Encouraging Carbon Sequestration on Private Agricultural Lands in the United States

Extended Abstract # 35

Adam S. Chambers
Air Quality Scientist, USDA-Natural Resources Conservation Service,
West National Technology Support Center, 1201 NE Lloyd Blvd, Suite 1000, Portland, OR 97232 Email: adam.chambers@por.usda.gov Phone: 503.273.2410

INTRODUCTION

The Natural Resources Conservation Service (NRCS) of the US Department of Agriculture works primarily with private land owners to conserve and maintain the productivity of our country's farms and ranches. Soil conservation and airborne particulate matter were the original priorities of the NRCS when the agency was founded in response to the Dust Bowl in the late 1930s. Gradually the NRCS has expanded the breadth of its conservation priorities to include soil, water, air, plants, animals, human health and most recently energy. These conservation priories, known inside the agency by the acronym SWAPA plus H&E, serve as the basis for all of the prescriptive conservation management measures that NRCS implements with the cooperation of private land owners.

Conservation practices supported by NRCS are intended to address specific resource concerns, ranging from threatened and endangered species to soil erosion and ambient air quality. The global climate seems to be changing more rapidly than expected and the agrarian community is on the front lines of these changes. This sector must adapt to meteorological changes such as drought, increased precipitation intensity, warmer winter minimum temperatures, and changes in water timing and availability. Conservation practices that are implemented on private lands should anticipate the changing climate and adapt to near-term changes. Current adaptation measures must be accompanied by greenhouse gas mitigation activities to minimize medium- and long-term climate change impacts anticipated under worst-case climate change model projections.

This extended abstract attempts to identify conservation actions taken to reduce greenhouse gas (GHG) emissions and sequester additional carbon on agricultural lands. The agricultural sector should view this as an opportunity, the opportunity to sequester atmospheric carbon on private lands as a co-benefit to traditional conservation programs. Atmospheric carbon sequestration and land conservation should be integrated to accomplish multiple objectives under the guise of a single conservation practice. Partnerships between private landowners and the NRCS have the ability to reduce GHG emissions, enhance the supply of carbon sequestration credits available to emissions trading programs, increase soil and biomass carbon, and accomplish the conservation goal of enhancing land, soil, air, and water quality.

This extended abstract provides an overview of U.S. private lands and the role that NRCS is playing to enable private landowner conservation practices. The environmental benefits of existing conservation programs are quantified within this abstract and provides an assessment of the carbon co-benefits of existing conservation programs. An example of a private landowner utilizing an NRCS conservation easement to participate in a carbon transaction is provided to exemplify the potential for environmental and economic co-benefits. This abstract concludes with a summary of quantification tools and a discussion of the potential for sequestering carbon on private farm and ranch lands in the U.S. agricultural sector.

METHODS

Overview of U.S. Private Lands and Enabling Private Landowner Conservation Practices

According to the 2007 USDA census of agriculture the United States has a total land area of approximately 2.3 billion acres. Nearly 70 percent of these lands are privately owned and 39 million acres are enrolled in the USDA pillar conservation programs[1]. A quick back-of –the-envelope calculation estimates that 1.6 billion acres of US lands are privately held with 2.4 percent of those lands being enrolled in land conservation programs. That leaves more than 1.5 billion acres (97.3 percent) of privately held land in the US that is not enrolled in any land conservation programs.

Granted, this large number of privately held acreage includes urban and suburban residential lands, marginal lands, plantations, golf courses, baseball fields, and other land applications that are not practical for conservation management. However, these numbers also convey an opportunity, there is plenty of room for increasing conservation programs on private lands. A doubling of conservation lands would have a nominal 5 percent of privately held lands enrolled in land conservation programs. In summary, there are plenty of non-conservation private lands available for physically increasing land conservation in the US.

The economics of America's farms demonstrate a need for additional revenue streams. Only 40 percent of all farms in the US report greater than $10,000 in sales of agricultural products. Furthermore, only 45 percent of US farms actually show a net cash income from the farm operation[2]. Slightly more than half (55 percent) of the 2.2 million farms in the US depend on non-farm income to cover farm expenses.

These statistics have been presented to shed light on a seemingly perfect partnership. Farms in the US desperately need additional revenue streams and the ecosystem services provided by private land conservation can serve as an additional monetized commodity and supplemental revenue stream. Soil and biomass carbon sequestered by the land, along with other ecosystem services such as nitrogen removal from runoff, should be used as an added-value commodity that drives revenue to private land owners who practice additional (in the carbon context) land conservation measures.

Creating additional carbon sequestration through private land conservation is a fairly simple concept. Landowners increase the above ground and below ground carbon stocks through no-till farming, conservation cover, silvopasture establishment, riparian forest buffers, vegetative barriers, windbreaks, etc. and the commodities market or carbon aggregators purchases the atmospheric decarbonization credits for a premium. The atmospheric decarbonization credits should be viewed as a market commodity and not exclusively as a necessary service supporting a cap and trade program. Commodity valuation of ecosystem services should be independent of any regulatory cap and trade program. It is certainly possible for such commodity valuation to support a national greenhouse gas cap and trade program but the intention is to place an autonomous price on decarbonization of the atmosphere and avoid the intermingling of enhanced ecosystem services with any regulatory scheme. Enhanced carbon sequestration through land conservation should be treated as commodity that commands a premium, similar to corn, oats, and oranges.

In order for conservation practices to be implemented and cost-shared by NRCS, the management practices must demonstrate benefits to at least one of the SWAPA plus H & E (soil, water, air, plants, animals, health, and energy) resource concerns. Several NRCS tools have been designed to support enhanced carbon uptake and reduce farm-level GHG emissions. These tools, including the decision support tool COMET, are discussed in the next section.

Table 1 contains a list of the most relevant NRCS land management practices that actively promote above- and below-ground carbon accumulation. **Table 2** lists other NRCS conservation measures that reduce GHG emissions through conservation. Conservation management practices like no-till farming increase soil carbon and reduce nitrogen emissions to the atmosphere and also reduce fossil fuel emissions from tillage equipment. The conservation measures in the Tables result in real and quantifiable emission benefits that can be verified. The emission benefits can be bundled if necessary, and sold as an environmental commodity.

Quantifying the Environmental Co-Benefits of Conservation Programs: Tools and Methodologies

There are a number calculation tools and methodologies being developed to quantify the benefits of land use change and forestry techniques being applied to the US landscape. The methodologies include quantification techniques for assessing the carbon benefits of avoided grassland conversion, avoided deforestation, no-till and precision agriculture, etc. and the avoided direct GHG emission from the utilization of conservation techniques in nutrient management, rice cultivation, etc. Organizations actively engaged in the development of quantification protocols include the American Carbon Registry (ACR), the Verified Carbon Standard (VCS), and the Climate Action Reserve.

Tier 1 emission factor-based quantification methodologies are available for the simpler conservation management practices (primarily carbon).Complex nitrogen emission benefits are quantified through more resource-intensive computer modeling approaches. Computer-based tools like COMET-VR, DNDC, and NTT quantify atmospheric and aquatic nitrogen emissions. These tools rely on a suite of user inputs to establish a baseline and evaluate emissions associated with management changes. Environmental benefits identified by the tools are intended to support nascent trading schemes like the nutrient management in the Chesapeake Bay and California’s Assembly Bill 32 - Global Warming Solutions Act. Draft and final quantification protocols often rely on one or more of the computer-based tools as an integral component of the methodology.

RESULTS

Current GHG Benefits of NRCS Conservation Practices and the Potential for Carbon Sequestration and GHG Emission Reductions on U.S. Agricultural Lands

Conservation programs offer an opportunity for US landowners to reduce emissions by increasing soil carbon, enhancing biomass productivity, and reducing nitrogen emissions from nutrient applications. These climate change mitigation benefits can be synergistic and harmonious with efforts to increase productivity. Highly efficient fertilizer applications reduce N_2O emissions, maintain yield performance, and optimize nitrogen availability for uptake by crops. Improving soil carbon through no-till farming also reduces soil erosion, dual benefits from a single conservation management practice. The term “conservation” does not necessarily mean changing the service provided by the land but rather improving efficiency and helping the land deliver an anthropocentric service more efficiently.

The NRCS works with private landowners to promote various conservation programs that also provide carbon sequestration and GHG emissions mitigation benefits on private lands. Conservation programs that provide these benefits include Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), Grassland Reserve Program (GRP), Conservation Technical Assistance (CTA), Wetlands Reserve Program (WRP), and the Wildlife Habitat Incentives Program (WHIP). The individual programs and the total GHG benefit for each program are summarized in **Summary Table 1**. The results in the summary table are cumulative for the entire United States and demonstrate a 34 percent increase in private land conservation-based emission reductions and carbon sequestration between 2007 and 2010.

Summary Table 1: NRCS Programs Fiscal Year 2007 and 2010 (Oct. 1- Sept. 30) GHG emissions reductions and carbon sequestration* (metric tonnes CO_2e)

Program	2007	2010
EQIP	3,938,900	3,969,900
CTA	3,927,600	8,250,500
GRP	7,400	32,600
WRP	184,000	104,600
WHIP	251,900	240,900
CSP	25,400	7,600
TOTALS	**8,335,200**	**12,606,100**

*Data compiled by Greg Zwicke and Greg Johnson and published internally

This analysis suggests that GHG emissions and carbon sequestration is increasing on private lands due to additional conservation practices. In 2010, reduction of 12.6 million metric tonnes of CO_2e was achieved through the application of NRCS practices. Acreage enrollment in Upland Wildlife Habitat Management, Prescribed Grazing, Windbreaks, and Shelterbelts were largely responsible for the increased carbon sequestration which more than offset a decrease in residue/tillage management and a limited number of anaerobic digester installations. Acreage under contract for the Nutrient Management practices under EQIP decreased by nearly 1 million acres from 2007.

It should also be noted that these numbers are for present contracts and do not represent the much larger pool of GHG-benefitting practice activities that are occurring in the U.S. due to NRCS investment and leveraging over previous years. For instance, current U.S. acreage in no-till related contracts is approximately 2 million, but credible estimates by the Conservation Technology Information Center and the National Agricultural Statistics Service put the total national acreage currently under no-till management to be between 40 and 60 million acres. The conservation benefits are having an impact on the landscape but there is plenty of room for improving conservation in the US agricultural sector. The 12.6 million metric tonnes of CO_2e benefits from NRCS conservation practices seem nominal when compared to the 419.3 million metric tonnes CO_2e of US emissions from the agricultural sector[3]. Documented conservation practices for the US are equal to a meager 3 percent of the agricultural footprint. There is clearly an opportunity for increasing conservation on the US landscape while mitigating the cause of global climate change.

Historic work by NRCS has no doubt multiplied many times over the actual contract effort in any one year, and thus the national GHG benefit of conservation on private lands is many times more than the contracted benefit shown above in Summary Table 1. It is very likely that continued prioritization and investment in these programs will make a significant impact on agriculturally-related GHG budgets in the U.S. over the coming decade.

Example of Private Landowners Utilizing NRCS Conservation Easements to Facilitate Carbon Transactions – Environmental and Economic Co-Benefits

In July 2011, Goldman Sachs, Blue Source, and CE2 Carbon Capital completed the final components of a $12 million carbon offset transaction.[4] According to sources involved in the transaction, a significant portion of the $12 million transaction is directly attributable to NRCS conservation programs but not the entire $12 million. The exact number of credits bundled for this transaction and the price per credit is confidential business information and has not been publicly released. In their press release Goldman Sachs does state that this is the largest publicly announced carbon offset transaction in North America.

The project is referred to as the Alligator River Avoided Conversion Forestry Project. In this project, the private conservation-minded landowners chose to forego future hardwood harvests and draining of the previously harvested coastal plains in exchange for an NRCS Wetland Reserve Program (WRP) easement and the potential for a carbon offset revenue stream. The tract of land is a 2,372 acre of high conservation value wetlands in Hyde County, North Carolina. The project is the first wetland conservation/carbon credit project as well as the first avoided forestry project located outside of California to be listed by the Climate Action Reserve.

In order for a carbon offset project to generate carbon credits the avoided forestry projects must clear four significant hurdles, emission reductions must be:

- **additional**
- **quantifiable**

- **real**
- **permanent**

The mechanism or instrument for assuring "permanence" in the 2,372 acre Alligator River Forestry Project is the Wetland Reserve Program Agreement (No. 66-4532-8-003/6645320800MHX) signed by J.B. Martin, NC State Conservationist, on May 13, 2010 for the sum of $1,541,852. Project details of particular interest include:

- The project developer stated that the NRCS WRP permanent easement was critical for bringing the emission reduction credits from this project to the nascent market.
- Carbon benefits were quantified for the following four carbon pools, not just standing carbon:
    - Live standing biomass carbon
    - Below ground biomass carbon
    - Lying dead carbon
    - Standing dead carbon
- The live standing biomass carbon and the below ground biomass carbon are the critical carbon offset components that make this project attractive to the developer.

Summary

In the Alligator River Avoided Conversion Forestry Project the owners of the wetland forest chose to harvest the ecosystem services of their property through wetlands preservation and carbon sequestration rather than timber. The Alligator River Avoided Conversion Forestry Project is a first of its kind but the landowners were encouraged by the success of this project and currently are investigating other projects.

As nascent US markets begin to value carbon sequestration and avoided emissions, it is likely that conservation services will be viewed as providing ecosystem benefits that command a commodity price just as corn commands a price for providing food and fuel. The potential for atmospheric co-benefits from conservation practices seems to provide an opportunity without a negative consequence, truly an opportunity for mitigating the cause of climate change, increasing productivity, and improving land, air, and water quality. There is plenty of land that is not yet enrolled in a conservation program, the land is available and the nation's farmers and ranchers are certainly in need of additional revenue streams. Assigning a fair market value to the ecosystem services of conservation lands is the first step in valuing these services as limited commodities.

ACKNOWLEDGMENTS

The information, views, and opinions herein are the responsibility of the individual paper author and do not represent the opinions of the United States Department of Agriculture nor the Natural Resources Conservation Service (USDA-NRCS). The author assumes all responsibility for errors and oversights. Special thanks are extended to Greg Zwicke and Dr. Greg Johnson for their work in quantifying the GHG and carbon sequestration benefits of NRCS conservation measures. Their work made the development of this extended abstract much easier.

Table 1: NRCS Conservation Practice Standards that Promote Carbon Sequestration on Private Lands

NRCS Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
327	Conservation Cover (Information Sheet)	Establishing perennial vegetation on land retired from agriculture production increases soil carbon and increases biomass carbon stocks.
329	Residue and Tillage Management, No Till/Strip Till/Direct Seed (Information Sheet)	Limiting soil-disturbing activities improves soil carbon retention and minimizes carbon emissions from soils.
379	Multi-Story Cropping	Establishing trees and shrubs that are managed as an overstory to crops increases net carbon storage in woody biomass and soils. Harvested biomass can serve as a renewable fuel and feedstock.
380	Windbreak/Shelterbelt Establishment (Information Sheet)	Establishing linear plantings of woody plants increases biomass carbon stocks and enhances soil carbon.
381	Silvopasture Establishment	Establishment of trees, shrubs, and compatible forages on the same acreage increases biomass carbon stocks and enhances soil carbon.
512	Forage and Biomass Planting (Information Sheet)	Deep-rooted perennial biomass sequesters carbon and may have slight soil carbon benefits. Harvested biomass can serve as a renewable fuel and feedstock.
612	Tree/Shrub Establishment (Information Sheet)	Establishing trees and shrubs on a site where trees/shrubs were not previously established increases biomass carbon and increases soil carbon. Mature biomass can serve as a renewable fuel and feedstock.
666	Forest Stand Improvement (Information Sheet)	Proper forest stand management (density, size class, understory species, etc.) improves forest health and increases carbon sequestration potential of the forest stand. Managed forests sequester carbon above and below ground. Harvested biomass can serve as a renewable fuel and feedstock.
332	Contour Buffer Strips (Information Sheet)	Permanent herbaceous vegetative cover increases biomass carbon sequestration and increases soil carbon stocks.
391	Riparian Forest Buffer (Information Sheet)	Planting trees and shrubs for riparian benefits also increases biomass carbon sequestration and increases soil carbon stocks.
601	Vegetative Barrier	Permanent strips of dense vegetation increase biomass carbon sequestration and soil carbon.
650	Windbreak/Shelterbelt Renovation (Information Sheet)	Restoring trees and shrubs to reduce plant competition and optimize planting density increases carbon sequestration.
311	Alley Cropping	Trees and/or shrubs are planted in combination with crops and forages. Increasing biomass density increases carbon sequestration and enhances soil carbon stocks.
390	Riparian Herbaceous Cover	Perennial herbaceous riparian cover increases biomass carbon and soil carbon stocks.
550	Range Planting (Information Sheet)	Establishing deep-rooted perennial and self-sustaining vegetation such as grasses, forbs, legumes, shrubs and trees improves biomass carbon sequestration and enhances soil carbon.
603	Herbaceous Wind Barriers (Information Sheet)	Perennial herbaceous vegetation increases biomass carbon sequestration and soil carbon.

NRCS Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
346	Residue and Tillage Management, Ridge Till (Information Sheet)	Ridge planting promotes organic material accumulation that increases soil carbon. Reconstruction of ridges in the same row year after year will maximize organic matter buildup in the row. Shallow soil disturbance maintains soil carbon in the undisturbed horizons.
632	Solid/Liquid Waste Separation Facility	Removal of solids from the liquid waste stream improves the efficiency of anaerobic digesters. CH_4 generation is maximized within the digester by separating solids from the liquid feedstock. Proper management of the solid and liquid waste streams increases CH_4 that is available for capture and combustion.
342	Critical Area Planting (Information Sheet)	Establishing permanent vegetation on degraded sites enhances soil carbon and increases carbon sequestration by adding vegetative biomass.
344	Residue Management, Seasonal (Information Sheet)	Managing residue enhances soil carbon when crop residues are allowed to decompose on a seasonal basis, increasing soil organic matter and reducing soil disturbance.
345	Residue and Tillage Management, Mulch Till (Information Sheet)	Soil carbon increases when crop residues are allowed to decompose, increasing soil organic matter and minimizing soil disturbance.
384	Forest Slash Treatment	Woody plant residues managed (chipped, scattered, etc.) on-site will increase soil carbon and soil organic matter. Forest slash that is removed can serve as a renewable fuel and feedstock.
386	Field Border (Information Sheet)	Permanent vegetative field borders sequester carbon and increase soil carbon content.
393	Filter Strip (Information Sheet)	Herbaceous vegetation in filter strips has slight carbon sequestration benefits and enhances soil carbon.
412	Grassed Waterway (Information Sheet)	Perennial forbs and tall bunch grasses provide slight carbon sequestration benefits, minimize soil disturbance, and increase soil carbon.
422	Hedgerow Planting (Information Sheet)	Woody plants and perennial bunch grasses increase biomass carbon stocks and enhance soil carbon.
543	Land Reclamation Abandoned Mined Land (Information Sheet)	Establishment of permanent trees, shrubs, and grasses on abandoned and unmanaged lands increases biomass carbon stocks and enhances soil carbon.
544	Land Reclamation Currently Mined Land (Information Sheet)	Establishment of permanent trees, shrubs, and grasses increases biomass carbon stocks and enhances soil carbon. Pre-mining baselines are important to establish prior to evaluating any carbon benefits.
589C	Cross Wind Trap Strips (Information Sheet)	Perennial vegetative cover increases biomass carbon stocks and enhances soil carbon. Minimized soil disturbance also enhances soil carbon.
657	Wetland Restoration (Information Sheet)	Establishment of vegetation, particularly woodland and forest vegetation, increases biomass carbon stocks. Soil organic carbon is increased by incorporating compost as a physical soil amendment.

Table 2: NRCS Conservation Practice Standards that Promote Greenhouse Gas Emission Reductions on Private Lands

NRCS Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
366	Anaerobic Digester (Information Sheet)	Biogas capture reduces CH_4 emissions to the atmosphere and provides a viable gas stream that is used for electricity generation or as a natural gas energy stream.
367	Roofs and Covers	Capture of biogas from waste management facilities reduces CH_4 emissions to the atmosphere and captures biogas for energy production. CH_4 management reduces direct greenhouse gas emissions.
372	Combustion System Improvement	Energy efficiency improvements reduce on-farm fossil fuel consumption and directly reduce CO_2 emissions.
590	Nutrient Management (Information Sheet)	Precisely managing the amount, source, timing, placement, and form of nutrient and soil amendments to ensure ample nitrogen availability and avoid excess nitrogen application reduces N_2O emissions to the atmosphere.
592	Feed Management	Diets and feed management strategies can be prescribed to minimize enteric CH_4 emissions from ruminants.

REFERENCES

[1] *2007 Census of Agriculture, Conservation and Agricultural Practices Fact Sheet;* U.S. Department of Agriculture, National Agricultural Statistics Service, http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/conservation.pdf (accessed on September 16, 2011). Conservation program enrollment includes the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program, and the Conservation Reserve Enhancement Programs (CREP).

[2] *2007 Census of Agriculture, Demographics Fact Sheet*; U.S. Department of Agriculture, National Agricultural Statistics Service, Farming as Lifestyle, Page 3 http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/conservation.pdf , (accessed on September 2011).

[3] *2009 Agriculture Chapter Greenhouse Gas Emissions Sources, Section 6 – Agriculture*. http://epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Chapter-6-Agriculture.pdf , (accessed September 2011).

[4] Goldman Sachs Press Release: http://www.goldman-sachs.com/services/advising/environmental-markets/business-initiatives/us-carbon-offset-announcement.pdf Reuters: http://www.reuters.com/article/2009/10/12/us-carbon-bluesource-idUSTRE59B3JF20091012
Climate Action Reserve project listing: https://thereserve1.apx.com/myModule/rpt/myrpt.asp?r=111 (accessed on October 2011).