An Analysis of the Effect of an Offset Program on Conversion of Cropland to Forest Land

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At Issue

A cap and trade system that includes domestic offsets will place a value on carbon sequestration in soil and vegetation on farms. Land management practices on farms that include conservation tillage, grass planting, and reforestation all have the potential to receive payments as carbon offsets. Concern has arisen that when afforestation and reforestation practices become eligible to receive offset payments, cropland will be converted to forestland as farmers opt to take advantage of these payments. The loss of cropland, particularly grains, could in turn force a price increase for feed, and thus adversely affect the livestock industry.

In this analysis, we assess the prospects for a crop-to-forest land-use change by modeling both the value of corn as a representative feed grain and the value of carbon sequestered in reforestation. The analysis compares future values for corn to potential values for forest carbon under a cap and trade compliance regime. We determine prospects for future cropland loss due to offsets in a cap and trade compliance regime.

Current Situation

Corn is a dominant field crop in the United States, and its yield and value have been steadily increasing. Corn is used for a range of food and non food products, and in recent years has been a dominant feedstock for ethanol bio-fuels.

Corn yields, prices, and overall value have been increasing in the United States. Since 1990 corn yields have increased from around 118 bu. per acre to 153 bu. per acre in 2008, with some variation from year to year. The price has increased markedly in recent years to $4.20 per bushel in 2007 and $3.90 per bushel in 2008. What has been most striking is the overall increase in production and the total value of production. Total value has increased from $18 Billion in 1990 to over $47 Billion in 2008.

The land base dedicated to corn has increased about 17% since 1990, signaling a steady increase in land used for corn production over other crops. The increases reflect the rising demand for corn ethanol in recent years, and a growing demand for a range of corn products in the last 15 years. In 2008 corn planted area comprised 27% of the total area planted in principle crops in the U.S. suggesting corn is a dominant and permanent annual crop.

Future Prospects

This analysis looks out to the year 2025. We derive estimates of corn yield changes from various literature sources from academia and industry. Most sources suggest that corn yields will increase by as much as 40%. One industry study by Monsanto estimates that yields will increase to 245 bu. per acre by 2020. Our analysis suggests a steady increase in corn yields tapering off at 190 Bu per acre in 2020. This estimate is consistent with the general fit of the historical trend in corn yields reported by the USDA. The area planted in corn is also expected to rise as demand for ethanol increases. Some estimates suggest a 60% increase in corn areas, but our analysis assumes no increase in planted area. It is unclear how corn prices may change in the future, but there is some expectation that they may increase while the demand for ethanol increases. Our analysis suggests corn could see a price of over $7.00 per bushel in the near term, but for our analysis we assume no change in price, staying level at $4.00 per bushel, a conservative estimate.

The cost of corn production is rising in recent years due to the rising prices of fuel, a trend we expect to see continuing through the term of the cap and trade system. Corn production costs range from $1.20 to $3.50 per acre, depending on productivity of the land: high costs are usually associated with lower yield land.

Results of Analysis: Base Prices

The calculations run at the MSU Carbon2Markets Project used conservative figures: area planted was assumed to stay constant, prices also are assumed to be increase slightly from $4.00 to $5.00 per bushel, and yields are projected to increase from 150 bu. per acre to 190 bu. per acre. Estimates of tree growth rates and stocking densities were derived from standard forestry yield models for medium to fast growing trees, such as pine and poplar. To be consistent with how offsets are measured and reported in carbon trading markets, we incorporated into our analysis the standard growth rates approved by the Chicago Climate Exchange, using a figure of 3.5 tons CO2e per year. This analysis does not assume a carbon price a priori, rather it produces the carbon "trigger" price as an output. This price is the value that a farmer would have to get from forest carbon to meet the estimated yield and price of corn per acre.

Model results suggest that at the beginning of a cap and trade compliance regime in 2012 corn yields will be 155 bu. per acre, and will deliver $620 per acre on the market before costs. Carbon in a young plantation would yield 3.5 tons CO2e per acre and would have to see and offset price of $172.00 per ton CO2e to deliver the same value per acre as corn before costs. By 2025, we estimate that corn will deliver $760 per acre on the commodity market, and carbon offset prices would have to rise to an extreme price of $217.00 per ton CO2e on the carbon market before costs.

Results of Analysis: After Costs and Revenues

To be more precise, it is important to factor in the cost of corn production and look only at the net revenue to the farmer. We assume a cost of production rising with the price of fuel over the term of the analysis, such that the cost is equal to 50% of the bushel price, from $2.00 to $2.50 per bu. over the term of the analysis.

This value then should be compared to the alternative value from carbon offsets as well as the value of the wood itself. We include an estimate of revenue from the timber based on the size of the stand after 15 years from the stand growth model and an average price per board foot: 5,000 board feet at a price of $200.00 per thousand board feet. When averaged over the term, we assume $67.00 per year. The establishment costs are low at $20.00 per year per acre. The net revenue from timber would be $47.00 per acre.

Thus we take into account the cost of corn production to estimate net value, and we consider the value of timber and its establishment costs in addition to the carbon sequestration offsets payments. This will decrease the trigger price by decreasing the net revenue from corn and increasing the total revenue from carbon and timber. Net corn revenues go from $320 per acre in 2012 to $475 per acre in 2025. This results in a trigger price for carbon of $78 in 2012 and $122 in 2025.

Conclusions

Our analysis suggests it is highly unlikely that farmers will find it more economical to replace corn land with forest land under a cap and trade offsets program. Our model used very conservative estimates and carbon prices would still have to be as high as $78 - $122 per ton CO2e to compete with the value of corn. Even though our analysis includes the cost of tree establishment and the additional revenue from timber sales, it does not include the cost of land conversion. Further, our analysis does not take into account the cost of carbon measurement and verification. Taken together these added costs for forestry make the option even more unlikely. Also note that carbon credits cease after tree growth stabilizes which could be anywhere from 15-30 years depending on the management plan, whereas corn production revenues are continuous. This also makes the proposition of trees less attractive.

However, there are some conditions and prospects in which farmers may option to engage the carbon markets through tree planting. It is reasonable to expect that marginal and unproductive land would be converted to forest, and here the competition for land will likely not be with cropland but with switch grass and other hardy perennial feed stocks for bio-fuels. Pastureland could also be converted to trees but this land-use change does not compete with corn production. Some unproductive corn land in the southern states may get converted to forest if the yields are very low, but even if yields were as low as 100 bu. per acre, farmers would have to see a carbon price of $60 per ton CO2e, and we still do not include measurement and verification costs.

Trees don't have to be placed on top of fields -- they can be used as shelter belts, riparian cover along streams, and indeed intermixed with some crops in some regions. Meanwhile, farmers can adopt conservation tillage, organic farming or many other field management methods to sell offsets at the same value per ton of CO2e as trees (although not as many tons) on cropland already in production. Since we computed corn prices without the added bonus of soil offsets, our estimate of corn revenues is conservative. Adding soil management offsets and trees within an existing crop-oriented farm allows for both grain production and carbon offsets, and enhances the proposition of cropland over forest land, and decreases the likelihood of land conversion. The offset revenues from cropland soil management can be enough to allow farmers to start practicing conservation tillage which many want to do but cannot afford the investment. It also has many environmental co-benefits

Corn prices may remain high due to upward price and demand pressures from bio-fuels, and while that would have the tendency to keep land in cropland rather than forest, it could mean higher prices for feed. But this price pressure is not at all related to whether or not there is a domestic offsets program. At the same time, it is conceivable that cellulose based bio-fuel production could raise the value of tree plantations and encourage a shift from grain for ethanol to wood for cellulosic, methanol or gasification, but again these pressures have nothing to do with establishing a domestic offset program.