An Energy Strategy Based on Energy Dedicated Crops or Corn: Differential Economic and Regional Impacts

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Abstract

The growth of the role of agriculture as a source of energy feedstock has been primarily concentrated on increasing corn use for ethanol. Alternatively, refocusing this growth in the utilization of dedicated energy crops could prove more advantageous as producers of more crops in a wider geographic area could benefit.

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Differential Economic and Regional Impacts

Daniel G. De La Torre Ugarte[1]

Introduction

The oil embargoes of the 1970s raised concerns about energy security. In response, programs to develop alternative energy sources were begun. Later on with the passage of the Clean Air Act of 1990, an additional emphasis was placed on the development, production, and use of alternative fuels considered being friendlier to the environment than fossil fuels. Among these fuels or sources of energy is ethanol which traditionally has been obtained from corn starch. In 1978 in addition to research on conversion technologies, the U.S. Department of Energy (DOE) established the Bioenergy Feedstock Development Program (BFDP) at Oak Ridge National Laboratory. The BFDP has focused on developing new crops and cropping systems that can be used as dedicated bioenergy feedstock. Switchgrass, hybrid poplars, and hybrid willows are among these dedicated crops. These dedicated crops, rich in lignocelluloses could also be used to obtained ethanol. These same dedicated crops could also be co-fired with coal to obtain electricity.

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Linking Agriculture and Energy Policies

Agriculture is well positioned to become an important component in the strategy to develop and use alternative energy sources. The corn-based ethanol industry was practically born as a result of the energy policy objective. It grew from non-existent to 1.9 billion gallons in 2001. The growth resulted from the combination of national security concerns, new gasoline standards, and government incentives. Use of corn for ethanol is estimated to represent 7.1% of total domestic use in the year 2001 (USDA). Several studies have documented the contribution of the ethanol industry to agriculture, in the form of higher corn price and farm income, and to savings in government expenditures, and also the potential gains if the growth of this industry speeds-up as a consequence of banning MBTE as a fuel component.

The engine behind the growth of the use of corn for ethanol has been environmental regulations, and tax breaks supporting the use of ethanol as a fuel to help with the compliance of the Clean Air Act. More recently the prohibition of MTBE, ethanol's most serious competitor to oxygenate gasoline, would provide an additional lift to the growth of the ethanol industry.

The increased use of agricultural commodities -corn or others- and their by-products for energy production results in resources moving away from feed and food production. However, agricultural input and output prices will respond to the changes in use, and consequently generate new levels of returns, income and government expenditures in the agricultural sector, without distinguishing the origin of the change, energy or food and feed markets. The energy sector, through the production of ethanol, competes with the feed and food market for the use of the same commodity. Because of this direct competition for corn use, changes in the feed market would directly affect the price of corn, and consequently the demand for ethanol, and vice versa; hence, more or less price variability of one market will be directly transferred to the other.

The link between the energy and agricultural sectors takes a new dimension in the case of a dedicated energy crop, like switchgrass. The competition between the two sectors occurs at the fixed resource use level, which is the allocation of cropland. Since dedicated energy crops have a very low value for the feed and food market; there is no competition on its final use. Instead the competition is transferred to the land allocation process. Short-run events in agricultural markets are less likely to impact the energy industry built on dedicated energy crops. In addition, unlike corn and the major crops, switchgrass is a perennial crop. This reinforces the fact that short run events in the agricultural sector are less likely to impact the dedicated energy crop market. Also, the transformation of corn into ethanol produces corn gluten feed, corn gluten meal, and protein distillers dried grains which primarily compete with domestic soybean meal. This competition negatively affects the soybean meal and soybean markets.

In summary, there are three basic differences between a dedicated energy crop and an agricultural commodity used for energy. First, the competition is transferred from the crop-use to the resource-use level. Second, dedicated energy crops are perennials; and third, the processing of dedicated crops does not produce by-products that could depress other agricultural markets. Additionally, because the areas in which it can be grown are much more diverse, a dedicated energy crop like switchgrass, offers a wider geographical impact than corn.

An Ex-Post What If…

Based on the characteristics of both corn and dedicated energy crops, and the high cost of the 1996 Farm Bill discussed above, the following counter-factual hypothesis or question could be defined: What could have changed if a bioenergy policy would have been in place at the time of the implementation of the 1996 Farm Bill? What if the emphasis would have been on a strategy based on corn or if a strategy based on a dedicated energy crop would have been pursued? Given the low commodity prices experienced during the 1998-2000 period, and the potential re-allocation of cropland planted to the major commodities to dedicated bioenergy crops, it would have been possible to achieve higher net farm income, and the additional production of renewable fuels at a lower budgetary cost that the one incurred by the 1996 Farm Bill alone.

The analytical tool used in the analysis is POLYSYS. POLYSYS is an agricultural policy simulation model of the U.S. agricultural sector (De La Torre Ugarte 2000; Walsh 2001) with roots in earlier models including the Policy Simulation Model (POLYSIM) (Ray 1976) and the Regional Allocation Summary System (RASS) (Huang 1988). POLYSYS (De La Torre Ugarte and Ray 2000; Ray et al. 1998) is a theoretically rigorous model which is capable of estimating annual changes in land use, crop prices, net farm income, and government costs associated with changes in agricultural policy mechanisms, yields, management practices, exogenous demand shocks, etc.(De La Torre Ugarte et al. 1998, Ray et al. 1998). The POLYSYS modeling framework can be conceptualized as a variant of an equilibrium displacement model (EDM). The general appeal of EDMs is in part due to the inherent ability to complete modeling exercises in a wide variety of market structures (Piggot et al. 1995, Wohlgenant 1993, Brown 1995, Kinnucan 1996). POLYSYS is a system of interdependent modules simulating livestock supply and demand, crop supply and demand, and agricultural income. POLYSYS is usually anchored to published baseline projections, however in this study it was anchored to the actual historical data from 1996 to 2000.

Because bioenergy crops are not currently produced on a large scale, production location, yields and management practices are based on research data and expert opinion. A workshop with experts from the USDA and DOE was held to determine bioenergy crop data used in the analysis. Bioenergy crop production was limited to areas where they can be produced under rain fed conditions and where sufficient research, demonstration and commercial operational data are available to provide reasonable yield and management recommendations.

To simulate the impacts of the counter factual hypothesis, the starting year of the analysis is chosen to be the first year of the 1996 Farm Bill. In this way the higher prices and low fiscal budget costs of those years are also included in the analysis, in an effort to ensure an unbiased analysis. Also, the scenarios representing the corn based and the dedicated energy crop base strategies we setup as to achieve a total use of ethanol of 7.6 billion gallons by the year 2000; which is the target specified in the standards being discussed in congress, although at a much accelerated rate.

Results

There are four major aspects of focus in the discussion of results: change in prices, change in net returns, the geographic distribution of the returns, and the cost of ethanol. In dealing with crop price impacts, the emphasis is placed on corn, soybeans, and wheat - the crops in which the impacts affect the largest area.

The changes in the price of corn are presented is Figure 1. The graph indicates that the largest impact on corn price occurs under the corn based strategy, in which the price reaches 2.49 $/bu. in the year 2000, compared to a 2.10 and a 1.85 for the dedicated crop and the historical price respectively. This occurrence is not surprising since the corn based strategy increases directly the demand for corn; and the dedicated crop strategy impacts the corn price through the displacement of acreage from all crops including corn.

In the case of the soybean price, Figure 2 indicates that during first two years both strategies have a similar impact, but for later years the price of soybeans is 50 cents per bushel higher for the dedicated energy crop strategy when compared to the corn based strategy and about 80 cents higher than the actual price for the same year. This differential impact is due to the fact that dedicated crops like swichtgrass are perennials, so once an acreage that used to be planted to soybeans or other crops shifts to a dedicated energy crop, it tends to remain in that use.

Figure 3 shows the behavior of the wheat price for both strategies. The energy dedicated crop strategy results in a significantly higher price of wheat. This because a significant portion of the acreage allocated to the energy dedicated crop used to be planted in wheat, and on the other hand an increase in the demand for corn has little impact on wheat, as the major wheat and corn areas are geographically independent.

From the discussion above it is possible to conclude that emphasizing a strategy based on an energy dedicated crop impacts a more diverse set of crops. The price impacts of a corn based strategy are highly concentrated in corn and to a lesser degree in soybeans too.

To assess income and regional impacts of the two strategies the analysis focuses on the behavior in the change in total market returns to the major crops. For the corn based strategy, the changes are presented in the map contained in Figure 4. A quick review of the information presented in the map leads to the observation that the change in total market returns are highly concentrated in the corn-belt. Agricultural Statistic Districts (ASD's) in Iowa, Illinois and eastern Nebraska experienced a gain in market returns of 300 million dollars and above for the period 1996-2000. The high plains of Texas and the southwest Kansas are ASD's outside the corn belt in which the gain of net returns is between 150 and 299 million dollars; to a large extent this is due to a significant production of sorghum. Although the concentration in the increase in total market returns occurs in the Corn Belt, there is no doubt that gains occur through the continental US especially in agricultural areas.

The results corresponding to the dedicated crop based strategy are presented in Figure 5. Again gains in market returns occurs through out the continental US, but in this scenario the concentration of gains includes a much larger area encompassing the corn belt, the northern plains, and the Mississippi delta.

The difference in the regional impacts is summarized in Figure 6, where the red color indicates that returns are larger in the corn based strategy, and the green areas that the returns are higher for the dedicated energy crop strategy. When emphasizing the dedicated crop strategy, dollars that would have concentrated in Nebraska, Iowa, and Illinois because the corn based strategy, are transferred to the rest of the country, specially the northern and southern plains, the Mississippi delta and the southeast. The greater number of crops impacted, the introduction of a more profitable crop, and the perennial characteristic of the energy dedicated crop are among the most important factors behind these results.

Another important element is the net cost of producing ethanol from corn grain and from a cellulose feedstock like swichtgrass. The data in Figure 7, shows the gross elements to compute the net cost of producing ethanol: feedstock cost, processing, credits for by-products resulting from the processing of the feedstock, an item labeled feedstock subsidy (to be explained later) and the production cost. The item feedstock "subsidy" requires a particular explanation. Both the corn and the dedicated energy crop strategies result in higher crop prices. These higher crop prices may allow for a reduction in the need to provide government support to agricultural producers. These government savings, computed based on what was actually spent in the period 1996-2000, are in turn converted into dollars per gallon of ethanol, and can be understood as the government's ability to use the savings to provide an incentive to the producers or users of ethanol. In the particular case of this study and of Figure 7, the assumption is that all government savings generated are converted into feedstock "subsidy", so the production cost presented in Figure 7 is the total cost net of this potential incentive.

The bottom line from Figure 7 is that even though the process of converting switchgrass into ethanol is more costly than the one incurred when processing corn grain into ethanol, the savings generated in agricultural commodity programs are large enough to almost eliminate the cost of production difference between the two feedstocks. Therefore, taking into account that the savings to the government of implementing the corn based strategy are 1.3 billion dollars, when compared with the average of actual spending for the 1996-2000 period; and those savings increase to 4.8 billion dollars in the case of the dedicated crop strategy, the difference in the cost of production of ethanol is about 5 cents per gallon.

Concluding Remarks

This study has shown that an energy strategy based on a dedicated crop has the ability to impact a larger number of commodities, and have a positive impact in a wider geographical area. It has also been shown that an energy dedicated crop has the potential of generating significant government savings from commodity programs.

The continuation with the over emphasis of using corn as agriculture's contribution to respond the energy needs of the country, may be shortchanging agriculture's capacity to produce energy feedstock, and also may be limiting the benefits that could be capture by agriculture and rural communities from the energy sector. While the corn based ethanol production is already an established industry, based on an well known and established feedstock, it is necessary to recognize the potential opportunity that an energy dedicated crop offers in terms of agricultural wide impacts, and regional distribution of those impacts.

Among issues for further research are the impacts of the food bill and how these strategies impact the variability of prices. Another key element for further research is to explore the limits of agriculture as source of energy feedstock. The potential environmental impacts of these strategies are also an issue of particular interest. Finally, a strategy based on the energy dedicated crop may be required to address storage and transportation obstacles, and may also require some new institutional contractual arrangements.

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Figure 1 Actual and Simulated Corn Price

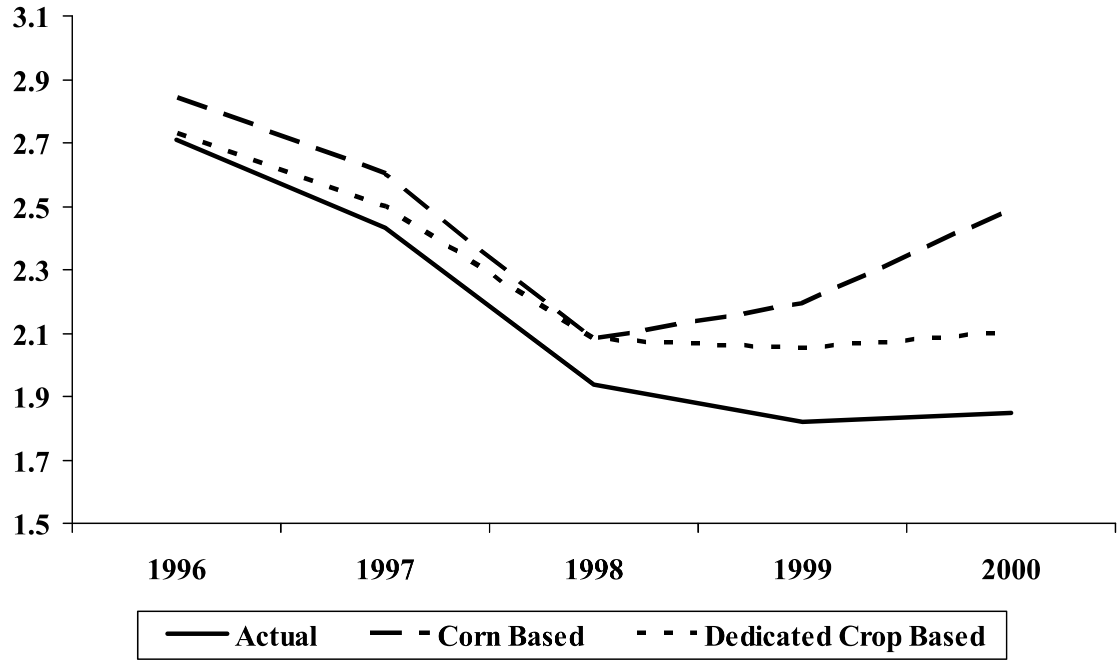

Figure 2 Actual and Simulated Soybeans Price

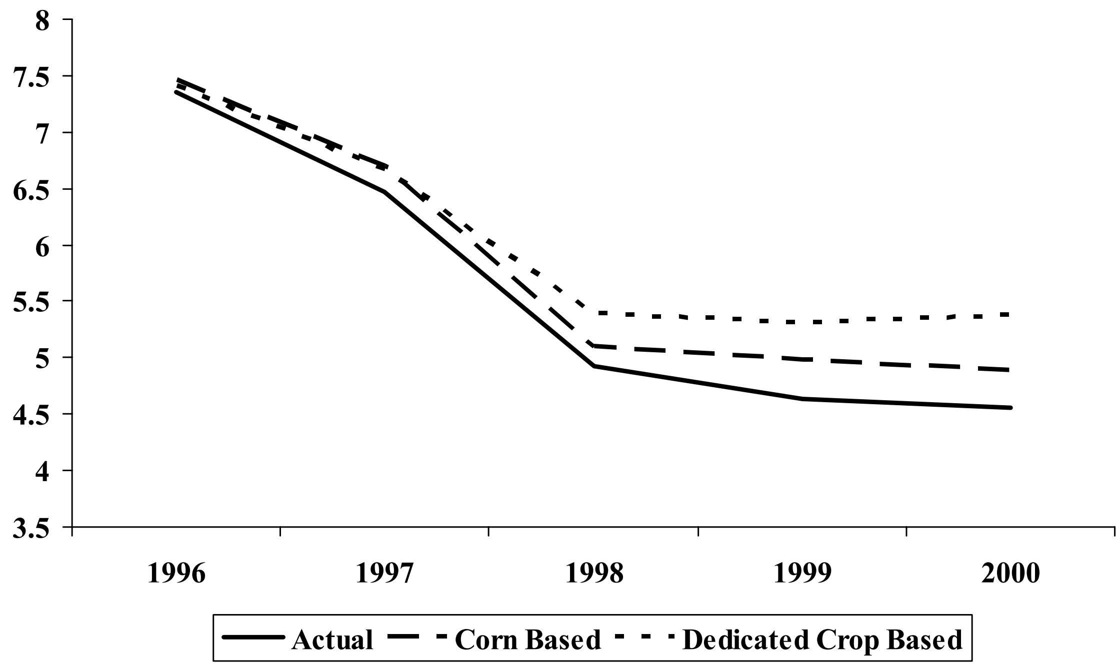

Figure 3 Actual and Simulated Wheat Price

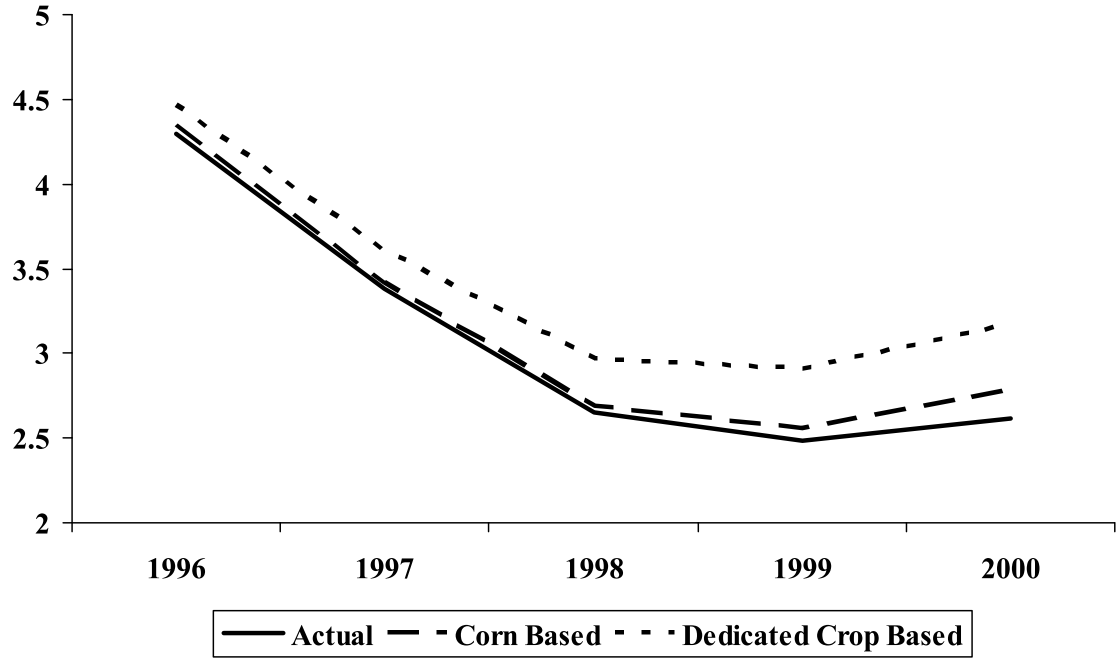

Figure 4 Corn Based Strategy. Change in Market Returns, 1996-2000 (million $)

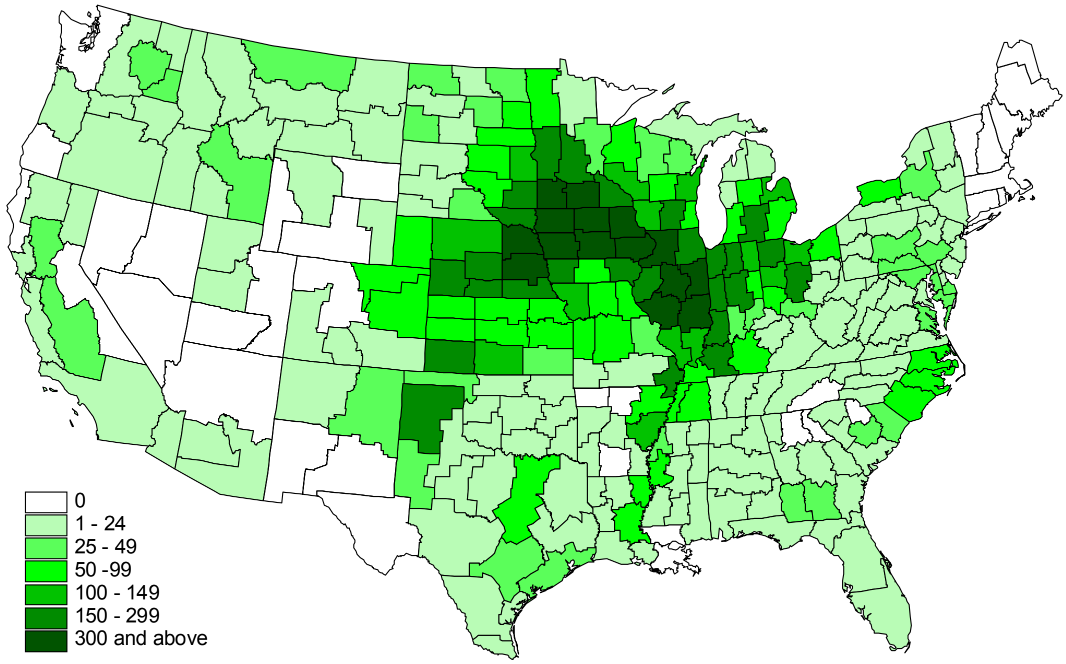

Figure 5 Dedicated Crop Based Strategy. Change in Market Returns, 1996-2000 (million $)

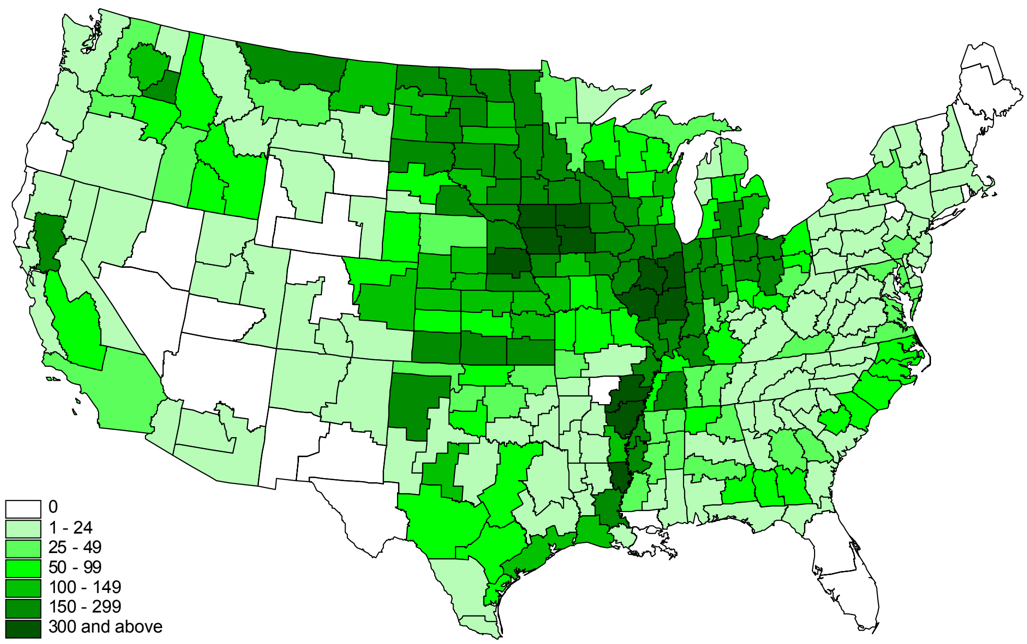

Figure 6 Dedicated Crop versus Corn Based Strategy. Difference in Market Returns, 1996-2000 (million $)

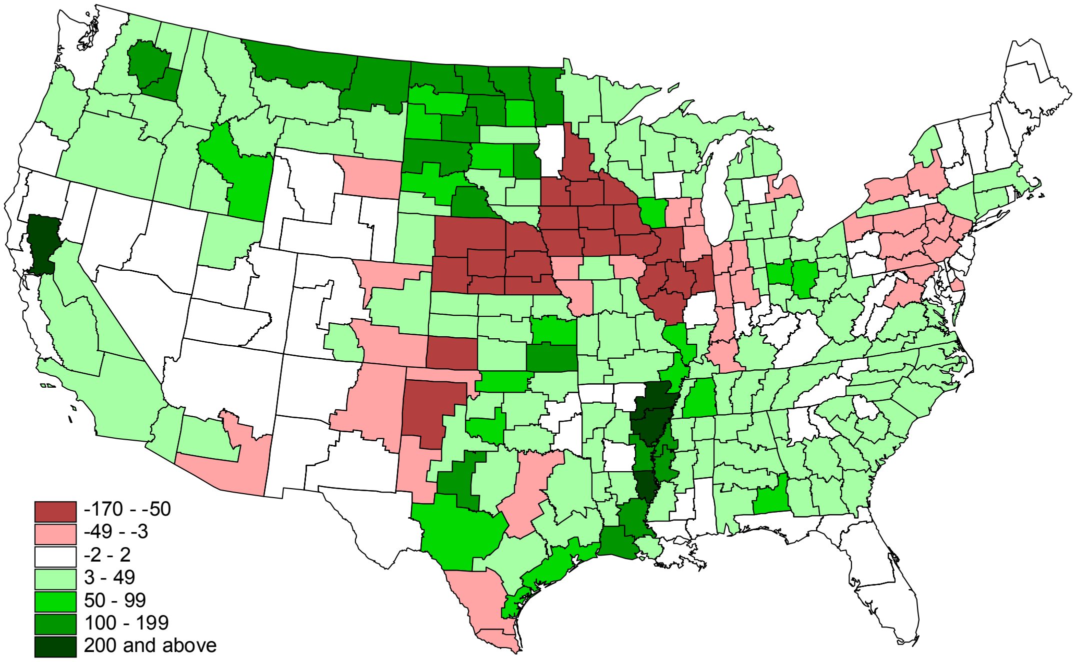

Figure 7 Cost of Producing Ethanol

	Corn 2.49 $/bu	***Switchgrass 50 $/dt***
Feedstock	**0.89**	**0.64**
Processing	**0.49**	**1.12**
By-Products credit	**-0.25**	**-0.11**
Feedstock "subsidy"	**-0.17**	**-0.64**
Production Cost	**0.96**	**1.01**

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