Forestry "Reduction" Opportunities
Emissions Reductions
Agricultural CH_4 Emissions Reductions
Manure Management Enteric Fermentation
Agricultural N_2O Emissions Reductions
Fertilizer Practices Manure Management
Biological Sequestration Fluxes
Agricultural CO_2 in Soils
Tillage, Crop Rotations, Cover Crops, Grazing Practices
Forestry CO_2 in Forests and Wood Products
Afforestation, Reforestation, Deforestation, Avoided Deforestation, Forest Management, Wood Products
Avoided Fossil Fuel Emissions
Emissions Avoided from Substitution for Fossil Fuel Combustion
Liquid Transportation Biofuels (ethanol, biodiesel, other renewable fuels) Thermal Biopower/Bioheat (biogas, wood, grasses, other cellulose) Renewable Electrical Power (biogas, wood, grasses, other cellulose)
Emissions Avoided from Efficiency Improvements
Agricultural and Forestry Operations Efficiency for Fuels and Electricity

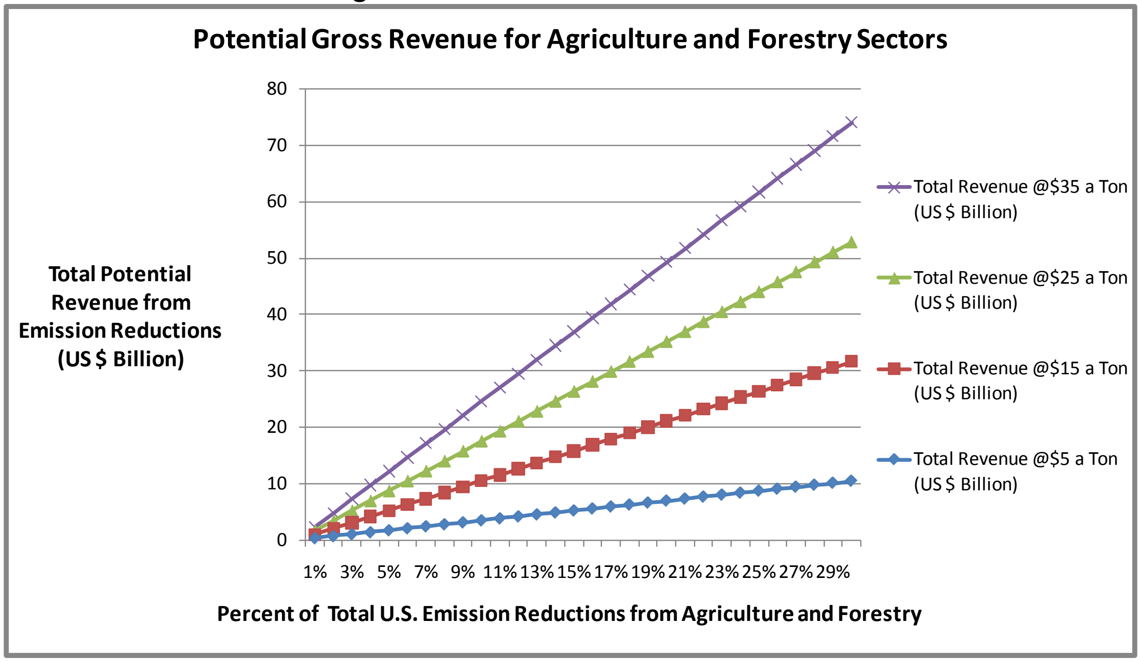
Source: (AgRefresh, 2008)

The term "reductions", as used throughout this Guide, represents all forms of improvement including emissions reductions, biological sequestration fluxes, and avoided fossil fuel emissions.

Offsets could provide a significant revenue stream for both sectors. Figure 2 illustrates the potential gross revenue at various price points per MT CO_2e. If the price is $5 per MT CO_2e (a relatively low price) and the agriculture and forestry sectors offset the lower bound estimate of 10 percent (705 MMT CO_2e) of total U.S. emissions, the annual gross revenue of these sectors is $3.5 billion. If there is a higher price ($35 per MT CO_2e) and the higher bound estimate of 25 percent (1,764 MMT CO_2e) reduction of total U.S. GHG emissions is achieved, the annual gross revenue is $61.7 billion. To put this into perspective, $3.5 and $61.7 billion represents 2 and 31 percent of the total value of U.S. agriculture in 2002, respectively (USCCSP, 2008).

While offsets represent an unprecedented opportunity for the two sectors to generate new revenues, the net gains will also depend on the associated costs. The relevant costs affected by climate change policy can roughly be grouped into: 1) costs to change operating practices such as sequestration via a vegetative buffer; 2) transaction costs to track and sell offsets; and 3) input costs such as fuel and fertilizer prices which will rise. Although studies have estimated some of these costs (EPA, 2005), the net gains for the sectors are still unknown.

Figure 2: Potential Gross Revenue



Data source: (EPA, 2007a)

2.5. *Scope of Potential Opportunities for Agriculture*

There are a number of ways in which the agriculture sector can contribute to GHG mitigation efforts (CAST, 2004), specifically by: Emission Reductions: Reducing emissions of N_2O and CH_4 through enhanced manure and fertilizer management; Biological Sequestration Fluxes: Improved agricultural land management to increase soil carbon storage; Avoided Fossil Fuel Emissions: Emissions avoided from substitution for fossil fuels, (e.g. increasing biomass energy crops for ethanol); and emissions avoided from efficiency.

Table 3 depicts the potential quantity of CO_2e reductions from agriculture and forestry mitigation activities at various carbon prices. Results are based on a mathematical programming model that simulates the actions of producers and consumers with predictions of future demands, yields, technologies, and GHG prices (EPA, 2005). The model does not include transactions costs, the costs to track and sell carbon offsets. [7]

Offsets could provide a significant revenue stream for the agriculture and forestry sectors. A study by the EPA (2005) suggests that an estimated 2,100 MMT CO_2e could be reduced per year over the next 100 years. By way of reference, 2,100 MMT is about 30 percent of total current U.S. GHG emissions. Using EPA's high end estimate for the average price of carbon ($50 MT CO_2e.), the agriculture and forestry sectors could realize over $100 billion in additional annual *gross* revenue. To put this into perspective, the total value of U.S. agriculture in 2002 was $200 billion.

With this unprecedented opportunity to generate new revenues, the net gains will depend on associated costs, including those required to change operating practices such as sequestration with a vegetative buffer; track and sell offsets; and from the increased costs for inputs such as fuel and

[7] For complete model detail and its affiliated models see: http://agecon2.tamu.edu/people/faculty/mccarl-bruce/papers.htm

fertilizer. Although studies have estimated some of these costs, the net gains for the sectors are still unknown. Agricultural and forestry leaders should also be aware, however, that revenue gains will not be uniform across the country. Soil sequestration opportunities and forest resources are not universal. Even where there is an opportunity, the revenue generated from carbon reduction services must be substantial enough to cover all costs.

Until final policy details are crafted, there is no guarantee that commercial carbon markets will provide sufficient incentives to maximize agriculture and forestry mitigation potential. Currently, market prices fluctuate depending upon a variety of factors including quality of offsets, artificial supply and demand pressures, general economic conditions, carbon price expectations, and policy specifics, among others. To gain the full participation of agriculture and forestry, any new climate change regulatory system adopted by Congress must create a market that can sustain robust prices.

The mitigation opportunities in agriculture offer some of the most cost-effective options for reductions anywhere in the economy, especially through soil sequestration activities such as no-till, manure incorporation, and planting winter cover crops. Activities such as no-till are also ways to conserve energy and provide a cost savings to farmers (Shoemaker et al., 2006). Because carbon policy will likely increase fuel prices and agriculture is an energy intensive sector, energy efficient actions such as no-till provide two sources of benefit simultaneously, increasing sequestration and reducing farm-equipment fuel consumption and its associated emissions.

Avoided fossil fuel emissions offer moderate mitigation potential at low carbon prices, but are the dominant mitigation activity for agriculture at a price of $30 MT CO_2e. Emission reductions of N_2O and CH_4 from improved manure and fertilizer management offer moderate reduction potential at all prices (Table 3).

Table 3: National Agriculture and Forestry Mitigation Total 2010-2110, MMT CO2e, Annualized Averages by Activity

Activity		$ per MT CO2e				
		$1	$5	$15	$30	$50
Emissions Reductions	Agricultural CH_4 / Agricultural N_2O	9	15	32	67	110
Biological Sequestration Fluxes	Agricultural Soil Carbon Sequestration	62	123	168	162	131
	Forestation (afforestation)	0	2	137	435	823
	Forest Management	25	105	219	314	385
Avoided Fossil Fuel Emissions	Emissions Avoided from Substitution For Fossil Fuels	0	0	57	375	561
	Emissions Avoided from Efficiency	21	32	53	78	96
Total from all Activities		**117**	**227**	**666**	**1,431**	**2,106**

Source: Adapted from (EPA, 2005)

2.5.1. Emission Reductions: Methane and Nitrous Oxide

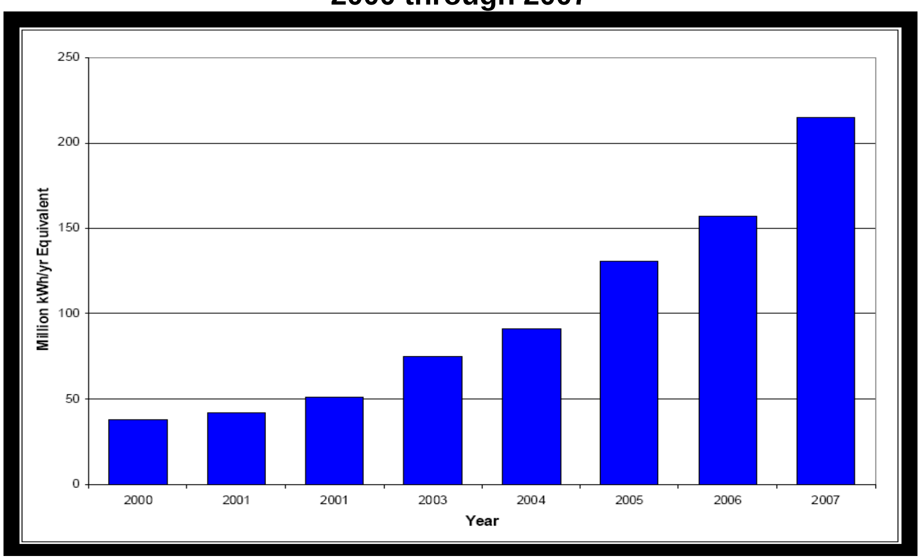
The main source of methane emissions in agriculture is enteric fermentation in the digestive systems of ruminant animals. Direct approaches try to increase rumen efficiency, which reduces the amount of methane per unit of feed. Indirect approaches target increased animal productivity and reduce the amount of methane emitted per unit of animal product (EPA, 2005).

Although enteric fermentation is the larger source of methane emissions, a currently proven opportunity for livestock-related emission reduction offsets exists: Managing manure with biogas recovery systems. Anaerobic digestion, a process that converts manure to biogas, provides a significant opportunity in the agriculture sector to reduce emissions. Anaerobic digesters can reduce two sources of GHG emissions: 1) Carbon dioxide emissions from electric energy produced by fossil fuels, coal or natural gas; and 2) methane from manure.

According to the EPA, GHG emissions from the agricultural sector account for 536 MMT CO_2e a year (8% of total U.S. emissions in 2005). An estimated 51 MMT CO_2e results from methane and nitrous oxide emissions from livestock manure (EPA, 2007a). Thus, the potential for anaerobic digesters to provide financial and environmental benefits to U.S. farms is substantial. Due to the potential for anaerobic digesters to provide financial and environmental benefits to U.S. farms, there has been acceleration in the construction of digesters in the past few years. EPA estimates that there were still only 111 commercial livestock digesters operating in the U.S in 2007 (EPA, 2007b). These digesters produced an estimated 215 million kilowatt-hours equivalent of useable energy (Fig. 3).

Development of new fertilizer application techniques to reduce nitrous oxide emissions is another potential opportunity to mitigate climate change. Reducing nitrous oxide primarily includes more efficient use of manure and nitrogen fertilizer. Management of manure and fertilizer application on fields includes improvement of application techniques, rates, and timing (Siikamaki, 2007; CAST, 2004). Innovative technologies such as manure injection that reduce nitrous oxide and improve crop yields provide scenarios for further GHG reductions. Some of these technologies could reduce up to 30 percent of nitrous oxide emissions from agriculture.

Figure 3: Trends in Energy Production by Anaerobic Digesters 2000 through 2007



Source: (EPA, 2007b)

2.5.2. Agricultural Biological Sequestration Fluxes

Increasing soil carbon sequestration is the most effective mitigation strategy at very low carbon prices ($1-$5). If carbon was $5 per MT CO_2e, soil carbon sequestration activities could reduce 123 MMT CO_2e per year over the next 100 years (EPA, 2005). Another study shows 72 to 160 MMT CO_2e a year of soil sequestration is available through various management activities if prices were $125 per tonne (Lewandrowski, 2004). These various management activities include:

- implementing conservation tillage, no-till, and new manure incorporation methods such as manure injection; planting winter cover crops;
- improving water and nutrient use;
- adopting rotational grazing systems; and
- conservation of cropland to grassland, riparian buffers, forests and wetlands.

Several challenges exist for soil carbon offsets under a cap-and-trade program. Accurately quantifying the amount of carbon stored in soils poses a challenge. Soils have different capacities to absorb and store carbon depending on climate and soil physical properties and current and past land use practices. The cost-effectiveness of direct measurement of soil carbon changes at the project scale; it is labor intensive and expensive, therefore project developers often want projects that encompass at least 25,000 acres to make measuring soil carbon cost-effective (Smith et al., 2007). This is a major barrier for smaller soil carbon offset projects, although one that an aggregator can mitigate. An aggregator is an intermediary buyer that purchases large volumes of credit to be delivered to end-buyers (Point Carbon, 2008). An alternative for broader national level policy implementation is to develop a national-scale monitoring network that could support model-based estimations such as currently deployed by USDA in the 1605b voluntary greenhouse gas reporting system (Paustian, 2006). Also, since soil carbon can be released rapidly if farmers revert back to less conservation-oriented practices, duration (permanence) is also a challenge.

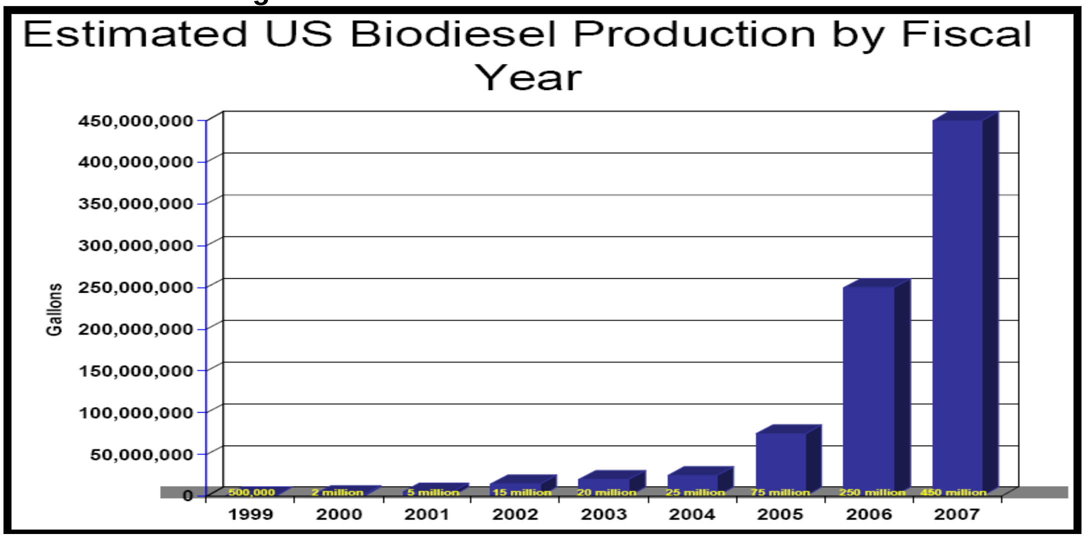
2.5.3. Avoided Fossil Fuel Emissions

Biofuels have the potential to mitigate climate change by avoiding emissions in two ways. First, emissions can be avoided through improved efficiencies in farming via the production of feedstocks, such as employing conservation tillage and irrigation system upgrades. The second way to avoid emissions is from substitution for fossil fuel combustion. The two main fuels for mitigating emissions currently are ethanol and biodiesel. Ethanol is produced from biomass crops high in sugar (e.g. sugarcane) or starch (e.g. corn using fermentation or heat and catalytic reaction processes to convert biomass into ethanol). Biodiesel can be made from feedstocks that contain high amounts of vegetable oil, such as palm, soybean, algae, or jatropha through a process of transesterification.

Ethanol production in the U.S. has increased significantly in recent years. In 2007, an estimated 130 ethanol biorefineries produced 6.5 billion gallons. A study by Wang et al. 2007 suggests the GHG emission impacts of using corn ethanol vary from a slight increase of 3 percent (if coal is used as process fuel) to 52 percent reduction (if wood chips are the process fuel). These estimates utilize the GREET model which does not account for potential GHG emissions increases from indirect land use change. Cellulosic ethanol has the potential to expand biofuel markets and reduce GHG emissions even further, but production has not yet become commercial. Biodiesel production too can avoid emissions from fossil fuel combustion. Like ethanol production, biodiesel production has increased significantly in the past five years (Figure 4).

The ability to claim credit within a cap and trade program for emission reductions occurring as a result of biofuel use will depend on the rules of the program. As discussed elsewhere, there are possible double counting dangers given that carbon credits may also be potentially claimed for biofuels related reductions under the federal RFS and separately by the California LCFS. Because the competing fuels (e.g. petroleum-based) will likely be covered by the cap, there is also the potential for double counting GHG reductions benefits to the agriculture sector under a cap and trade program.

Figure 4: Increase in Production of Biodiesel



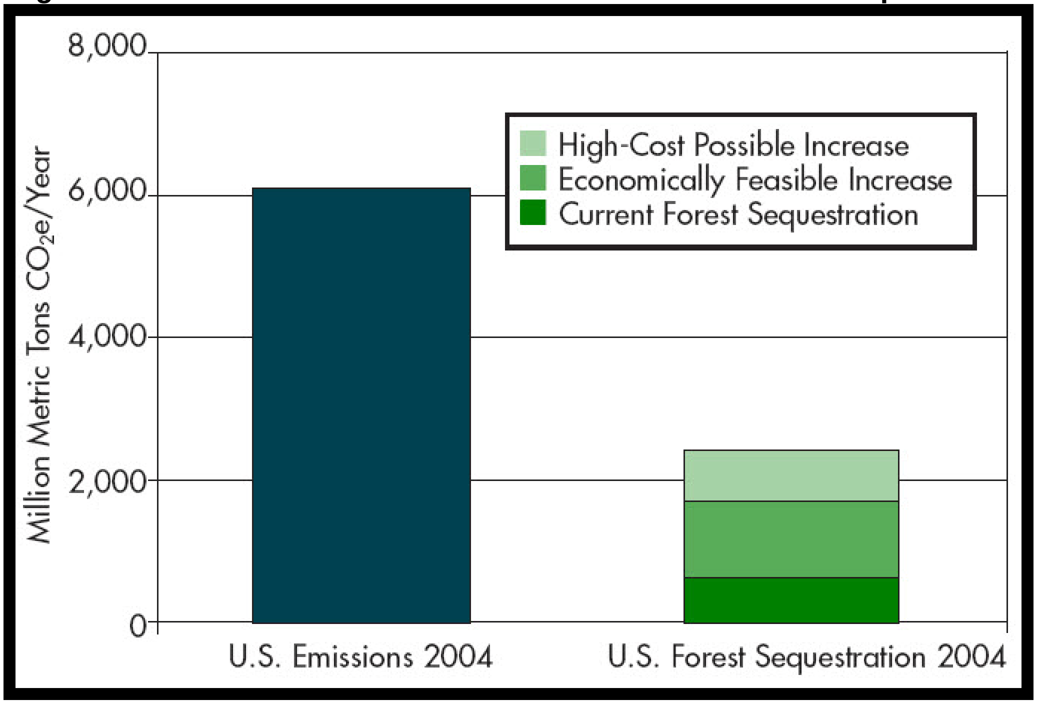
Source: (National Biodiesel Board, 2008)

2.6. Scope of Potential Opportunities for Forestry

U.S. forests store about 152,236 MMT CO_2e which accounts for 2 percent of global terrestrial carbon stores. An additional 8,781 MMT CO_2e are stored in wood products and in landfills (EPA 2007a; Ingerson, 2007). Unlike many countries where deforestation rates exceed regeneration rates, the forest in the U.S. sequesters more carbon than it emits. In other words, the forest-related carbon sink is actually increasing in the U.S. This can be easily or drastically changed by widespread fire or disease, however.

Presently, our annual forestry sequestration is equal to about 10 percent of annual U.S. CO_2 emissions. With the right policies we could sequester as much as 36 percent of U.S. CO_2 emissions, although the high costs may make this unlikely (Figure 5) (Ingerson, 2007). While reaching this level of sequestration may be costly, there are many forestry actions that will sequester carbon and for which offset accounting methodologies are or will likely be available.

Figure 5: U.S. CO2 Emissions and Current Potential Forest Sequestration



Source: (Ingerson, 2007)

2.6.1. Forestry Biological Sequestration Fluxes

There are different ways and slightly overlapping categories which describe how forestry and related wood products activities can offset emissions.

1. **Afforestation (Forestation)** – The Intergovernmental Panel on Climate Change (IPCC) defines afforestation as the planting of trees on lands that have not contained forests (IPCC, 2001).
2. **Reforestation** – Reestablishment of forest on land recently devoted to forestry, such as burned land or recently harvested land. Carbon sequestration through tree planting or regeneration is the most easily documented means of boosting forest carbon and most commonly traded in voluntary offsets marketplace.
3. **Forest management** – Managers can enhance carbon sequestration through certain management practices, such as selecting specific species, varying harvesting rotations, and managing for pests and fires. Carbon sequestration through changes in forest management can provide many added benefits, such as preserving a host of other ecosystem services.
4. **REDD (Reduced Emissions from Deforestation and Degradation) -** Forest preservation to avoid deforestation provides incentives for developing countries to cut emissions by preserving forests or having better forest management. Deforestation and degradation are defined differently. Deforestation is forest conversion to pasture land, crop land, or other managed uses. Forest degradation occurs when changes in the forest negatively affect its production capacity, such as gradual thinning of forests. At present, REDD is primarily an option for carbon market credits in developing countries.
5. **Wood products** – There is a potential for durable wood products to qualify as carbon offsets. Harvested wood products serve as reservoirs of carbon that are not immediately released to the atmosphere when harvested. The amount of carbon sequestered in products depends on how much wood is harvested and removed from the forest, what the products are harvested

for, and the half-life of wood in the products (Smith, 2005). Typically, only a fraction of the stored carbon in live trees make it to wood products (15-40 percent), and not all of the fraction of the carbon stored in wood products remains for an extended period of time. The Department of Energy's 1605(b) voluntary reporting program has fairly straightforward accounting methods that provide estimates of net carbon stored in harvested wood products, which makes for easier project implementation.

Another opportunity for offsets in the forestry sector is for wood products to substitute for concrete construction. Several studies have shown that wood-based building material usually results in lower energy use and CO_2e emissions compared to other materials such as concrete, brick or steel (Sathre, 2008). A study conducted by the Consortium for Research on Renewable Industrial Materials suggests that carbon storage for wood products, if considered a substitute for concrete construction, is substantial. Concrete manufacturing releases large amounts of CO_2e emissions. If wood products replace concrete construction there is the potential for offset credits from avoided GHG emissions from fossil fuel combustion (Ingerson, 2007). In many instances credits will depend on the design of the policy. Credits may be counted in the industrial sector as its fossil energy inputs are reduced due to lower demand for concrete, instead of credited to the forestry sector.

2.6.2. Avoided Fossil Fuel Emissions

Short-rotation wood crops (SRWC) along with other wood biomass feedstock can play a significant role in reducing fossil fuel emissions. Woody biomass can be a substitute for fossil fuel directly via combustion or indirectly through cellulosic biofuels production. One potential opportunity that exists is to use forest biomass ("slash") that is often left when forests are thinned or cut for timber. In 2004, the U.S. Forest Service estimated that 780,000 tons of woody biomass is generated on National Forest land in the Fuels for Schools program per year (DNRC, 2008). But as with biofuels and wood products, the ability to claim credit for emission reductions occurring as a result of substitution depends on the construction of the larger cap and trade program.

2.7. Macroeconomic Impacts of Policy

This section addresses the question: Given that cap and trade is the leading contender for a national policy, what macroeconomic impacts should be expected from such a policy?

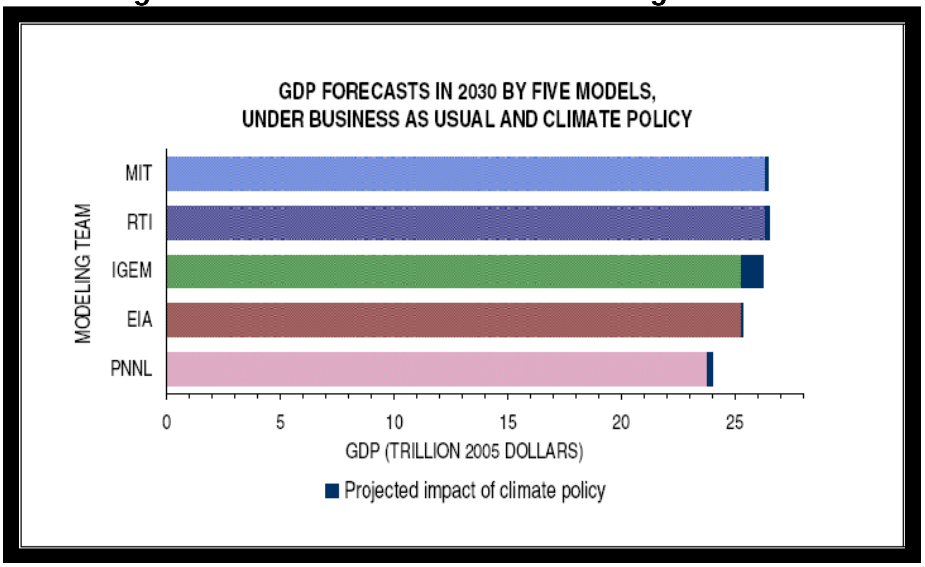
In general, regulation for GHG emissions means that firms and individuals will have to change their behavior from business as usual. Changing behavior incurs costs. How great are these costs to firms and individuals? Several models have examined the impact of a domestic cap and trade policy on energy prices, GDP, employment, and distribution of those costs. Independent reviews or meta studies of an array of models conclude that the economic impact of a cap and trade policy on the U.S. economy would be moderate (Aldy, 2007; Jorgenson, 2008; Keohane, 2008).

The median projected impact of climate change policy in the U.S. is less than one-half of one percent of GDP for the period 2010-2030 and below three quarters of one percent of GDP through the middle of the century. To put it in relative terms, under a business as usual scenario the total output of the U.S. economy is expected to reach $26 trillion in January 2030. Under a cap and trade policy it will take four months longer, getting there in April 2030 (Keohane, 2008).

Testimony given by the Congressional Budget Office stated that a 15 percent cut in CO_2 emissions would cost the average household in the lowest one-fifth of all households, ordered by income, slightly more than 3 percent of its income. Under the same scenario, it would cost the average household in the highest one-fifth just under 2 percent of its income. There are alternatives discussed about how to correct for unintended income distribution effects falling disproportionately on the poorest households (Orszag, 2008; Goulder et al., 2008).

An important point to make is that any delay in action would increase the costs of mitigation as well as increase the risks of climate change. It makes economic sense to act now rather than later (Keohane, 2008).

Figure 6: GDP Forecasts from Modeling Scenarios



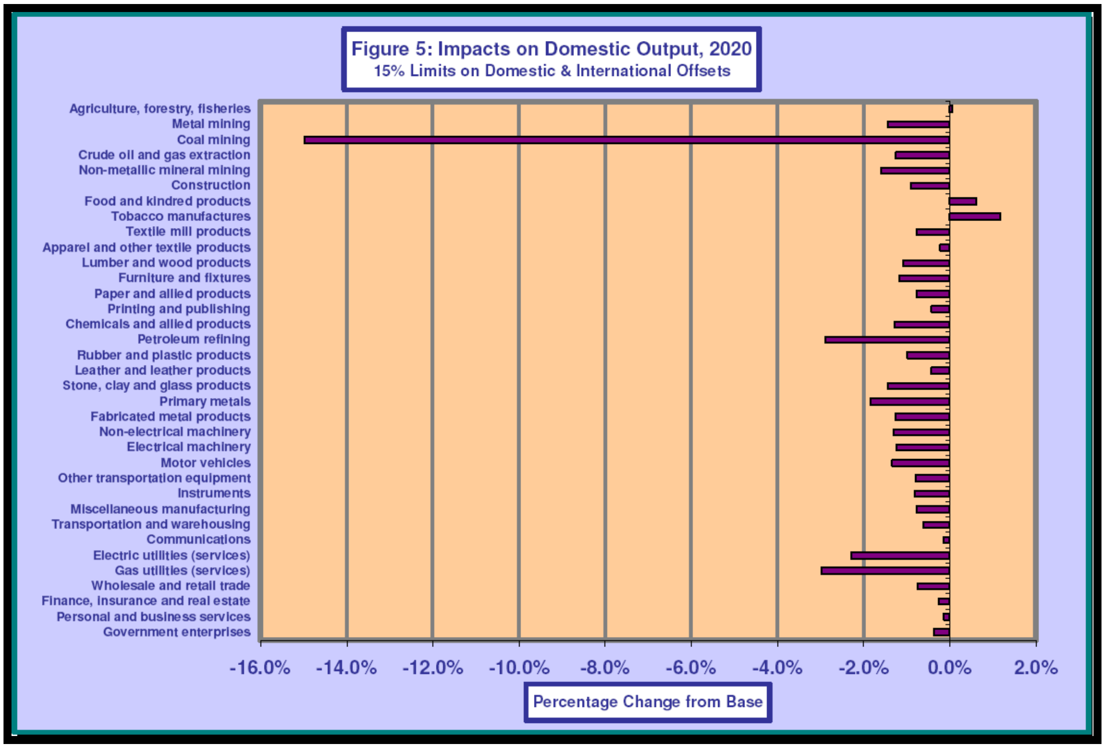
Source: (Keohane, 2008)

Climate change policy will have a greater economic impact on some sectors than others. Higher prices as a result of a cap would adversely affect firms in the energy and energy-intensive goods and services industry, which would create losses for some investors and workers in this sector (Orszag, 2008). Manufacturing, the most energy intensive industry, is likely to feel the greatest impact (Keohane, 2008). As illustrated in Figure 7, agriculture and forestry sectors, on the other hand, are the only sectors on the production side of the economy that are expected to experience a positive output as a result of mitigation (Jorgenson, 2008).

Because most economic models do not have the level of precision to estimate employment within specific industries, there is a dearth of information on the impact of mitigation policy on jobs. The Energy Information Agency (EIA) is the only model in the meta study that considered job projections. Overall, the model suggests there will be hardly any impact on U.S. jobs. However, manufacturing, the most energy intensive industry, is likely to feel the greatest impact (Keohane, 2008). While some sectors will likely experience job loss, mitigation will have a positive effect on other sectors, such as technology.

Basic economic theory dictates that firms will respond to increased prices by investing in the development of new technologies to reduce costs. This will provide new job opportunities. We know from history that the engine of progress in America is technological innovation. Over the past, we have developed new industries and adapted quickly to changing economies. Take for example the industrial revolution, the space age, and the new Internet age. Innovative industries do not develop on their own. It takes economic incentives to induce firms to invest in research and development. A cap and trade policy has the potential to provide this incentive.

Figure 7: Impacts of Mitigation on Production by Sectors



Source: (Jorgenson, 2008)

3. Recommendations

Guided by discussions and input from a wide cross-section of 25x'25 partners, the Carbon Work Group has developed the following principles and policy imperatives to aid stakeholders and policy makers in the nation's transition to a reduced carbon economy. The result is an evolving collection of recommendations regarding climate change policy, its implementation, and what must happen for the agriculture and forestry sectors to deliver maximum greenhouse gas emissions reductions.

3.1. Overarching Principles

The following overarching principles should be considered in the formulation of climate change policy:

- The environmental impacts (e.g. increasing frequency of wildfires, insect outbreaks and rising sea levels) and economic cost of inaction warrant action.
- Sufficient science and political momentum exist to warrant action now.
- Adaptation and mitigation must be pursued simultaneously.
- Sustainability must be considered in all policy decisions.
- The requirements of the global as well as national communities must be considered.

3.2. General Policy Principles

Any climate change policy to be considered:

- Should include emissions reductions, biological sequestration (removals), and avoided emissions.
- Should be designed to cover a term long enough to allow effective planning by both capped and uncapped sectors.
- Should recognize "early actors" under all policy options.
- Should be developed in a process that is outcome-oriented and technology-neutral, as well as neutral regarding the choice of the transactions marketplace.
- Must be enforceable.

3.3. Agriculture and Forestry Climate Change Principles

Any climate change policy encompassing agriculture and forestry:

- Must allow the sectors, which represent primarily diffuse emissions sources and/or sequestration opportunities, to deliver reductions.
- Must include a well-specified project qualification process that allows quick inclusion of new project types (e.g. enteric fermentation) that meet eligibility requirements.
- Must engage sector participation to the fullest available extent, given the sectors' potential to reduce hundreds of millions of tones of emissions per year.
- Must acknowledge and count climate change benefits in programs that reward landowners for other ecosystem services.

- Must recognize that the agriculture and forestry sectors will strive to produce emissions reductions that are complementary to their role as stewards of the land, protecting and enhancing the economic value of their land assets.
- Must include significant investment in research and development and education to actualize emissions reduction opportunities.

3.4. Overarching Cap & Trade Imperatives

If cap and trade is the ultimate policy vehicle, compliance with the following specific imperatives must occur for the delivery of real reductions by the agriculture and forestry sectors:

- Agriculture and forestry should be identified explicitly as uncapped sectors capable of generating significant quantities of GHG reductions.
- While offsets must be allowed, only qualified offsets will be acceptable. Qualified offsets must be real, additional to reductions that would have occurred without the offset credits verifiable, registered, substitutable at par for allowances, and permanent (or of a contracted duration).
- If allowances are auctioned under a cap and trade system, the funds generated could be beneficially used for a wide variety of program requirements, including conducting needed research and financing government carbon sequestration programs.
- Cap and trade program rules must balance environmental rigor and accounting precision against operational practicality.
- Offsets must be registered based upon reductions verified after the fact; no forward crediting based upon future expectations will be allowed.
- Under cap and trade, there must be recognition of both “early actors” in uncapped sectors and "credit for early action" within capped sectors.
- Under cap and trade, the system design must identify and guard against potential perverse outcomes, such as the temporary cessation of a practice in order to restart the same practice as a qualified additional project earning offsets.
- Cap and trade system design must guard against unintended collateral consequences such as water quantity or quality degradation.
- While there may be challenges relative to whether an offset project would have happened under a business as usual scenario, payments for other ecosystem services such as water quality improvements should not be precluded by participation in the carbon offsets markets. Rather, participation in multiple ecosystem service marketplaces should be allowed and the benefits should be “stackable.”
- International offsets should be allowed into a U.S. domestic cap and trade system under requirements that ensure compliance with domestic offset rules. They should be subject to the special requirements of trade agreements, reasonable quantitative limits, and reciprocal linkage to other broad-based programs such as the United Nations Framework Convention on Climate Change (UNFCCC) and international agreements, such as the Kyoto Protocol.
- Cap and trade program rules must clarify ownership and prevent double counting.

- Existing and proposed policies ancillary to, or parallel with, a federal cap and trade system must not conflict with cap and trade rules.
- While the Environmental Protection Agency should be the administrator of a cap and trade program, the USDA should be the administering agency with respect to agriculture and forestry offset project rules.

Appendices

Appendix A: 25x'25 Organizational Background

25x'25 is a diverse alliance of agricultural, forestry, environmental, conservation and other organizations and businesses that are working collaboratively to advance the goal of securing 25 percent of the nation's energy needs from renewable sources by the year 2025. 25x'25 is led by a national steering committee composed of volunteer leaders. The 25x'25 goal has been endorsed by nearly 800 partners, 30 governors, 14 state legislatures and the U.S. Congress through The Energy Independence and Security Act, which was signed into law by President Bush on December 19, 2007. 25x'25 is a special project of the Energy Future Coalition (EFC). The EFC is a broad-based non-partisan public policy initiative that seeks to bring about change in U.S. energy policy to address overarching challenges related to the production and use of energy.

Appendix B: 25x'25 Carbon Work Group Members

CHAIRMAN - Nathan Rudgers - Batavia, NY
Senior Vice-President, Director, Business Development, Farm Credit of Western New York; former Commissioner, New York State Department of Agriculture and Markets; former President, National Association of State Departments of Agriculture

Chuck Ahlem – Hilmar, CA
Owner, Hilmar Cheese Company

R. Bruce Arnold - West Chester, PA
Consultant, woody biomass utilization for the pulp and paper industry; retired engineer and manufacturer, Scott Paper Company

Peggy Beltrone - Great Falls, MT
Commissioner, Cascade County Montana; Member, National Association of Counties' Environment, Energy and Land Use Steering Committee

Dr. Antonio M. Bento – Ithaca, NY
Associate Professor, Cornell University, Department of Applied Economics & Management Directs environmental and energy economics program for public policy solutions on critical environmental and energy challenges such as climate change and renewable energy growth.

Doug Berven - Sioux Falls, SD
Director of Corporate Affairs, POET

Dr. Richard Birdsey – Newtown Square, PA
Program Manager, Northern Global Change Research Program, USDA Forest Service

Dr. Tracey Blackmer - Urbandale, IA
Director of Research, Iowa Soybean Association

Michael Bowman - Wray, CO
Wheat, corn and alfalfa producer; Steering Committee member, Colorado Renewable Energy Forum; Rural Chair, Colorado Ag Energy Task Force

Ray Brownfield - Oswego, IL
President, American Society of Farm Managers and Rural Appraisers

Dr. Leonard Bull – Raleigh, NC
Professor of Animal Science & Associate Director, Animal & Poultry Waste Management Center, North Carolina State University

Dr. R. Neil Elliott – Washington, DC
Industrial Program Director, American Council for an Energy-Efficient Economy

Glenn English - Arlington, VA
CEO, National Rural Electric Cooperative Association; former Co-Chair, U.S. Department of Agriculture, DOE Biomass R&D Federal Advisory Committee; former Member of Congress (6th-OK) 1974-1994; Chairman, House Agriculture Subcommittee on Environment, Credit, and Rural Development

Dr. Barry Flinchbaugh - Manhattan, KS
Professor of Agricultural Economics, Kansas State University; Chairman, Commission on 21st Century Production Agriculture

Robert Foster - Weybridge, VT
Dairy producer, Owner, Vermont Natural Ag Products, Inc.

Gary Freeman – Orland, CA
Chair, National Energy Committee, National Association of Resource Conservation and Development Councils**;** Past president of the California State Association of RC&D Councils

Jeffrey Frost – Burlington, VT
AgRefresh Executive Director, President of Renagen

Christopher Galik - Durham, NC
Research Coordinator, Climate Change Policy Partnership, Duke University

David Gardiner – Washington, DC
President, David Gardiner & Associates

Michael Goergen – Bethesda, MD
Executive Vice President and CEO, Society of American Foresters

Dr. Jerry Hatfield – Ames, IA
Supervisory Plant Physiologist, National Soil Tilth Research Laboratory, USDA-Agricultural Research Service; Past President, American Society of Agronomy

Dr. John Helms – Berkeley, CA
Past President, Society of American Foresters; Professor Emeritus, Environmental Science, Policy and Management, University of California-Berkeley

Dr. John Hickman - Moline, IL
Director, Biorenewable Energy and Life Sciences, Moline Technology Innovation Center Deere & Co

AG Kawamura – Sacramento, CA
Secretary of Agriculture, California Department of Food and Agriculture

Dr. Rattan Lal – Columbus, OH
Director, Carbon Management and Sequestration Center, Ohio Agricultural Research and Development Center, Ohio State University; Professor, School of Natural Resources College of Food, Agricultural, and Environmental Science, Ohio State University

Richard Lewis – Rockville, MD
President, Forest Resources Association

John Long – Newberry, SC
Past Chairman, American Soybean Association Board of Directors

Dan McClendon - Montrose, CO
General Manager, Delta Montrose Electrical Association

David Miller – West Des Moines, IA
Director, Research and Commodity Services, Iowa Farm Bureau

Dr. Keith Paustian – Fort Collins, CO
Senior Research Scientist, Natural Resource Ecology Lab; Professor, Department of Soil and Crop Sciences, Colorado State University

Tim Reich - Belle Fourche, SD
Cattle producer; Past president of the American International Charolais Association, and the South Dakota Association of Conservation Districts; Past Second VP, National Association of Conservation Districts

Dr. Charles W. Rice – Manhattan, KS
Professor, Department of Agronomy, Kansas State University; Lead Author, Inter-Governmental Protocol on Climate Change Working Group III Mitigation, 2004-2007

William Richards - Circleville, OH
25x'25 Steering Committee Co-Chair; Corn and soybean producer; former Chief, U.S. Department of Agriculture Soil Conservation Service

Bart Ruth - Rising City, NE
Corn and soybean producer; Past President, American Soybean Association; 2005 Eisenhower Fellow for Agriculture

Neil Sampson - Alexandria, VA
President of the Sampson Group, Inc. and President of Vision Forestry, LLC; Past EVP of American Forests and the National Association of Conservation Districts

Ernest Shea – Lutherville, MD
Project Coordinator, 25x'25 Alliance; President, Natural Resources Solutions, LLC; Past CEO, National Association of Conservation Districts

Matthew Smith – Falconer, NY
Director, GSA and Certification Services, Forecon, Inc.

J. Read Smith - St. John, WA
25x'25 Steering Committee Co-Chair; Wheat, small grains and cattle producer; former President, National Association of Conservation Districts

Tommy Smith – Monticello, AR
Chief Financial Officer, The Price Companies, wood processing

Dr. E. Dale Threadgill - Athens, GA
Director, Faculty of Engineering, and Dept. Head, Biological & Agricultural Engineering, the Driftmier Engineering Center, and the Biorefinery and Carbon Cycling Program, University of Georgia; private forest landowner

Tim Warman - Washington, DC
Executive Director, Global Warming Solutions Program, National Wildlife Federation

Kraig Westerbeek – Warsaw, NC
Director, Environmental Compliance, Murphy-Brown, LLC; Board Member, North Carolina Pork Council

Dr. Ann C. Wilkie – Gainesville, FL
Research Associate, Soil and Water Science Department, University of Florida - IFAS

Doug Williams - Alexandria, VA
Consultant to Association of Consulting Foresters of America, Inc.; Retired career employee of USDA-Natural Resources Conservation Service

Fred Yoder –Plain City, OH
Corn, soybeans and wheat producer; Past president of the National Corn Growers Association

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Staff:

Jeffrey Frost – Burlington, VT
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Anna Pavlova – Washington, DC
25x'25 Policy Liaison

Federal Agency Liaisons:

Dr. Joel Brown - Las Cruces, NM
Cooperating Scientist, USDA-Natural Resources Conservation Service

Bill Hohenstein – Washington, DC
Director, Global Change Program Office, USDA- Office of the Chief Economist

Work Product Development Process

1. The 25x25 Steering Committee formed a Carbon Work Group with a membership of both Steering Committee members and independent experts from the agriculture and forestry sectors, including experts and practitioners from the carbon markets policy and practice sectors.

Mission: Analyze agriculture and forestry's role in a reduced carbon economy and develop recommendations for how each sector can capitalize on efforts to reduce and capture greenhouse gas emissions.

2. Three Carbon Work Group Meetings held (April, July, and September).
3. A Technical Subcommittee was appointed and it held a telephone conference and worked to refine technical details in the interim between the July and September full Carbon Work Group Meetings.
4. Initially characterized as a "thought piece" or "white paper", the 25x25 Carbon Discussion Guide, as it is now called, is intended to be the primary information repository and overarching communications vehicle for the 25x25 carbon economy work on behalf of its ag and forestry sector stakeholders.

Appendix C: Acronyms and Abbreviations

CAA – Clean Air Act
CH_4 - Methane
CO_2 – Carbon dioxide
CO_2e – Carbon dioxide equivalent
MT CO_2e – Metric tonne of carbon dioxide equivalent
DOE – Department of Energy
CSP – Conservation Security Program
EIA – Energy Information Agency
EPA – Environmental Protection Agency
EQIP - Environmental Quality Incentives Program
GHG – Greenhouse Gases
IPCC – The Intergovernmental Panel on Climate Change
MMT CO_2e – Million metric tonnes of carbon dioxide equivalent
mpg – miles per gallon
MT CO_2e – Metric tonne of carbon dioxide equivalent
N_2O – Nitrous Oxide
REC – Renewable Electricity Credit
RGGI - Regional Greenhouse Gas Initiative
RFS – Renewable Fuel Standard
SRWC – Short-rotation wood crops
UNFCCC – United Nations Framework Convention on Climate Change
USDA – United States Department of Agriculture
USGRP - US Global Change Research Program
WCI - Western Climate Initiative

Appendix D: Organizations Engaged in Allied Action

The following are some of the other organizations, besides the 25x'25 Carbon Work Group, engaged in looking forward to the policy alternatives and technical measurement details on behalf of the agriculture and forests sectors within a carbon constrained future:

1. AFF – American Forest Foundation – Climate Working Group
2. AFT – American Farmland Trust - Carbon Initiative
3. Ag Carbon Markets Working Group
4. CASMGS – Consortium for Ag Soil Mitigation of GHGs
5. DMI – Dairy Management Inc. - Carbon Council
6. DC Working Group
7. Dole-Daschle 21st Century Ag Project
8. Midwestern Governors Association
9. Offset Quality Initiative
10. Society of American Foresters – Climate Change Carbon Sequestration Task Force
11. RSB – Roundtable on Sustainable Biofuels

Appendix E: Q&A (living) Document

Readers are invited to submit a list of questions for possible inclusion in an evolving set of Questions and Answers.

Here is the 25x'25 Q&A document link:

http://www.25x25.org/storage/25x25/documents/Carbon_Subcommittee/25x25_carbon_qanda.pdf

For another good Q&A document related to climate change and offsets for farms and forests, see this from the Nicholas Institute for Environmental Policy Solutions:

http://www.nicholas.duke.edu/ccpp/convenientguide/PDFs/harnessingfaqs.pdf

Appendix F: Ag and Forestry Vulnerabilities to a Changing Climate

There are expected to be effects on U.S. ecosystems from climate change, including for agriculture and forestry. Forest ecosystems and agricultural systems are intrinsically linked to climate. Ecosystems will be impacted which means humans will be affected as well.

The longer-term effects of climate change on agriculture and forests are less well known than short-term effects. For example, in the short term forest productivity is expected to increase, while in the long term changes in drought, fires, and disease may decrease forest productivity. Some of the effects of climate change on agriculture and forest sectors include: extended range and lifetime of pests and stress; higher temperatures and/or decreased precipitation; increasing drought stress; decreased water availability; reduced animal production of meat and dairy products in the summer; and increased fire hazards, among others as discussed in the following.

A study by the U.S. Global Change Research Program (USGRP) suggest that there will be a slight increase in forest and agriculture productivity at the average national level, but with large gains and losses in certain geographic regions. While the models used in this study suggest an average increase in productivity, they also assume other environmental factors remain constant, such as adequate nutrient and water availability. They do not account for potential consequences of warming, such as extreme drought or rising sea level. There could be catastrophic consequences on ecosystem structure and ecosystem functions, which are critical to human well-being. These models predict under a business as usual scenario, but without climate change mitigation, the future will be anything but business as usual.

Changing Climate Vulnerabilities for Agriculture

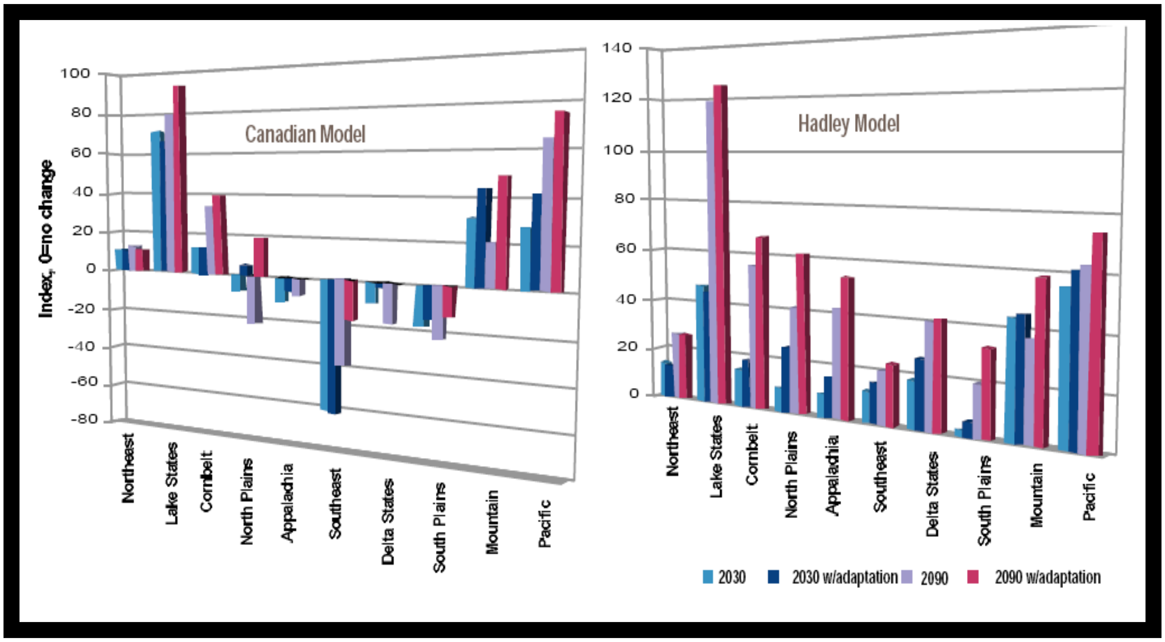
Climate Change Impacts on Production

Predictions on the effects of climate change on agriculture vary greatly, primarily because of the limited ability to predict environmental and financial factors that affect crop yields (Branosky, 2006). Overall, the U.S. agriculture sector is expected to adapt to climate change with a predicted net gain in productivity, but the gains will not be uniform across the nation (NAST, 2001).

Research conducted by the US Global Change Research Program (USGRP) suggests the U.S. agriculture will benefit in the long-term because higher carbon dioxide levels will increase crop yields in many geographic regions. The Hadley and Canadian models were used in the USGRP study to estimate the regional effect of climate change in the U.S. The Hadley model predicted that all regions in the U.S. would exhibit high yields in the next century. The Canadian model predicts slightly lower yields than the Hadley model and a yield loss in the Southeast (Figure 8). The increase in yields is attributed to greater concentrations of CO_2, which enhances photosynthesis, longer growing seasons, and warmer temperatures

Individual crops respond differently to increased levels of CO_2. Most commercial crops in the U.S., including wheat, rice, barley, oats, and potatoes tend to show yield increases of 15-20 percent with a doubling of atmospheric CO_2 concentrations. Other crops such as corn, sorghum, sugar cane, and tropical grasses show yield increases of about 5 percent under the same conditions. In general, horticultural crops, such as tomatoes, onions, and fruits are more sensitive to minor environmental stresses than grain and oilseeds and may not react favorably to climate change (USCCSP, 2008).

Figure 8: Regional Crop Production Changes Relative to Current Production



Source: (NAST, 2001)

It is important to note there is a great deal of uncertainty about the overall impact that climate change will have on agricultural systems. The Hadley and Canadian models are based on assumptions that adequate nutrient and water availability will support temperature increases. It is possible that unanticipated impacts of climate change will occur in the next century and models cannot predict these cause-and-effect scenarios. These unforeseen changes in ocean circulation, cloud distribution or storms can have a major impact on agricultural productivity.

Many ecosystems are highly vulnerable to the projected rate and magnitude of climate change. While the agriculture sector is expected to adapt to climate change at the national level, the increased temperature will have a profound effect at the regional level, with crop ranges tending to shift northward. Increases in temperature will also likely lead to northern migration of invasive weeds. This may force U.S. farmer to plant hardier crops or use more pesticides to maintain current crop yields (Branosky, 2006). Primary climate change challenges identified in the report by the U.S. Climate Change Science Program (USCCSP) (2008) include:

- **Weather variability** – Generally, climate change will result in more moisture across large areas of the U.S., but not in a consistent pattern; consequently, some regions will become wetter while others experience increased temperatures and decreased precipitation. At the same time, more severe weather events are anticipated.
- **Crop ranges** – As the average temperature rises over time, crop ranges extend northward at the approximate rate of 60-90 miles per degree Fahrenheit. With breeding for cold tolerance, the Corn Belt is moving into the prairie provinces of Canada. Adaptation of crop selection may be required in the southern reaches of a crop when the average weather conditions become too warm and dry.
- **Water resources** – In drier areas of the country, drawdown of aquifers can be accelerated by increased demand due to climate change. Excessive depletion could

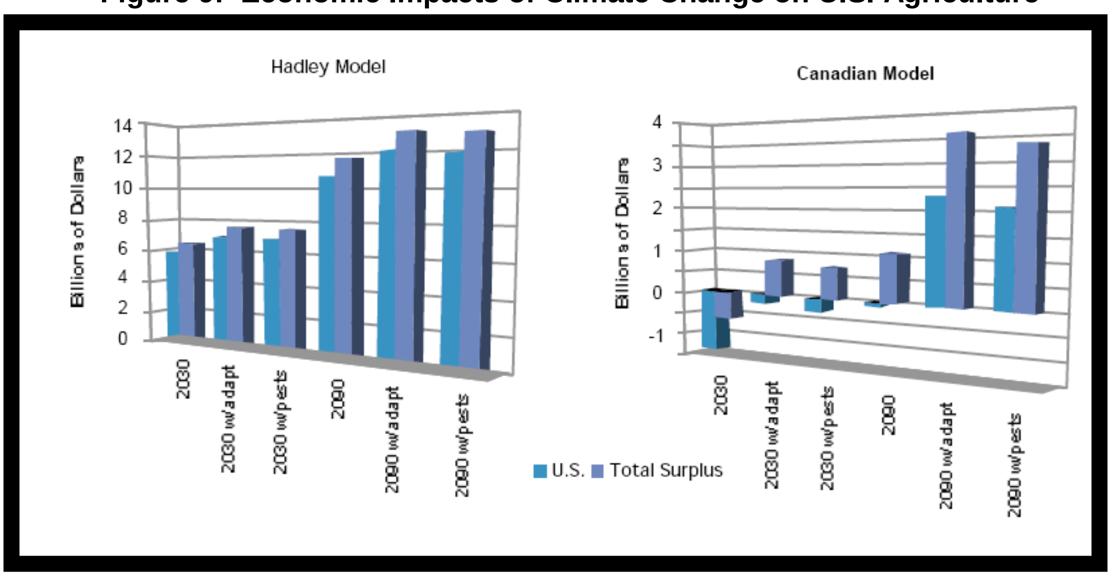
increase the cost of pumping for agricultural and urban uses and can have negative effects on wetlands, water levels in rivers and lakes and threaten wildlife and recreation. Climate change will also reduce snowpack and spring flow. In wetter areas of the country, the increase of frequency and intensity of storm events will increase soil erosion and nutrient runoff from crop and livestock production.

- **Soil health** – Climate change and extreme weather events will alter soil microbial populations and diversity. Excessive runoff from increased storm activity can increase soil erosion and carry sediment, fertilizer and chemicals into receiving streams and rivers.
- **Insects, weeds and pesticides** – Cold-sensitive insects such as fire ants are expected to move northward into the Corn Belt. With a warmer and wetter climate, pesticide use is likely to increase. The U.S. Global Change Research Program estimates that when rainfall increases by one percent, corn pesticide costs will increase by 1.49 percent. In riparian zones, the competition between native and invasive exotic species is likely to shift towards exotics as temperature increases.
- **Animal production** – Warmer temperatures reduce livestock production during the summer. Climate changes that matter most to ruminants are increases in temperature levels, increases in nighttime temperatures and increases in the frequency of heat waves. These conditions will also affect certain parasites and pathogens with adverse effects on host animals. Livestock managers can cope with these changes with adaptation.

Climate Change Impacts on Economies

The U.S. is a major supplier of food and fiber in the world, accounting for more than 25 percent of the total global trade. Overall, models predict that as a result of increased yields, consumers will profit from lower prices and agricultural producers' profits will decline. These economic effects on the national economy are expected to balance themselves out or be slightly positive, depending on the model being considered (Figure 9).

Figure 9: Economic Impacts of Climate Change on U.S. Agriculture[8]



Source: (NAST, 2001)

[8] The economic impact index is change in welfare expressed as the sum of producer and consumer surplus in billion dollars. Overall, there were net economic benefits for the U.S. national economy (NAST 2001)

Under the Canadian scenario there is a small net effect on the national economy. Producers' are expected to experience a reduction in producer profits of $4-5 billion while consumers will save $3-6 billion on food and fiber expenditures. Under the Hadley scenario producers' profits decline by $3 billion while consumers save $9-12 billion, resulting in a greater net positive effect on the national economy.

The Hadley model predicts greater productivity from climate change, resulting in lower food prices and providing the consumer with a greater benefit. The smaller producer loss in the Hadley scenario, despite greater yields, assumes a policy scenario where U.S. farmers will have a competitive advantage over foreign competitors and will be able to increase export volume (NAST, 2001).

Changing Climate Vulnerabilities for Forestry

Climate Change Impacts on Production

Similar to agricultural systems, the effect of increased temperatures on forestry may vary depending on the spatial and temporal scales being considered and local conditions such as moisture stress and nutrient availability. In the short term, forest productivity is expected to increase, while in the long term changes in drought, fires, and disease may decrease forest productivity.

Forest productivity will also vary between regions in the U.S. For most regions, carbon storage is expected to increase. However, the Southeast and Northwest regions could experience drought-induced losses of carbon with higher potential of fire disturbance (NAST, 2001). Climate change will also change species composition, which will have an impact on regional industries. For example, in the Northeast forests, sugar maple will mostly likely be lost, which will affect the maple syrup industry in New England.

Natural ecosystems appear to be the most vulnerable to the harmful effects of climate change because there can be little done to help them adapt. Many ecosystems like the alpine meadows in the Rocky Mountains are likely to experience heavy stress and possibly disappear all together. In the Southeast, there is the potential for forests to become fragmented into scattered pieces of forest, savannas, and grasslands. As mentioned before, certain specie composition will likely shift, causing a change in distribution and abundance of plant and animal species leading to local disappearances and introduction of new ones (USCCSP, 2008).

The biggest challenges to forest ecosystems identified by the U.S. Climate Change Science Program (2008) are:

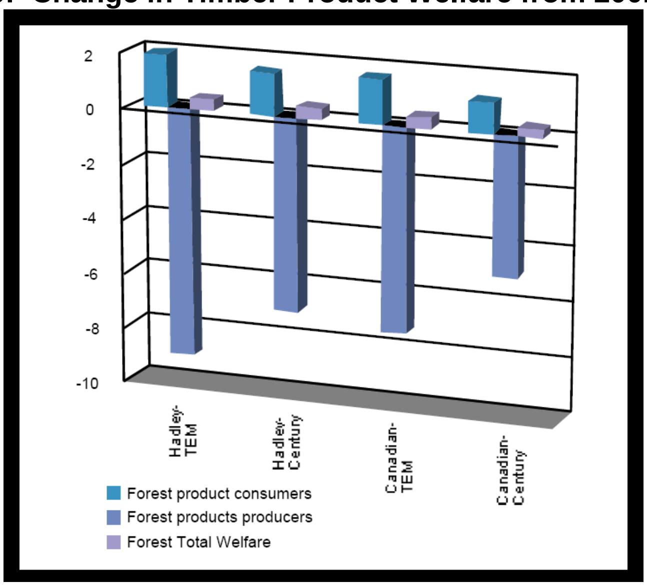
- **Forests** –Over the next 30 years, if warming continues large, stand-replacing wildfires are likely to increase and the range and frequency of large insect outbreaks are also likely to increase. Hadley and Canadian climate scenarios predict fire hazards will increase by 10 percent in the U.S. Tree mortality in interior West, Southwest, and Alaska is expected to occur.
- **Wildlife** – Climate change has contributed to earlier migrations, shorter hibernations, changes in range patterns and severe impacts on some species.
- **Riparian systems-** The net result of climate change is likely to be greater depletion of water along riverine corridors. In addition the balance of competition between native and non-native species in riparian zones is likely to continue to shift toward favoring exotics.

- **Biodiversity-** Scientists have concluded that there are observable impacts of climate change on terrestrial ecosystems in North America, including in the timing and growing season length, phenology, primary production, and species distributions and diversity. Species community composition will likely differ from those of today.

Climate Change Impacts on Economies

North America is the world's leading producer and consumer of wood products. The overall predicted increase in forest productivity will result in increased timber inventories over the next century. The increased wood supply leads to reductions in log prices that will decrease producers' profits (Figure 10). On the other hand, lower forest-product prices means the consumers benefit. The predicted net effect on the national economy increases about 1% from climate change impacts on the forestry sector (NAST, 2001).

Figure 10: Change in Timber Product Welfare from 2001 to 2100



Source: (NAST, 2001)

Appendix G: References

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