

## Short-Term Impact of Cap-and-Trade Climate Policy and Agricultural Adjustment

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As the U.S. Congress considers comprehensive energy policy and greenhouse gas (GHG) emissions regulation (Adams, 2009), it is possible that a federal cap-and-trade (CAT) program could be established. The impact that CAT would have on the agricultural sector has received increased attention with different views among stakeholders. Farmer groups such as the National Farmers Union (NFU) have clearly expressed their support for a climate policy, believing that agriculture is part of a climate change solution (National Farmers Union, 2010). Others like the American Farm Bureau Federation (AFBF), however, are more concerned about the cost impact on agriculture and have remained engaged in the policy debate to assure that any final legislation does not diminish American agriculture (American Farm Bureau Federation, 2010). Understanding both the opportunities and the challenges that farmers would face under GHG CAT becomes critical with impending climate legislation in the United States.

Although GHG CAT implies rising production costs for agricultural producers, many agricultural economists are optimistic. They believe that the cost impact of a CAT climate policy would be limited while its benefits or the costs of no action may be more significant. For example, in testimony to the House Subcommittee on Conservation, Credit, Energy and Research, McCarl (2009) was more focused on the opportunities enabled by climate policy, expecting that agriculture would benefit even in the absence of carbon emission offsets. Based on a “back of the envelope” calculation that indicated limited benefit and cost impacts, Babcock (2009) concluded that any disruptive change in climate would have a far greater impact on livelihood than would the carbon price.

The goal of this paper is to provide a local perspective on the possible short-term impact of a CAT climate policy on agricultural producers and their potential for adjust-

ment. It summarizes findings of an empirical study focused on a region in the Northern Great Plains that explicitly considers local farmer behavior with respect to on-farm carbon sequestration and production cost management. While several analyses have developed an overview on the agricultural impact of GHG CAT at the national level, this empirical study attempts to shed some light on the agricultural potential of adjustment to economy-wide climate change mitigation while providing a bottom-up economic analysis on some of the short-term costs and benefits to agricultural producers in the transition process.

### Economics of the Agricultural Impacts of GHG CAT

The relevance of GHG CAT to agricultural producers comes mainly from the intensive consumption of energy and energy-related inputs in production and its GHG emission profile. Under a CAT regulation, a carbon price is introduced to the economy such that energy and other energy-related commodities that involve GHG emissions in production or consumption will see higher prices to cover their carbon costs. To agriculture, rising energy prices caused by CAT means higher input prices that in turn raise the costs of production. Meanwhile, agricultural production can change in response to higher input prices to mitigate the production cost impact (Baker et al., 2010). Additionally, CAT would likely establish a domestic offset market in which capped entities could purchase GHG emissions “offsets” from uncapped sectors, such as agriculture. Since agriculture can change its GHG emission profile by shifting land use and practices at relatively low costs, it may play an important role in the offset market.

Economic studies have emerged that examine the implications of a CAT climate policy for agricultural producers. Focused on different aspects of possible impacts, these studies can be grouped into two types by their assump-

tions on policy and farmer behavior: one with no production changes, and subsequent market effects, at all under rising input prices (e.g., Doane Advisory Services, 2008; U.S. Department of Agriculture, 2009), and the other considering market competitive equilibrium with complete production adjustment resulting from the introduction of GHG prices (e.g., Baker et al., 2010). While revealing the range of the possible impacts, all these studies pay less attention to the short-term shock to the farm economy, a case falling between no production changes and a full, complete production adjustment at new market equilibrium.

Short-term impacts and the process of production adjustment to new market equilibrium do matter to agriculture, and might be even more important than the long-term benefits themselves to producers. U.S. farmers are typically in their middle ages. They are risk-averse in production (Chavas and Holt, 1996) and may not be fully responsive to new policy-created market opportunities where they lack experience or where major changes in land use or additional capital investment would be required in spite of uncertain future benefits and transaction costs. Relevant examples include carbon sequestration and converting conventional cropland to perennial biomass for bio-energy feedstock production. Indeed, McCarl (2009) in his testimony to the House acknowledged that adjustment would be needed for agriculture to obtain the potential benefits brought by CAT climate policy.

On the other hand, farmers are sensitive to production cost increases and can adjust to a certain degree to mitigate any negative impacts caused by biophysical or economic conditions that affect production costs or profits. Farmer adjustment to climate, environment, policy, and economic factors is a fundamental and on-going agricultural sector activity (Rose and McCarl, 2008). With ris-

ing energy prices, farmers may reduce field operations or increase farm machinery maintenance to cut energy consumption and production expenses. While increased production costs may be expected resulting from CAT, profit-maximizing farmers will adjust their production to mitigate the cost impacts of carbon prices.

### **A Local Perspective with Farmer Behavior**

To provide a local perspective on the short-term impacts of a CAT climate policy on farm income, we developed an economic analysis that estimated the costs and benefits of carbon prices to agricultural producers in North Dakota—an important agricultural production region in the United States. In this study, we considered a CAT that exempts agriculture from GHG emissions regulation and allows agricultural producers to provide and sell GHG emissions offsets in a carbon market. This study was focused on two possible direct impacts on net farm income: potential revenue from carbon sequestration and rising production costs due to government GHG regulation. It examined the impacts within the period after the carbon price has raised input prices as well as production costs but before the new market equilibrium of agricultural production adjustment has fully established.

We first calibrated a farmer behavior model with respect to carbon sequestration based on farmer stated preferences in a mail survey. The survey questionnaire was composed of three sections. After a brief introduction, section 1 explicitly elicited farmer willingness to participate in four different carbon credit programs like those administered by NFU, including conservation tillage, cropland conversion to grass, rangeland management, and tree planting. Sections 2 and 3 contained questions to collect information on farmer socioeconomic background, their attitudes to climate change and legislation,

and current production practices. We designed six different versions of survey questionnaires to incorporate different levels of the carbon price ranging from \$5/metric ton to \$70/metric ton, thus varying profitability for carbon program enrollment. For each version of the questionnaire, a sample of 500 farmers across North Dakota was randomly selected from the U.S. Department of Agriculture National Agricultural Statistics Service database to receive the survey. A total of 322 survey questionnaires were returned.

On the cost side, we used historical observations to estimate farmer production costs per acre as a reduced function of energy prices. We calculated the increase of energy prices under different carbon prices based on the carbon content of the energy source, assuming the carbon price is fully passed on to consumers. The production cost function in its reduced form captures farmer ability of production adjustment to mitigate the cost impact of rising input prices due to carbon pricing. Based on the above models, a policy simulation with agricultural census data revealed production cost impacts, potential carbon sequestration revenues, and distributional effects on farm income under varying carbon prices.

Table 1 presents the production cost impact on average for North Dakota farms. If the fertilizer industry is exempted from GHG regulation, the cost impact for a carbon price range of \$5-65/metric ton will come largely from crude oil consumption, with an estimated cost increase ranging from \$0.54/acre to \$7.07/acre, a 0.69% to 9.00% increase relative to the average variable production cost for per unit land in 2009. Based on a recent EPA study of the Waxman-Markey climate bill published in June 2009 (U.S. Environmental Protection Agency, 2009), the carbon price for 2015 was estimated at \$12.64/metric ton CO<sub>2</sub> equivalent in 2005 value—\$56/metric ton carbon in 2009 value—which

**Table 1:** Annual Marginal Production Costs of Carbon Prices to Agriculture in North Dakota

Carbon price, \$/metric ton carbon	Production cost increase <sup>a</sup> , \$/acre (%) <sup>b</sup>	Break-even carbon credit <sup>c</sup> , metric ton carbon/acre
5	0.54 (0.69)	0.11
10	1.09 (1.38)	0.11
30	3.26 (4.15)	0.11
50	5.44 (6.92)	0.11
65	7.07 (9.00)	0.11

- a. The estimates of production cost increases did not account for the market equilibrium effect of the carbon prices on energy prices and assumed the fertilizer industry was exempted from cap-and-trade regulation.
- b. The percentages in parentheses are relative to the 2009 annual average of variable production costs for per unit land in North Dakota.
- c. The break-even carbon credits were calculated by dividing the production cost increases by the corresponding carbon prices.

implied a production cost increase of approximately \$6, a 7.6% increase per acre relative to the 2009 level for North Dakota farms.

Table 1 also calculates carbon emission offsets needed on a per acre basis for farmers to break even with the production cost increase. The existing voluntary carbon credit programs managed by the NFU estimates an annual carbon sequestration potential of 0.12 to 0.7 metric ton carbon/acre, at least for the North Dakota region (National Farmers Union, 2009). Compared to the potentially available carbon credits, the estimated break-even carbon offsets of 0.11 metric ton carbon/acre can be provided with some adjustment in production practices. This implies that farmers can sequester carbon without necessarily incurring significant opportunity costs except some capital investment and transaction costs. Those private costs could be covered by government cost-sharing programs similar to those supporting biomass production for bio-energy in the 2008 farm bill. As demonstrated by Baker et al. (2010) farmers would benefit from CAT in the long run at market equilibrium, these government programs do not have

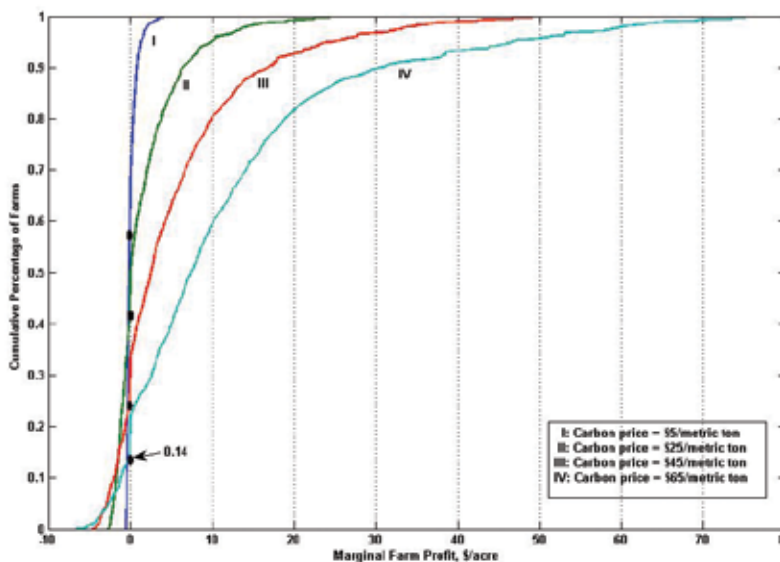
to be long term. The major purpose of these programs, like their counterparts for bio-energy, is to stimulate farmer participation in climate change mitigation while alleviating the negative short-term impact of CAT before agricultural adjustment to new market conditions.

Figure 1 illustrates the distributions of the impacts on net farm

income based on our model simulation of farmer behavior in combination with the 2007 agricultural census data. With the fertilizer industry exempted from CAT, Figure 1 shows that 69% of North Dakota farms would be negatively affected by GHG CAT for a carbon price at \$5/metric ton. However, the percentage of farms that would lose falls with increases in carbon prices. For a high carbon price up to \$65/metric ton (or \$17.7/metric ton CO<sub>2</sub> equivalent), only 14% of the farms would lose. Figure 1 also shows that the net losses suffered by some North Dakota farms would be limited compared to the gains for other farms that could stretch out over a wide range. For example, for a carbon price range of \$5-65/metric ton, or \$1.36-17.72/metric ton CO<sub>2</sub> equivalent, the net losses for some farms would be less than \$10/acre, but the net gains for other farms would be more than \$20/acre and could reach up to \$70/acre depending on the carbon price.

Some caveats deserve mentioning for the above results. First, the production cost impact might be overestimated as it did not consider the market equilibrium effect of car-

**Figure 1:** Cumulative Distributions of Marginal Farm Profits under Different Carbon Prices for North Dakota



bon costs on energy prices. In market equilibrium, these costs will be shared jointly by energy producers and consumers including agricultural producers. Second, the carbon sequestration revenue was based on farmer stated preferences for participating in carbon sequestration, which is not necessarily the maximum level that can be reached by optimal management in agricultural production. Farmers may do better if they turn out to be more active when a program is established and the production cost impact becomes a reality. Third, since this study was focused on the short-term impact, there were no long-term market equilibrium effects considered for the agricultural sector, which include part of the production cost increase that would be passed to consumers, increased demand for bio-energy feedstock, and higher commodity prices due to land competition, all of which can further increase farm income. Fourth, many potential creditable offset activities such as N<sub>2</sub>O reductions from altered fertilizer management and land set-asides for carbon sequestration were not considered, which limits profit maximizing options under CAT in our analysis.

### **The Best Strategy for Agriculture under Climate Change Mitigation Policy**

Given its joint benefit in both energy security and climate change mitigation, regulating and reducing GHG emissions represents an inevitable political choice for the United States. Within this context, the best strategy for agriculture is to adjust to government climate policy by identifying opportunities to mitigate the production-cost increasing impacts of the policy. Providing GHG emissions offsets is one such opportunity to which the agricultural sector should pay close attention. Production of bioenergy feedstocks, while not examined

in this analysis, presents another mitigation activity in agriculture with potential to boost revenues.

Based on farmer behavior modeling with agricultural census data, our empirical analysis indicates that: 1) the short-term cost impact of a CAT climate policy on agriculture is likely to be limited; 2) there is large potential for on-farm carbon sequestration that does not necessarily require major land use shifts; and 3) revenue from carbon sequestration may more than offset the production cost impact of carbon pricing such that the majority of agricultural producers will gain from CAT with increased farm income, particularly for high carbon prices.

However, institutions and policies with government assistance are needed to help agriculture adjust to societal climate change mitigation. First, as carbon sequestration is a new concept, better education and extension programs are needed to help agricultural producers understand and identify carbon sequestration potential of their land. Indeed, from our farmer preference survey, we found that farmers were biased against participating in carbon credit programs due mainly to concerns over regulation on farm management. Second, the U.S. government needs to develop rules and standards that could facilitate measurement and certification of GHG emissions offsets and that would reduce transaction costs, thereby encouraging farmer participation. Third, as capital investment can be a major obstacle for farmers to adopt carbon-sequestering practices, government assistance to share some of the cost would encourage wider participation in carbon credit programs.

### **For More Information**

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