



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Abstract

Carbon sequestration on agricultural lands might become an important instrument of the U.S. policy for reduction of atmospheric carbon, which is believed to be a major contributing factor to recent climatic change. Herein, we examine the near term income enhancing prospects of carbon sequestration for landowners. Based on a review of current U.S. policies, sequestration cost, and recent developments in the carbon market, we show that presently the prospects may be limited.

Implications of Carbon Sequestration for Landowners

By Tanveer A. Butt and Bruce A. McCarl

Introduction

Concern about human-induced climate change has increased in recent years with substantial attention being focused on options to mitigate climate change. Scientists believe that the atmospheric build up of greenhouse gas¹ (GHG) concentrations is causing the climate to change (Intergovernmental Panel on Climate Change – IPCC, 2001). Further, they assert that continuing levels of GHG emissions will lead to future climate change. Carbon dioxide is the largest of the GHGs in both emissions and concentration. Reducing net carbon dioxide emissions to the atmosphere is increasingly being considered as a way of addressing the climate change problem.



Tanveer Butt is a Visiting Assistant Professor in the Department of Agricultural Economics at Texas A&M University, College Station, Texas. His primary research is in areas of climate change, carbon sequestration, food security, and risk modeling. He holds a Ph.D. degree in Agricultural Economics from Texas A&M University (year 2002 graduate). He has three professional publications and several are in progress.

Bruce McCarl is a Regents Professor in the Department of Agricultural Economics at Texas A&M University, College Station, Texas. His primary research is in areas of climate change, carbon sequestration, water economics, biosecurity, biofuels and risk management. He holds a Ph.D. degree in Management Science from Pennsylvania State University (year 1973 graduate). He is a member of various professional organizations and has written more than 160 articles in professional journals.

Direct emission reduction is the obvious strategy to reduce net emissions but involves modifying key elements of the American way of life since as much as 84 percent of current emissions are related to energy consumption (heating/cooling, traveling, etc.). An alternative strategy involves enhancing absorption of atmospheric carbon into vegetation with subsequent storage in soils and long-lived plants/trees/wood products. Such a process is commonly called biological carbon sequestration.

Biological carbon sequestration is an appealing alternative as it allows continued energy consumption, while potentially benefiting the environment and landowners. As a result, this sequestration alternative has attracted interest of researchers, energy industry, policy makers, and landowners alike. This paper explores the income enhancing potential of carbon sequestration as it exists presently in the U.S. In particular, we will overview the following topics:

- Options for GHG emission mitigation;
- Potential participants in a GHG offsets/carbon market;
- The existing status of the carbon market in the U.S.; and
- Current income enhancing potential of carbon sequestration for landowners.

GHG Emission Mitigation

International efforts to stabilize the atmospheric concentration of GHG emissions resulted in a 1997 treaty, called the Kyoto Protocol, which was developed by a meeting involving over 160 countries including the U.S. In the Protocol, the developed countries (like U.S., U.K., and Canada) agreed to limit their GHG emissions, relative to the levels emitted in 1990. The U.S. being the highest GHG emitter, both in absolute terms and on per capita basis as shown in Figure 1, agreed to reduce its emissions from 1990 levels by seven percent during the implementation period of 2008-2012. However, before going into effect the Protocol required ratification and in 2002, the U.S. administration rejected the Protocol saying that it did not limit emissions from developing countries and would be too expensive. Subsequently, the administration stated its domestic policy goal of an 18 percent reduction in GHG emissions per dollar of gross domestic product by 2010. Such actions portend a need for low cost net GHG reductions, and a market where reduction targets can be met by developments of reductions by emitters or purchasers from others who can develop low cost emission offsets. Soil-based sequestration is a candidate low cost practice that could enter such a market.

Who Might Buy and Sell in a GHG Offset/Carbon Market?

A buyer of carbon offset can be any entity needing to reduce/offset emissions. For example, a power plant facing an emission cap might be looking for ways to offset emissions that are over and above certain limit. The objective of buyers would be to acquire offset credits at a lower cost than the cost of altering operations to reduce emissions. The largest buyers are likely to be from the electric utility (power plants), energy production, transportation, and manufacturing industries as they are either the largest emitters as shown in Figure 2 or sell products that are associated with large emissions.

The supply of carbon offsets may come from various sources. GHG emitters may alter practices that cause lower GHG emissions, reduce fuel consumption, or switch to alternative fuels (for example, from coal to natural gas or biofuels).² In addition, various land-based strategies can be pursued that largely involve soil sequestration through tillage change, crop rotation, grassland, afforestation, and biofuels feedstock production (see McCarl and Schneider [2001] for details). Implementing land-based carbon mitigation strategies would require incentives for landowners to follow practices that sequester carbon. Hence, the returns to land might increase.

The Current Prospects for Landowners Making Money from Sequestration

Producers may someday earn additional income through carbon sequestration. The current prospects for this depend on the status of the market, the competitiveness of landowners in producing carbon offsets, and the role of government. We briefly review each of these factors below.

Existing Status of the U.S. GHG Market

The status of the U.S. GHG market depends strongly on the governmental GHG net emissions reduction policy regime. The current U.S. administration plan does not greatly encourage net emissions reduction as not only it sets a low emissions reduction limit (about 1/6th of the Kyoto obligations) but also the emission reduction is made voluntary. Hence, there is no widespread policy stimulus that will create a significant value for GHG offsets. Several states, however, are taking unilateral actions. For example, Oregon has established Oregon Climate Trust, where those developing new projects are charged a certain number of cents per ton of carbon emissions. Likewise,

Wisconsin, California, and New Jersey along with most of the Northeast also have their own emission reduction plans.

Internationally, with the signing of Russia in November 2004, the Kyoto Protocol is now entering into implementation, where the ratifying annex B countries will be required to reduce their carbon emissions to levels committed in the Protocol. These developments suggest that we are heading toward a carbon constrained future. This has raised concerns on behalf of emitters in the US who now face uncertainty as to whether GHG emission limits will be imposed in the next 10-20 years.

The prospective emission caps place business assets at risk. The magnitude of the risk caused by possible implementation of GHG emission limits has drawn industry attention. For example, if implemented in the U.S., the Kyoto Protocol may require 30 to 40 percent emissions reductions in the 2012 projected emissions.³ As a result, many firms have started the quest to discover and even begun implementation of ways to reduce GHG emissions in an economically sound manner. Sequestration is a major option available.

The situation has led to what can be termed a niche carbon market, where emitters and mitigators have signed limited-scope contracts for producing carbon offsets. The main motivation of the participants in this niche is a mixture of:

- Environmental citizenship where firms wish to be responsible environmental actors possibly for advertising purposes;
- Business venture exploration where firms desire to see if they can develop future salable capabilities for GHG emission management;
- Cost reduction efforts where firms wish to tie up low cost alternatives in anticipation of future emission caps; and
- Multi-nationalism where multi-national firms must comply within elements of their total operation and are experimenting where convenient including inside the U.S.

On the supply side, landowners who are participating are either in close proximity to the niche market and have been offered participation options or are venturing to explore new opportunities anticipating they will be low cost producers of offsets or that they can be paid for GHG offsetting practices they have already undertaken.

There have been two ways that the niche markets have been operating:

- *Direct Contracts:* Some energy companies have directly approached agricultural producers to generate carbon offsets. For example, Reliant Energy, a Houston-based energy company, is funding planting of over 150 thousand trees in an effort to capture an estimated 215 thousand tons of carbon dioxide from the atmosphere, generating "carbon credits" that will be retained by Reliant.
- *The Chicago Climate Exchange (CCX):* A fledgling trading operation is emerging that is based on a voluntary association of a number of emitters and offset suppliers. The CCX has set up guidelines for soil carbon participation. For cropland, an entering group has to represent a minimum of 10,000 tons of carbon, has to commit to four years of continuous conservation tillage, and must not plant soybeans for more than two years. No requirements are imposed on how that land was used in the past. Participating farms must have at least 250 acres that will be inspected by the CCE to ensure that conservation tillage is practiced. Farmers will be paid at the rate of 0.15 ton of carbon per acre. Carbon offsets generated from grassland may also get credit at the rate of 0.21 ton of carbon per acre, provided grasses are planted after January 1, 1999. For forestry, the CCE carbon allowance is based on a combination of age of the trees, planting densities, and tree species. A forester entering a contract with CCX must at least offer 3,400 tons of carbon for trees planted after January 1, 1990 on sites not forested before then. On average, an acre of a tree provides about a ton of carbon (McCarl and Schneider, 2001). Auction prices at CCE, as of early 2004, have ranged from \$1.84 - \$9.90 per ton carbon, with a weighted average of \$3.60 per ton carbon. Under the CCE terms and these prices, land owners would get \$0.50 per acre for tillage changes, \$0.74 per acre for grass conversions, and about \$3.60 per acre for forestry.

It is fair to say that the present buying and selling activities in the carbon market are indicative of exploratory behavior of buyers and sellers rather than economic opportunities. As the market develops and prices rise, sequestration could start to play a greater role if it were cheap, which raises the question whether or not landowners are competitive suppliers of carbon offsets.

Are Landowners Competitive Suppliers of Carbon Offsets?

To mitigate GHG emissions, a variety of alternatives may be pursued including switching fuel sources (for example, coal to natural gas and biofuels), increased mass transit usage, improved energy efficiency, and carbon sequestration. Under trading, carbon sequestration must be competitive in order to find its place in the carbon market, where the competitiveness is based on sequestration cost that would differ by landowners and regions. Paustian, et al., (2001) show that sequestration cost under tillage change may vary from \$0 a ton of carbon to over \$300 a ton of carbon for farmers in Iowa. As represented in Figure 3, McCarl and Schneider (2001) showed in a modeling study that land management practices (mainly tillage change and converting cropland to grassland) were competitive at relatively low offset prices, about \$25 per ton of carbon, showing that not only altering land management practices may cheaply generate carbon offsets but also that the potential may not be great compared to other alternatives. Namely, the potential offsets from forestry and bio-fuel production are substantially greater but involve greater opportunity costs and thus, are economical only at higher prices.

The cost estimates are indicative of the level of compensation that must be paid to landowners to adopt sequestration practices. How much compensation would be paid to landowners depends on the U.S. mitigation policy. For example, Edmonds, et al., (1998) estimate per ton cost of meeting the Kyoto Protocol target for the U.S. They show that if the U.S., acting on its own, were to meet its Kyoto Protocol target emission reduction, the cost may be as high as \$250 per ton of carbon. With international trading of carbon offsets, however, they estimated the cost would fall to around \$25 per ton of carbon.

Other concerns

There are several additional factors that might influence the desirability of a sequestration opportunity to landowners. These include altering operations, middle man costs, possible discounts, longer term commitments, and measurement costs.

Altering Operations. Sequestering carbon often involves landowners altering technology or management. For example, farmers may have to shift to no till practices or/and apply less fertilizer, while foresters may have to delay harvesting mature trees. This can lead to altered equipment requirements,

increased management demands, increased risk especially during early stages of use, and educational needs.

Middleman Costs. The amount of carbon sequestered by a landowner will be small compared to buyers' needs. For example, a tillage change may sequester, on average, one quarter ton of carbon per acre annually (West and Post, 2002). In turn, a farmer owning 400 acres of land would supply about 100 tons of carbon. In contrast, the buyers' want substantially larger volumes. For example, at the Chicago Climate Exchange a minimum of 10,000 tons of carbon must be offered for sale. This means someone would need to assemble a group of 100 farmers to sell one contract. Middlemen doing such assembly will introduce a wedge between the price received by landowners and that paid by buyers.

Long-term Contract. The nature of sequestration dictates that sequestering practices must continue, or else the carbon stored in soils would revert back to the atmosphere (Cramer and Field, 1999). This characteristic of carbon sequestration is called impermanence. Presently at CCX, sequestration based offsets require a four year commitment. Once an emission cap is in place, the length of contract is likely to increase and may require 20 or more year continuation of practices. This raises property rights issues such as whether the contracted land can be sold and how the obligation is passed down in case of sale of land.

Market Discounts. Landowners may not be able to sell all the carbon they store as discussed in McCarl, Butt, and Kim (2003). In the more general market place, discounts may arise to correct for:

- The *impermanence* nature of carbon sequestration, where the sequestered carbon may revert back to the atmosphere once the sequestering practices are discontinued/ reversed (e.g., switching back from conservation tillage to conventional tillage);
- Actions that would have occurred in the absence of a carbon program (commonly called additionality), which also means that there is a risk to early entrants in generating offsets as they may be treated as not being additional meaning that landowners may not get full credit for their offsets;

- Actions in other regions that offset gains made in a region⁴ (commonly called leakage); and
- Uncertainty in the amount of carbon obtained as the soil-based sequestration is affected by natural factors such as weather conditions as discussed in Kim, McCarl, and Butt (2005).

Measurement Costs. A mechanism to verify the quantity of carbon sequestered is needed as carbon is not directly measurable. Either buyer or landowners would have to incur the cost of measuring carbon (through lab experiments or other sources), which ultimately means an abrasion of landowners' payoff. Mooney, et al., show a low measurement cost that ranges between \$0.01 to \$0.28 per ton of carbon, where the cost varies depending on field heterogeneity.

Role of Government

The activities that stimulate carbon sequestration are commonly in harmony with resource conservation objectives like reduced erosion, improved water quality, and wildlife preservation. Consequently, the government may have an interest in promoting carbon sequestration. Hence, the government may bear a part of the cost of producing soil-based carbon offsets improving their competitiveness against non-soil-based carbon offsets. Though, there has been an active consideration of carbon sequestration in the U.S. farm policy arena, no tangible, well-funded program is in place yet.

Closing Remarks

A review of the current carbon market reveals that the prospects for landowners making money from sequestration in the short run are limited. Landowners who have participated are generally exploiting some small market niche. At the existing carbon offset prices, as reported by CCE, land owners would get \$0.50 per acre for tillage changes, \$0.74 per acre for grass conversions, and about \$3.60 per acre of forest. The real future prospects for landowners earning significant additional income through carbon sequestration depend on policy. Namely, market prices could rise substantially if the government implements an aggressive emissions reduction policy but that does not seem to be likely in the near term. The government may also introduce well-funded programs that share part of the carbon sequestration cost through the environmental aspects of farm policy, but while this is more likely in our judgment than

an aggressive emissions cap, it appears unlikely in the current budgetary environment.

Interested landowners also need to be cognizant of two issues: risk to early participants and the likely rise in carbon prices, and the long-term obligations that will likely characterize carbon programs and contracts. Early participants run the risk of being caught by the additionality principle that will not credit projects unless they were started after the official mitigation begun. Further future prices are likely to be higher than current prices and beginning now may lower the rewards one can earn. Finally, once covered by a contract, landowners may well be liable for emissions caused by reversal of the practices laid down in the contract. This may raise a number of legal issues including the following:

- The contracted land may have to be sold with the obligation transferred to the purchasing third party;
- There may be significant liabilities if landowners choose to reverse practices; and
- Soil carbon accumulation tends to decrease over time but practice reversal causes a large release. Hence, to preserve carbon in the soil, practices may still need to be continued even after carbon increments cease.

Carbon sequestration does offer landowners a potential for earning additional money. However, the potential is presently limited and is likely to benefit landowners more in future. That said, it is probably best for farm managers, rural appraisers, commercial interests, and university/extension personnel to keep an eye out for policy changes that will really stimulate the opportunity while not making too much of this as a current opportunity. Stimulating too much early adoption or anticipatory interest may hurt long term income prospects due to additionality concerns and likely future rising carbon prices.

Endnotes

- ¹ The term Greenhouse gas refers to a group of gasses that adds to the reflective and heat trapping characteristics of the atmosphere. The name Greenhouse Gases is given due to the similarity of effects that GHG concentrations have relative to the effects of Greenhouse glass on the climate within a Greenhouse. In particular, GHGs are largely transparent to the Sun's energy coming to the Earth, but allow less of the

solar energy reflected off of the earth's surface to be reflected into space trapping additional heat. As a result, the Greenhouse theory argues that the Earth's overall temperature increases when the concentration of greenhouse gases increases.

- ² Natural gas results in lower carbon emissions. Biofuels are based on green matter that sequesters carbon before burnt for energy, thereby, partially offsetting carbon emissions.
- ³ The Protocol implementation period is 2008-2012, where after 2012 emission reduction will be enforced by the participating countries.
- ⁴ For example, delayed harvest of trees in one region may increase the market price of timber encouraging deforestation in other regions.

References

- Cramer, W. and Field, C. B. "Comparing Global Models of Terrestrial Net Primary Productivity (NNP): Introduction", *Global Change Biology*, 5(1999), 3-5.
- Edmonds, J.A., MacCracken, C.N., Sands, R.D., and Kim, S.H. Unfinished Business. The Economics of the Kyoto Protocol. US Dept. of Energy, September 1998. http://www.pnl.gov/globalchange/pubs/gtsp/kyoto_paper_98.pdf
- Intergovernmental Panel on Climate Change (IPCC). *Climate Change: The IPCC Third Assessment Report – Impacts, Adaptations, and Vulnerability*. J.J. McCarthy, O.F. Canziani, N.A. Leary, D.G. Dokken, and K.S. White, ed. Cambridge, MA: Cambridge University Press, 2001.
- Kim, M., McCarl, B. A., and Butt, T.A., and "Uncertainty Discounting for Land-Based Carbon Sequestration" Submitted to *Canadian Journal of Agricultural Economics*, 2005.
- McCarl, B.A. and Schneider, U.A. "The Cost of Greenhouse Gas Mitigation in US Agriculture and Forestry", *Science*, 294 (December, 2001), 2481-82.
- McCarl, B. A., Butt, T.A., and Kim, M. "How Much Would Carbon Cost a Buyer?" Department of Agricultural Economics, Texas A&M University, College Station, Texas. 2003.
- Mooney, S., Antle, J., Capalbo, S., Paustian, K. "Contracting for Soil Carbon Credits: Design and Costs of Measurement and Monitoring", AAEA Annual Meetings, CA, July 28-31, 2002. Available at <http://www.casmgs.montana.edu/pdf/mooney.pdf>
- Paustian, G.R., Kurkalova, L.A., Babcock, B.A. and Kling, C.L. "The Efficiency Of Sequestering Carbon In Agricultural Soils." *Contemporary Economic Policy*, 19(April 2001): 123-124. <http://www.card.iastate.edu/publications/texts/00wp246.pdf>
- West, T.O. and W.M. Post, "Soil Organic Carbon Sequestration Rates by Tillage and Crop Rotation. A Global Analysis. " *Soil Society of America*, 66(2002), 1930-46.
- The World Bank. *The Little Green Data Book – 2002*. International Bank for Reconstruction and Development/The World Bank, Washington D.C.

Figure 1. Total and Per Capita CO₂ Emission

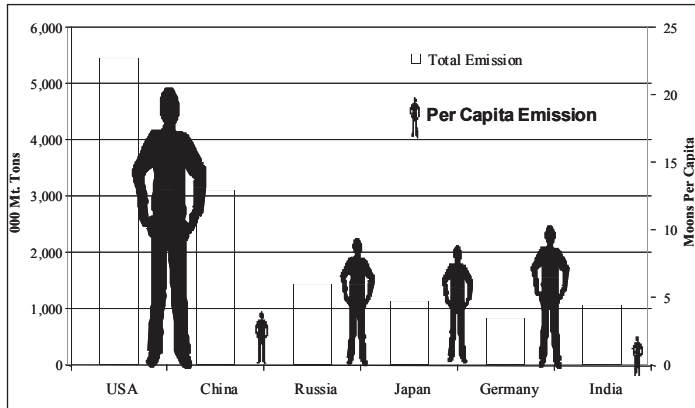


Figure 2. Major Source of Carbon Emissions in the U.S.

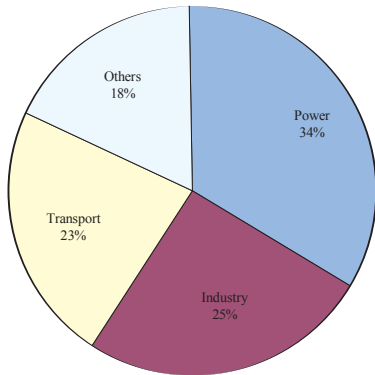


Figure 3. Competitive Potential of Soil-based GHG Mitigation Practices

