Carbon Markets: a Potential Source of Financial Benefits for Farmers and Ranchers

Research Report 08-3

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Concerns regarding climate changes due to human activities have largely increased in the past few years. Scientists believe that atmospheric build-up of greenhouse gas[1] (GHG) concentrations is causing the climate to change (IPCC, 2007a,b). Furthermore, a large number of scientists assert that continuing levels of GHG emissions will lead to substantial future climate change. Carbon dioxide is the largest of the GHGs in both emissions and concentration (Butt and McCarl, 2005, IPCC, 2007c). Reducing net carbon dioxide emissions to the atmosphere is increasingly being considered as a way of addressing the climate change problem.

International efforts to stabilize the atmospheric concentration of GHGs resulted in a 1997 treaty, the Kyoto Protocol, which was developed with the involvement of over 160 countries, including the U.S. (Butt and McCarl, 2005). In the Kyoto Protocol, the developed countries (like the U.S., U.K., and Canada) agreed to limit their GHG emissions, rolling back to below the levels emitted in 1990. Currently, U.S. emissions are about six billion metric tons (tonnes) of carbon dioxide plus about 1 million more carbon dioxide-equivalent (CO_2e) in other gasses. Within the Kyoto Protocol, the U.S. emissions were to be reduced to seven percent below 1990 levels by 2008-2012. Given projected emissions growth, this would have required scaling back emissions by 30 to 40 percent of what would have occurred in the 2008-2012 time period.

In 2002, the U.S. stated it would not sign the Kyoto Protocol. The U.S. administration has subsequently set a domestic policy goal of an 18 percent reduction in GHG emissions per dollar of gross domestic product by 2010. The U.S. administration then in April 2008 set a national goal of stopping the growth of U.S. greenhouse gas emissions by 2025. The 2002 administration plan did not greatly encourage net emission reductions and set a low emissions reduction limit (about 1/6th of the Kyoto obligations – as reviewed in Butt and McCarl, 2005). In addition, the emission reduction in both the 2002 and 2008 goals are voluntary. Hence, there is no widespread policy stimulus that will create a significant value for GHG offsets. However, there is an international and a small domestic voluntary carbon market.

Why are There Carbon Markets?

When GHG emissions are limited, policy approaches like that used in the Kyoto Protocol or the recently proposed Lieberman-Warner bill allow emitters to either reduce emissions themselves or pay for someone else to reduce emissions. This is the origin of a so-called carbon market, which is a market where reductions in carbon dioxide or other GHG emissions can be bought and sold. The market will exist as long as someone other than the large emitters reduce net emissions cheaper than the emitters themselves could have.

Who Might be the Participants in the Carbon Market?

Markets consist of buyers and sellers. A buyer of carbon offsets[2] would be an entity needing to reduce or 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 limits (Butt and McCarl, 2004). The objective of a buyer would be to acquire offset credits cheaper than it would cost them to alter operations to reduce their emissions. Therefore,

[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 atmospheric GHG concentrations have relative to the effects of the glass ceiling of a horticultural 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 escape 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 (Butt and McCarl, 2005, IPCC 2007a).

[2] Carbon offset is a financial instrument representing a reduction in GHG emissions. Although there are six primary categories of GHGs, carbon offsets are measured in metric tons of carbon dioxide-equivalent. One carbon offset represents the reduction of one metric ton of carbon dioxide, or its equivalent in other greenhouse gases. Carbon offsets are also called carbon credits, offset credits or carbon sequestered/absorbed.

the largest buyers of carbon offsets are likely to be the largest emitters, like power plants, transportation and industry as a whole (Note that EPA estimates that more than 80 percent of current emissions come from coal and petroleum combustion in about equal proportions with the agricultural share being small.).

Potential carbon offset sellers come from various sources. A group of GHG emitters may find they can cheaply change their operations so as to reduce GHG emissions for example reducing fuel consumption, switching to alternative fuels, e.g., from coal to natural gas or bioenergy, altering manure management, reducing fertilization etc. (Butt and McCarl, 2004). In addition, so called sequestration activities may be undertaken where rather than emitting GHGs they are captured and stored. One sequestration possibility employs biological sequestration through the characteristics of plants. Such sequestration possibilities may offer market participation possibilities for agriculture.

There are several agricultural forms of biological sequestration that may be pursued, such as changes in tillage practices, crop rotations, land conversion to grasslands, and afforestation. Agriculturalists may also reduce emissions through alterations in livestock herd size, livestock feeding, manure management, crop fertilization and biofuel feedstock production, among others (McCarl and Schneider, 2001). However, such activities are costly and there needs to be an economic incentive for producers to make changes in their production practices in the name of sequestering carbon or reducing emissions. Namely, the market price of GHG offsets needs to be high enough to motivate potential suppliers to change their current production practices such as changing from a conventional tillage to reduced or no tillage production system. Moreover, another issue that may prevent producers to participate in the carbon market in the long run is if they are already performing activities/actions that would have produced offsets in the absence of a carbon program (commonly called additionality) and this is some risk that those participating today in the CCX market may not be eligible for possibly more lucrative future markets. This means that there is a risk to those generating offsets before a mandatory program is implemented because they may be treated as non eligible offsets after program implementation as their offsets predate the project beginning (Butt and McCarl, 2005).

Status of the U.S. GHG Market

The ability of farmers and ranchers to enter a GHG market depends heavily on the existence of the market and in turn on the policies that the government sets in place to limit or reduce GHG emissions plus allow market participation. As previously mentioned, the U.S. government already has a program for GHG emission reduction that is on a voluntary basis, and therefore has not stimulated a wide spread national market. There are other initiatives at the state or private industry levels to reduce GHG emissions. For example, 10 Northeastern states, including New York, Maine, and Maryland, among others, have joined to create the first mandatory carbon cap-and-trade program[3] in the U.S. while California is in the process of setting up such a market. The Northeastern market aims to reduce emissions from power plants by 10 percent in 10 years (Fairfield, 2007). Moreover, in October 2006, Morgan Stanley announced it would invest $3 billion in the carbon market over the next five years – the largest single investment to date (Lavelle, 2007). Also, there is an experimental voluntary market called Chicago Climate Exchange (CCX) where firms are voluntarily buying and selling GHG offsets.

The current price for carbon offsets in the U.S. is around $6 per tonne (price for a metric ton or 2,204 pounds of carbon dioxide equivalent offset), while in Europe the carbon offset price is around $35 per tonne, a much higher level than in the US due to more strict emission regulations (CCX, 2008). However, the US domestic price of carbon offsets will likely increase if tighter emissions controls are implemented. For example, Edmonds et al. (1998) estimated a cost as high as $250 per tonne of carbon for the U.S. if it acted to meet its Kyoto Protocol target for reducing emissions. With international trading of carbon offsets, however, the cost

[3] A cap-and-trade program establishes a GHG emitter mandatory emission cap and a commercial trade option where emitters buy offset credits from sequesters such as agricultural producers.

was found to fall to around $25 per tonne of carbon. Estimates from Edmonds et al. are based on an overall GHG emissions reduction, including agriculture, fuel substitution, and energy production/consumption.

On April 2, 2007, the U.S. Supreme Court ruled on the Massachusetts v. Environmental Protection Agency (EPA) case that the federal government, through the EPA, has the authority to regulate the carbon dioxide and other GHG produced by motor vehicles. If EPA decides to regulate GHG emissions, it could increase the demand for carbon offsets, therefore supporting a probable increase in price. Moreover, the members of the Intergovernmental Panel on Climate Change (IPCC) recently won the Nobel Peace Price for their work on climate change, demonstrating an increased awareness and interest on the topic. These developments are creating more public and industry-wide awareness of the potential problems of climate change associated with GHG emissions, and has also contributed to increased interest in global emissions reductions. In the U.S., suppliers of GHG offsets are able to sell their offsets through direct contracts with buyers, or sell their offsets through the CCX. An example of selling GHG offsets through direct contract is the funding of planting over 150,000 trees by the Houston-based energy company, Reliant Energy, in an effort to capture an estimated 215 tonnes of carbon dioxide from the atmosphere, generating "carbon credits" that will be retained by Reliant (http://www.ewire.com/display.cfm/Wire_ID/1557).

The CCX route merits discussion. The CCX was launched in 2003 and is a trading operation that is based on a voluntary, but legally binding association of a number of emitters and offset suppliers. The commodity traded at the CCX is the Carbon Financial Instrument (CFI), each of which represents 100 tonnes of CO_2e. The volume traded on the CCX in the first quarter of 2008 was about 25 million tonnes of CO_2e or annually around 100 million tonnes. Although, CO_2e traded on the CCX has been increasing since it was launched, the total amount traded represents less than five percent of the full Kyoto Protocol level.

The CCX has set up guidelines for participation in a carbon sequestration program through crop production, rangeland management and/or afforestation. One of the most restrictive requirements for agriculture to participate in the CCX market would be that an entering group would have to represent a minimum of 10,000 tonnes of CO_2e. A contract of that size would require a cropland farmer to have around 25,000 acres, making that option somewhat impractical since not many farmers have that amount of acreage. A practical alternative for most producers involves the use of an aggregator, which is an entity that aggregates (pools) producers. An aggregator would act like the "county elevator" for the carbon credits marketplace. An aggregator combines carbon credits from agricultural offset projects initiated by farmers, ranchers and private forest owners.

The remainder of this report will explain the steps and requirements to participate in the carbon credits marketplace through the CCX, as well as the potential cash flows for cropland and rangeland management offset projects.

How to Enroll?

To enroll in the process there is an application form that must be completed which requires the following information:

- Landowner information: Land maps to document ownership for a given tract of land, including the legal land description of the tract.
- Tract description forms: Document of management practices, such as program forms for croplands, grass and forest management, etc.
- A signed contract between the landowner and the Chicago Climate Exchange or an aggregator for the appropriate management practices.

Before the contract is signed, a carbon sequestration estimate will be provided to the landowner for consideration. Then, upon submission of the tract verification by the landowner, which is the confirmation of the amount of carbon being sequestrated, the land enrollment request needs to be submitted to a third party reviewer and it will be verified on an annual basis. There is no enrollment fee (Dogwood Carbon Solutions, 2007).

Contracts run on a five-year period for crop production and/or rangeland management projects. After the five years, producers are free to renew the contract for another five years or let the contract expire. There is no limit on the number of times the landowner can renew his/her contract. Once a contract expires, producers have no more obligations to the CCX or aggregator. However, if a landowner discontinues the approved sequestration production practice such as conservation tillage or grass planting prior to the end of the contract, the CCX or aggregator will ask the owner to return the amount of carbon that would have been sequestered up to that point or pay for the same amount of carbon at market price. Additionally, the project owner will not be allowed to further participate in the CCX (CCX, 2008).

Some special cases arise when a landowner sells land under a carbon sequestration contract. In that case, the next landowner would have to accept the previous arrangement and continue the established practices, or the first landowner could face penalties for breaking the contract. If the land is rented to another tenant during the contract, the new tenant would have to agree to the contract terms and continue with the contracted land practices, or the contract holder would face penalties and the loss of the account (Parker, 2007).

Every project owner is paid yearly, and carbon payments do not disqualify participants from any governmental payments programs. The typical price paid to landowners for carbon has ranged between \$2 to \$5 per tonne, but currently is around \$6 per tonne. The exact amount a farmer gets paid depends on market conditions at the time of the sale, and the amount of carbon sequestrated during the year. Prices can go up or down on a daily basis as they are dictated by market forces.

As mentioned above, if the volume of carbon produced by a landowner is not the minimum required (10,000 tonnes/year) by the CCX, or if the landowner produces more than the minimum and does not want to complete the enrollment paper work directly with the CCX, he/she can partner with an aggregator. Aggregators charge between 8 to10 percent of the value of a carbon credit at market price on a yearly basis (Dogwood Carbon Solution, 2008; Krog, 2008). Some aggregators require a minimum of 250 acres for a landowner to enroll in a contract.

There are three different fees that the landowner has to pay to sell his/her carbon offsets in the carbon market. There is a registration fee and a trading fee of \$0.15 and \$0.05 per credit, respectively. Moreover, a verification fee of \$0.10 to \$0.12 per credit is charged to all landowners participating in the program to pay for the third party that verifies the projects (Krog, 2008). Third party reviewers verify that the landowner is following the correct procedures to sequester the carbon, i.e. reduced or no till for crop production offset projects and employment of reduced stocking rates, rotational grazing and seasonal use for rangeland management offset projects. The verifier does not measure the initial level or the changes in soil carbon levels, he/she only verifies that the contracted practices are being followed.

Finally, the CCX or aggregator sets aside 20 percent of the annual carbon credits from every project as an insurance pool, to protect against any carbon storage reversal that might occur in the unfortunate events such as fires, hurricanes, etc. (Krog, 2008). The maximum amount of storage reversal that a project owner could face is the amount withheld at the retention pool. In addition, the total amount of carbon set aside on the retention pool is paid back to the landowner the last year of the contract.

Crop Production Offset Projects

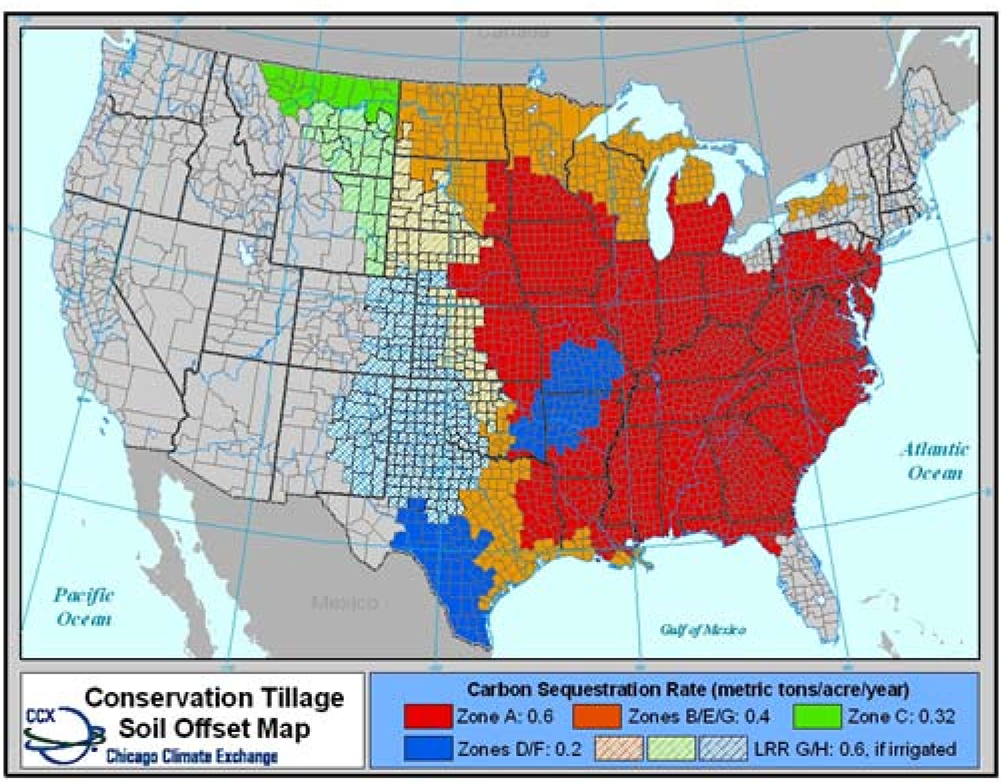
The CCX specifies that all crop production contracts are for a minimum of five years of continuous conservation or no tillage practice. In this arrangement, at least two thirds of the soil surface must be left undisturbed and at least two thirds of the residue on the field surface must remain (CCX, 2008). For more detailed conservation tillage practices allowed by CCX, refer to the Natural Resources Conservation Service (NRCS), *National Handbook of Conservation Practices* (NRCS, 2008a). An additional requirement is that soybeans should not be planted for more that two years of the five-year contract.

The volume of carbon that can be sold via crop production related tillage changes, measured in tonnes of CO_2e, has been determined by the CCX (Figure 1). Moreover, Figure 2 shows the volume of carbon that can be sold through grass planting on cropland. Some special contracts can be arranged if the farmer can guarantee a specific practice on the land. Otherwise, the range of carbon sequestration estimated by the CCX tables is between 0.2 to 1.0 tonnes per acre per year, depending on the state and county where the land is located (Krog, 2008). For example, in south Texas (Figure 1-blue area), the rate of carbon sequestration is 0.2 tonnes per acre per year and remains the same for each year of the five-year contract, as long as the verifier certifies that the landowner is following the specified conservation tillage practices. This means that at current prices the annual gross income potential is on the order of $1.20 per acre and the farmer has to use continuous reduced or no till practices for the length of the contract.

Rangeland Management Offset Projects

In the case of rangeland management, sequestration practices include the employment of lowered stocking rates, along with rotational grazing to allow forage re-growth and seasonal use as needed in eligible locations. Eligible projects must be on non-degraded rangeland or previously degraded, but restored rangeland, as a result of changes in management practices undertaken on or after January 1, 1999. For a more detailed descrip-

Figure 1. Conservation Tillage Soil Offset Map

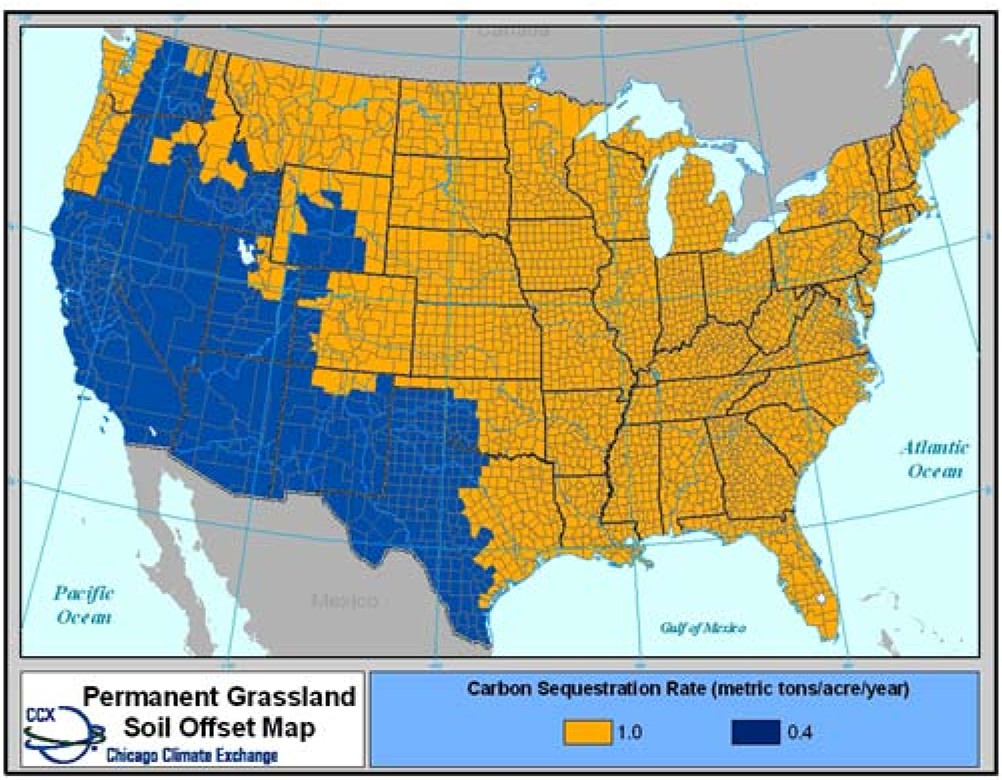


Source: Chicago Climate Exchange

Table 1. Expected Gross Returns for a Crop Production Offset Project on East Texas for a 2,500 Acre Farm.

Market Price	$6.00				
Aggregator Fee (/tonne)	$0.60				
Verification Fee (/tonne)	$0.12				
Registration Fee (/tonne)	$0.15				
Trading Fee (/tonne)	$0.05				
Total Fees (/tonne)	$0.92				
Actual Price (/tonne)	$5.08				
Acreage	2,500				
Rate of Sequestration (tonnes/yr)	0.4				
Year	1	2	3	4	5
Carbon Sequestered (tonne)	1000	1000	1000	1000	1000
Retention (20%) (tonne)	200	200	200	200	200
Carbon - Retention (tonne)	800	800	800	800	800
Retention Released (tonne)					1,000
Gross Returns	$4,064	$4,064	$4,064	$4,064	$9,144
Average Gross Returns	$5,080				
Total Gross Returns (5 years)	$25,400				

Figure 2. Permanent Grassland Soil Offset Map



Source: Chicago Climate Exchange

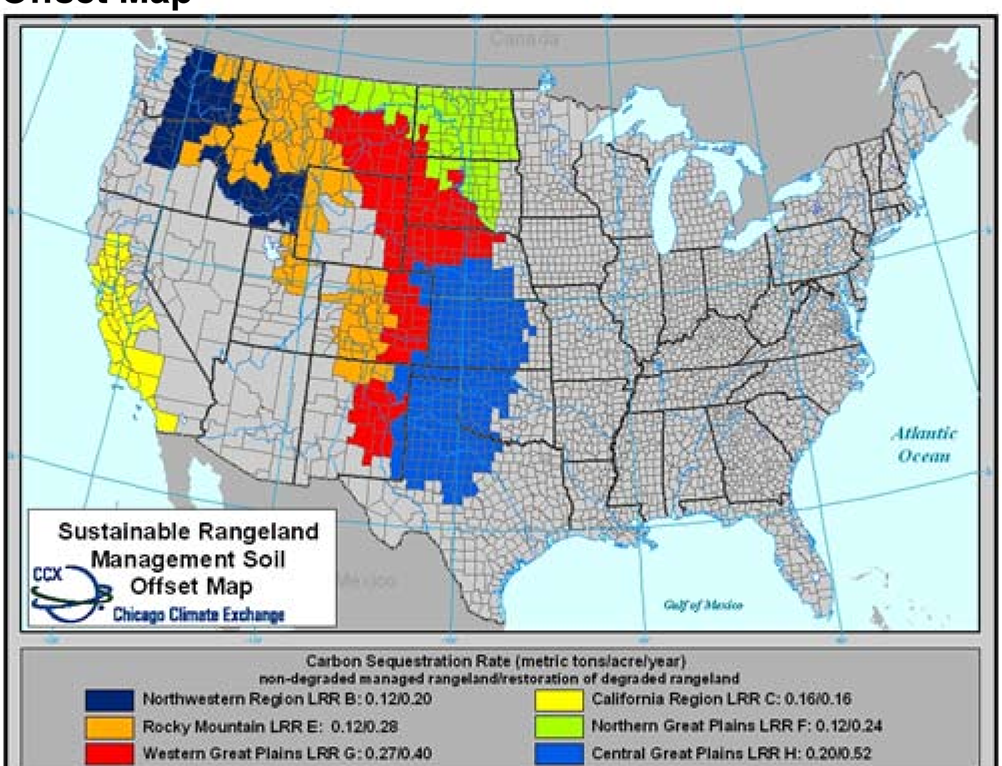
Table 2. Expected Gross Returns per Acre of Farm or Ranch Land with Different Carbon Sequestration Rates at Selected Carbon Prices.

Sequestion Rate (tonnes/ac)	Carbon Price ($/tonne)							
	$2.00	$4.00	$6.00	$10.00	$15.00	$25.00	$35.00	$45.00
0.12	$0.18	$0.39	$0.61	$1.04	$1.58	$2.66	$3.74	$4.82
0.16	$0.24	$0.52	$0.81	$1.39	$2.11	$3.55	$4.99	$6.43
0.20	$0.30	$0.66	$1.02	$1.74	$2.64	$4.44	$6.24	$8.04
0.24	$0.36	$0.79	$1.22	$2.08	$3.16	$5.32	$7.48	$9.64
0.27	$0.40	$0.89	$1.37	$2.34	$3.56	$5.99	$8.42	$10.85
0.28	$0.41	$0.92	$1.42	$2.43	$3.69	$6.21	$8.73	$11.25
0.32	$0.47	$1.05	$1.63	$2.78	$4.22	$7.10	$9.98	$12.86
0.40	$0.59	$1.31	$2.03	$3.47	$5.27	$8.87	$12.47	$16.07
0.52	$0.77	$1.71	$2.64	$4.51	$6.85	$11.53	$16.21	$20.89
0.60	$0.89	$1.97	$3.05	$5.21	$7.91	$13.31	$18.71	$24.11
1.00	$1.48	$3.28	$5.08	$8.68	$13.18	$22.18	$31.18	$40.18

Note these do not account for alterations in the net income from crop production after alterations in yields and inputs like fertilizer, diesel, gasoline, water pumping, pesticides and labor.

tion of CCX approved practices, refer to the NRCS Field Office Technical Guides, where guidelines for managing the controlled harvest of vegetation with grazing animals are published (NRCS, 2008b). All projects must take place on rangeland in which long-term average precipitation is no less than 14 and no more than 40 inches. The range of carbon sequestration estimated by the CCX table for rangeland management projects is between

Figure 3. Sustainable Rangeland Management Soil Offset Map



Source: Chicago Climate Exchange

0.12 to 0.52 tonne per acre per year, depending on the state and county in which the land is located and the type of rangeland project, i.e. previously degraded or improved management (Figure 3).

Specific Examples of Cash Flow for Crop Production and Rangeland Management Offset Projects

Examples of gross cash flow estimates for crop production and rangeland management offset projects in Texas are shown in Tables 1 and 2. In these examples, it is assumed that the landowner will participate in the CCX market through an aggregator for a fee of 10 percent of the market price for carbon. Verification, registration and trading fees were set at $0.12, $0.15, and $0.05 per credit, respectively.

Table 1 shows an expected gross cash flow for a crop production offset project in East Texas on a farm with 2,500-acres being tilled. Rate of carbon offsets for East Texas (gold area) is 0.4 tonne per acre per year (Figure 1). Assuming a market price of $6/tonne of carbon, total fees add up to $0.92/tonne, yielding an actual price paid to project owners of $5.08/tonne of carbon sequestered or $2.03 per acre. Total carbon sequestered for the entire farm will be 1,000 tonnes per year, of which 200 tonnes (20 percent) is set aside in the retention pool. Therefore, total carbon available to sell each of the first four years of the contract is 800 tonnes, giving a cash flow of $4,064 per year for the entire farm. On the fifth year, besides the usual 800 tonnes of carbon available to sell, the amount of carbon which had been retained in the pool is also available for sale, giving a total cash flow for the fifth year of the contract of $9,144. On average, the cash flow for the entire farm would be $5,080 per year, including the retention pool, for a total gross return of $25,400 or $10.16 per acre over the life of the 5-year contract. Naturally this would be offset by or possibly augmented with the differential crop production returns arising under the tillage alteration accounting for changes in yields, fossil fuel use, labor use, fertilization, pesticides etc.

A matrix of average annual gross returns per acre given different carbon sequestration rates and carbon prices is presented in Table 2. The different rates of carbon sequestration cover all offset ranges for practices in either crop production or rangeland management projects across the U.S. Different prices for carbon across the table were selected to show the impact of the price on the average gross returns. Although the prices listed across the top of Table 2 are the alternative market prices of carbon, the prices used to calculate the expected gross returns are the actual prices paid to the project owner. In other words, the price used to calculate each average gross return is the market price minus all four fees – aggregator, verification, registration and trading fees.

To find the expected return per acre for a specific project, find the rate of sequestration for a specific county (Figures 1, 2 or 3) and then locate the market price of carbon at the top of Table 2; then scale it up or down to find the expected return for a specific farm or ranch size. To illustrate for a farming operation located in Nacogdoches County, locate the sequestration rate for Nacogdoches County (red area), in this case a rate of 0.6 tonne/acre/year and at $6/tonne, the expected average return would be $3.05/year/acre or $3,048/year on 1,000 acres or $6,096 on 2,000 acres, etc. Also, using the same sequestration rate, 0.6, at current U.S. carbon price of $6 per tonne, and current European price of $35 per tonne, the expected average gross returns per acre would be $3.05 and $18.71 per year, respectively.

Conclusion

Concerns about climate change caused by human activities have greatly increased in the past several years. Scientists believe that atmospheric build up of GHG concentrations is causing the climate to change. International and domestic efforts to stabilize the atmospheric GHG concentration emissions are currently in place. In the international arena, this mainly involves the Kyoto Protocol, while in the U.S. both federal and state programs are in place.

The U.S. Chicago Climate Exchange provides some opportunities for buyers and sellers to trade carbon credits. The agricultural industry could play a role in the reduction of atmospheric GHGs by sequestering carbon through crop production, rangeland management and afforestation offsets. However, there is a limited economic opportunity for landowners to participate in the carbon market as carbon prices have ranged over the years between $2 to $5 per tonne and currently is around $6 leading to returns on the order of $1-5 per acre. In addition, the current volume traded is small compared to what would happen with a widespread program and a large influx of participants would likely drive prices lower. On the other hand, factors such as

- the recent ruling of the Supreme Court that granted the EPA authority to regulate motor fuel emissions;
- the Climate Change related Presidential platforms of both 2008 major party candidates;
- The emerging state programs in for example California and the Northeast;

all seem to move toward a mandatory program in the U.S. such as a cap-and-trade program. If society decides to regulate GHG emissions, prices of carbon would likely increase, giving an economic incentive to farmers to participate in the carbon market.

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