

Synergism Between Agricultural and Energy Policy: The Case of Dedicated Bioenergy Crops¹

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Abstract

A counterfactual scenario, in which during the period 1996-2000 incentives were in place for growing dedicated bioenergy crops, is analyzed. POLYSYS an agricultural policy analysis model was the analytical tool of choice. In the absence of commercial size operations, data for bioenergy crops was collected from pilot and research fields and validated by expert opinion. Results indicate that on an annual average basis, market returns to major crops would have increased up to \$3.6 billion with government savings of \$1.8 billion a year.

Key words: bioenergy, biomass, policy, farm bill, simulation.

¹ Selected paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Orlando, Florida, February 2-5, 2002.

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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 to be friendlier to the environment than fossil fuels. Among these fuels or sources of energy is biomass energy. 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.

The origin of agricultural commodity policy can be traced to the 1930's. Since then commodity programs have been an integral part of the development of the agricultural sector. In general, their objective was to deal with three major characteristics of crop agriculture markets: supply growth outpacing demand growth, inelastic crop supply, and inelastic food demand. These three elements are at the root of crop agriculture's inability to self correct itself through the market mechanism, or alternatively stated are the root of politically unacceptable cost of market correction of economic resources used in agriculture. Through the enactment of a series of farm bills, Congress has adopted legislation establishing commodity programs. Over time farm bills have included mechanisms such as price supports, direct government payments, acreage set asides, stock management, and land retirement programs. The 1996 Farm Bill, officially known as the Federal Agriculture Improvement and Reform Act (FAIR), established the mechanisms currently in place and marked a significant departure from traditional commodity

programs. The 1996 Farm Bill was debated and passed during one of the best of times in U.S. agriculture and has presided over one of the worst of times in terms of crop prices, market incomes, and government payments.

Linking Agriculture and Energy

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 increase 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 sector, 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, that 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 a 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.

Agricultural Policy: The 1996 Farm Bill

During the debate and passing of the 1996 Farm Bill, the prevailing expectations were that it would mark the dawn of a new era for U.S. agriculture where expanding export markets would fuel agricultural prices and incomes without restraint. However, these expectations did not materialize. While many suggest a long list of short-run events as the cause—the Asian Crisis, exchange rates, trade sanctions, loan rates, emergency payments, etc.—Ray(2001), examination reveals the fallacy of the supposition that the very nature of crop agriculture had changed. As Ray argues, basic characteristics of crop agricultural

markets remain unchanged: the rate of supply growth exceeds demand growth, crop supply is price inelastic, and crop demand is price inelastic.

Major changes introduced by the FAIR Act were the introduction of full planting flexibility, modifying the loan rate from a price support to a marketing loan rate, and direct payments would be given in a lump sum rather than based on production. The expectation was that in the absence of a price support mechanism as prices fall, producers would adjust their production and exporters would increase their purchases. The full planting flexibility, would allow farmers to allocate their acreage to the most profitable alternative (except fruits and vegetables), and hence avoid excess production of crops with low prices. The marketing loan rate provided producers with a minimum revenue per unit of production, but because it was not a support price it allowed prices to drop as low as needed by the market to clear the demand and supply of the commodity. The intent was to let the market prices fall triggering an increase in exports as well as pressuring competitors to reduce their production by making it less profitable for them to produce at those new lower price levels. Finally, the lump sum payments or production flexibility contract payments had the goal of decoupling production decisions from government payments, with the expectation of reducing or eliminating over production.

The expectations that supporters of the bill placed on the FAIR Act and the euphoria of high prices and income only lasted through crop year 1997. Although prices started to decline in the 1996 crop year, by 1998, prices had declined to politically unacceptable levels. In response Congress provided emergency direct payments to farmers. By 1999, direct government payments (contract, loan deficiency, market loss assistance payments, etc.) accounted for 48 percent of all net income in agriculture. Figure 1 shows net cash income computed in two ways: (i) the sum of the value of production and government payments less total cash production expenses, and (ii) excluding government payments. Therefore the vertical distance represents the total government payments to farmers by marketing year. In the 1999 crop year, government payments were seven times greater than net cash income for the eight major crops. Total government expenditures, shown in Figure 2, reached record levels in 1999 and more importantly significantly departed from the stated intent of the Bill authors.

The 1996 Farm Bill, if anything, has shown that the basic characteristics of crop agricultural markets that originated commodity programs in the first place, remain unchanged: the rate of supply growth exceeds demand growth, crop supply is price inelastic, and crop demand is price inelastic. What also remains unchanged is that there is a limit to the cost of a downward adjustment that seems to be politically acceptable, as seem to be indicated by the series of emergency payments enacted since 1998.

An Ex-Post What If...

Based on the characteristics of the dedicated energy crops, and the high cost of the 1996 Farm Bill discussed above, the following counterfactual hypothesis or question could be defined: What could have changed if a bioenergy policy based on a dedicated energy crop was pursued at the time of the implementation of the 1996 Farm Bill? 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 than 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 is a system of interdependent modules simulating livestock supply and demand, crop supply and demand, and agricultural income. Major crops and livestock are considered endogenously. Alfalfa, other hay, and edible oils and meals sectors are considered exogenously. POLYSYS is usually anchored to published baseline projections, however in this study it was anchored to the actual historical data from 1996 to 2000.

The crop supply module is composed of 305 independent regional linear programming (LP) models representing land allocation decisions in regions with relatively homogeneous production characteristics. The crop demand module estimates prices and utilization for each crop by use (food, feed, industrial, export, and stock carryover). The demand module interacts with the derivatives markets such as the oil

and meal markets. The livestock module is an econometric model that interacts with the demand and supply modules to estimate production quantities and market prices, primarily through links to feed demand. The income module uses information from the other modules to estimate cash receipts, production expenses, government outlays, net returns, and net realized income. Each module is self-contained, but works interdependently in a recursive framework to perform a multi-period simulation.

Switchgrass (*Panicum virgatum*) is a perennial warm season grass; its native range includes the United States east of the Rocky Mountains and extends into Mexico and Canada. The production of switchgrass utilizes agricultural management practices that are similar to those used in traditional hay crops. 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. Management practices assumed for switchgrass include a 10 year production rotation with harvest as large round bales. Varieties appropriate to each region are assumed. Fertilizer (both quantity and type) varies by region. Production costs for conventional and bioenergy crops vary for each of the 305 regions. Conventional crop costs are estimated using the APAC Budgeting System (ABS) (Slinsky 1999). To ensure consistency, the ABS is also used to estimate all costs associated with producing switchgrass.

Due to the multi-year characteristics of bioenergy crops, a net present value approach is used to decide which crops are produced. To better account for the impacts of large-scale changes in land-use resulting from significant shifts of acreage to bioenergy crop production, a modified rational price expectations approach is used

To simulate the impacts of the counterfactual 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, two alternative

price scenarios for switchgrass were considered, one in which farmers receive \$ 30 per dry ton, and another one in which the farm gate price is \$40 per dry ton.

Results

Unless otherwise specified, the results of the analysis are presented as averages across the period of analysis 1996-2000. In most cases then the historical average is compared to the estimates obtained from POLYSYS. In this way the impacts are easier to present and hopefully easier to understand. Also the explanations of the results focuses on the scenario in which the price of switchgrass is set at \$40 per dry ton; references to the \$30 per dry ton scenario are made when appropriate.

The POLYSYS estimates indicate that by the year 2000, switchgrass could have been planted in 9.420 and 22.230 million acres, at the prices of 30 and 40 dollars per dry ton respectively. The corresponding geographic distribution is shown in Figures 3 and 4; the estimated plantings in the Southeast region by the year 2000 are 2.6 and 5.0 millions acres corresponding to the low and high price scenarios respectively. Under the \$30 per dry ton scenario the plantings of switchgrass are about 27% on the national total, while in the other case is 22.3%.

The price impacts driven by the acreage re-allocation described above are presented in Figure 5. Under the 40 dollars scenario the price gains are such that in every year of the period, the seasonal average market price lies above the loan rate, significantly reducing loan deficiency payments. The largest price gains occur in soybeans, follow it by wheat. Cotton experienced a price gain of up to 10 percent.

Following with the \$40 dollars scenario, the price gains driven by shifting acreage from the major crops to switchgrass, triggered several major impacts. First, loan deficiency payments are significantly reduced, since the gap between market price and loan rate is virtually eliminated. Next, the higher prices also imply an increase in the per unit revenues, although the quantity produced of these crops decreased. Third, if income increases significantly, emergency payments would be reduced because they were triggered by the low income caused by falling prices. A summary of these events are presented in Figure 6.

Figure 7 indicates that on the average for the period under the higher price scenario, because of the higher market prices for the major crops, the market returns to these crops increased from \$21.5 to 25.1 billion; this despite the lower production levels due to the reallocation of 22.23 million acres to the production of switchgrass. Also, loan deficiency payments are reduced from an average of 1.888 billion dollars a year to 206 million dollars. The increased returns should have triggered some reduction in the level of emergency payments paid to farmers, however because those payments were ad-hoc, to maintain a conservative estimate of the government savings there are assumed to be constant in this analysis.

The results of this analysis can be best summarized in Figure 7. This figure shows estimated government savings of \$936 and \$1,682 million a year for the low and high price scenario respectively. Also, while the scenario of \$30 per dry ton resulted in a loss of \$96 million a year, the other scenario resulted in a gain of 1.873 billion dollars a year. So if the counter-factual scenarios analyzed in this study would have been in place, the performance of the sector could have been improved with significant savings for the treasury. Moreover, the last line of Figure 7 was computed as savings in government payments divided by the production of switchgrass, which can be considered as the potential subsidy that could be transferred to switchgrass producers and users, while keeping the level of government expenditures exactly at the same level that the one actually observed for the 1996-2000 period. At the extreme, the size of the switchgrass subsidy could have been higher than assumed farm gate prices of \$30 and \$40 dollars per dry ton. In the first case the subsidy could have been \$56.5 and in the second \$50.6 per dry ton.

Concluding Remarks

The results of this study indicate that if the current agricultural policies of full production and free price adjustments continued to be pursued, implementing an aggressive dedicated bioenergy could result in higher farm income and significant savings for the treasury, as well as an increase in the production of renewable and cleaner energy sources. There are many issues to be resolved before we see a wide spread

implementation of a dedicated bioenergy industry—logistics as well as technical issues. However, given the potential pay-offs, the additional research required in this area could be money well spent.

In the economics area, it is critical to further understand the implications for price variability that such an strategy may imply for the agricultural sector. Additionally, it is important to make a direct comparison directly with the ethanol corn based industry to assess the advantages and disadvantages of each feedstock and energy industry.

References

- De La Torre Ugarte, D.G. and D.E. Ray (2000), 'Biomass and Bioenergy Applications of the POLYSYS Modeling Framework'. *Biomass and Bioenergy* **18** (4), 291--308.
- Huang, W., M.R. Dicks, B.T. Hyberg, S. Webb, C. Ogg (1988), 'Land Use and Soil Erosion: A National Linear Programming Model'. Technical Bulletin 1742, U.S. Department of Agriculture, Economic Research Service, Washington, DC.
- Ray, D.E. (2001). The Economic Climate for the Farm Bill Debate. Paper presented at the Fixing the Farm Bill Policy Conference, Washington, D.C., March 27, 2001.
- Ray, D.E. and T.F. Moriak (1976), 'POLYSIM: A National Agricultural Policy Simulator.' *Agricultural Economics Research* **28** (1), 14--21.
- Slinsky, S.P. and K.H. Tiller, (1999), 'Application of an Alternative Methodological Approach for Budget Generators for Research.' Published Abstract, *Journal of Agricultural and Applied Economics* **31** (2), 401.
- Walsh, M.E. and D.A. Becker, (1996), 'BIOCOST: A Software Program to Estimate the Cost of Producing Bioenergy Crops.' *Proceedings of Bioenergy '96*, Nashville, TN, Pp. 480--486.
- Walsh, M.E., D.G. de la Torre Ugarte, H. Shapour, and S.P. Slinsky (2001) 'Bioenergy Crop Production in the United States: Potential Quantities, Land Use Changes, and Economic Impacts on the Agricultural Sector'. *Journal of Environmental and Resource Economics*, in press.

Figure 1
Net cash income for eight major crops, 1990–2000. (Source: USDA Office of Chief Economist).

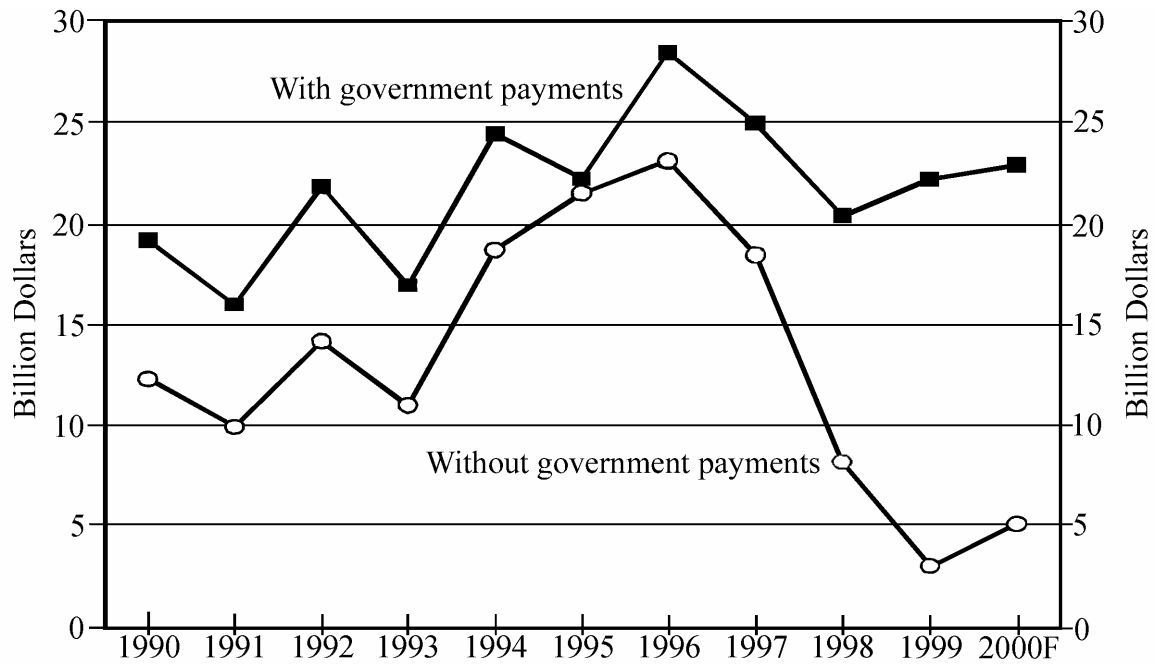
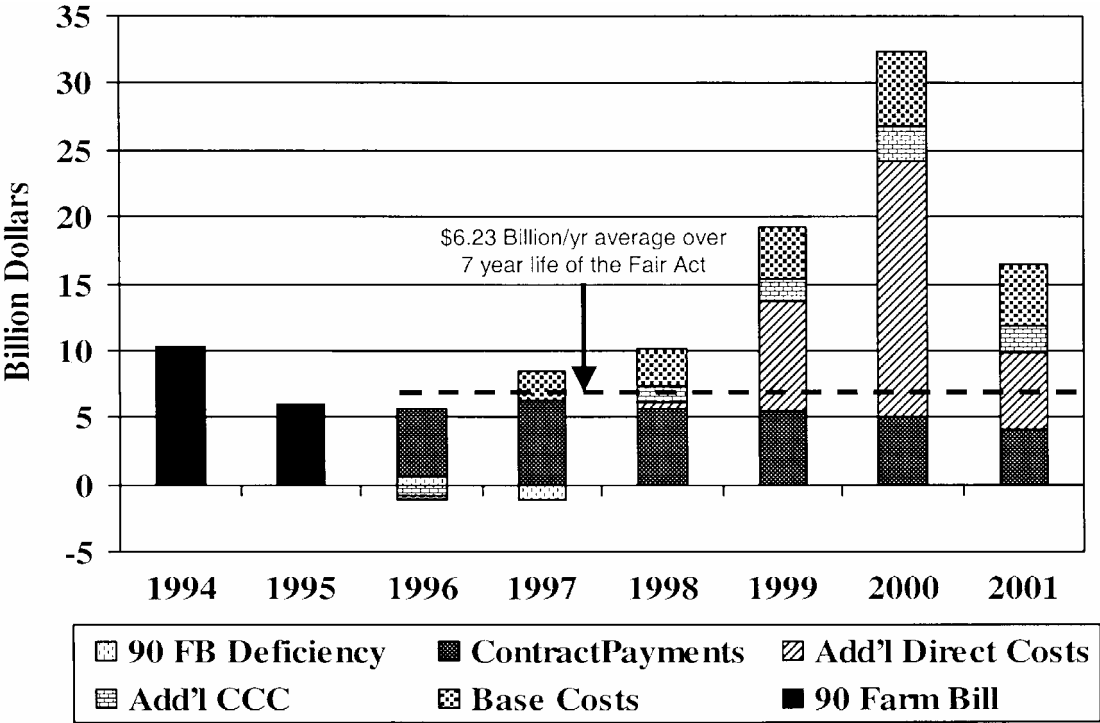
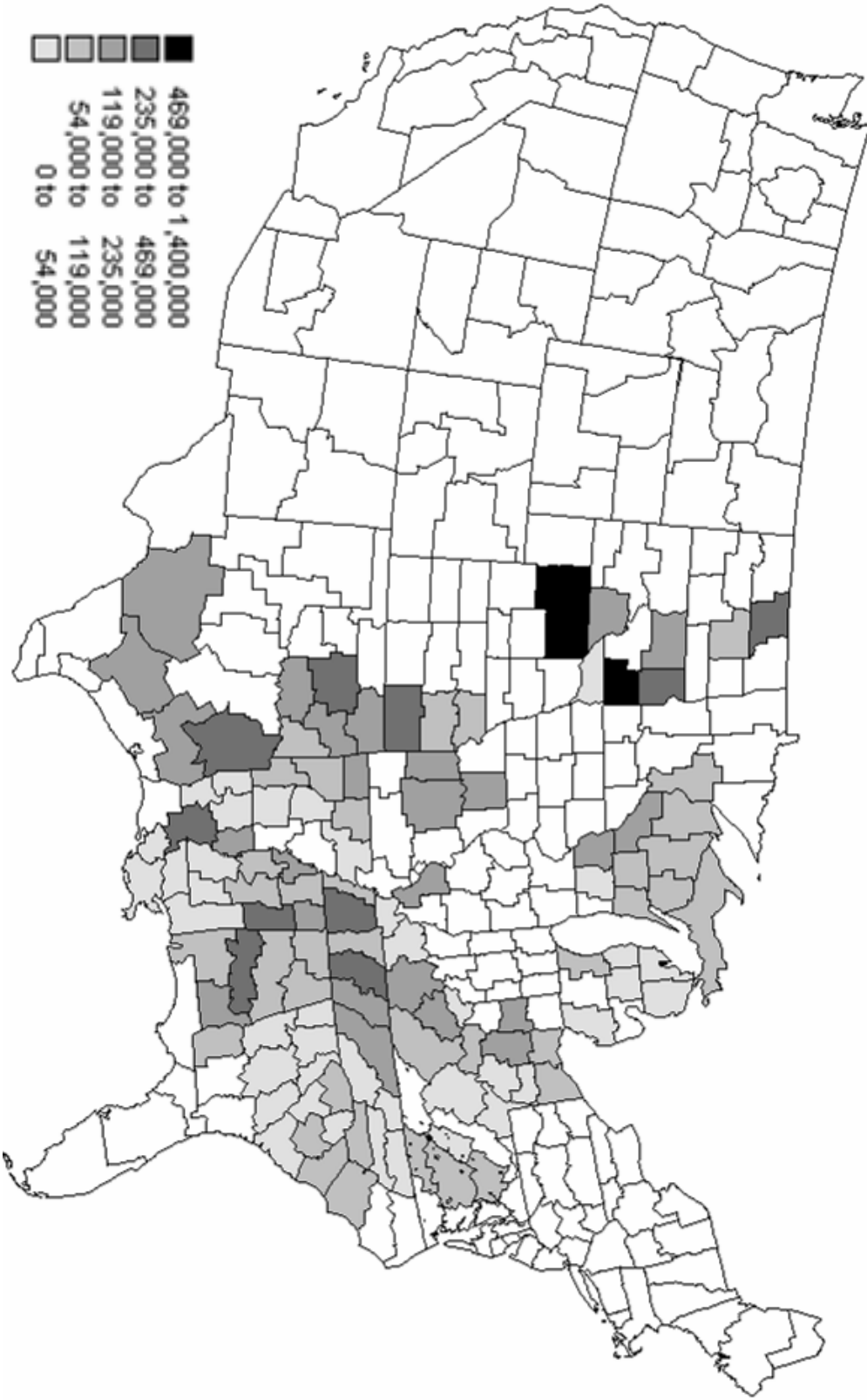


Figure 2
Government outlays by source, 1994–2001 (Source: USDA).





Scenario 1 - \$30 / dt : Acres Planted to Switchgrass, 2000

Figure 3

Figure 4
Scenario 2 - \$40 / dt : Acres Planted to Switchgrass, 2000

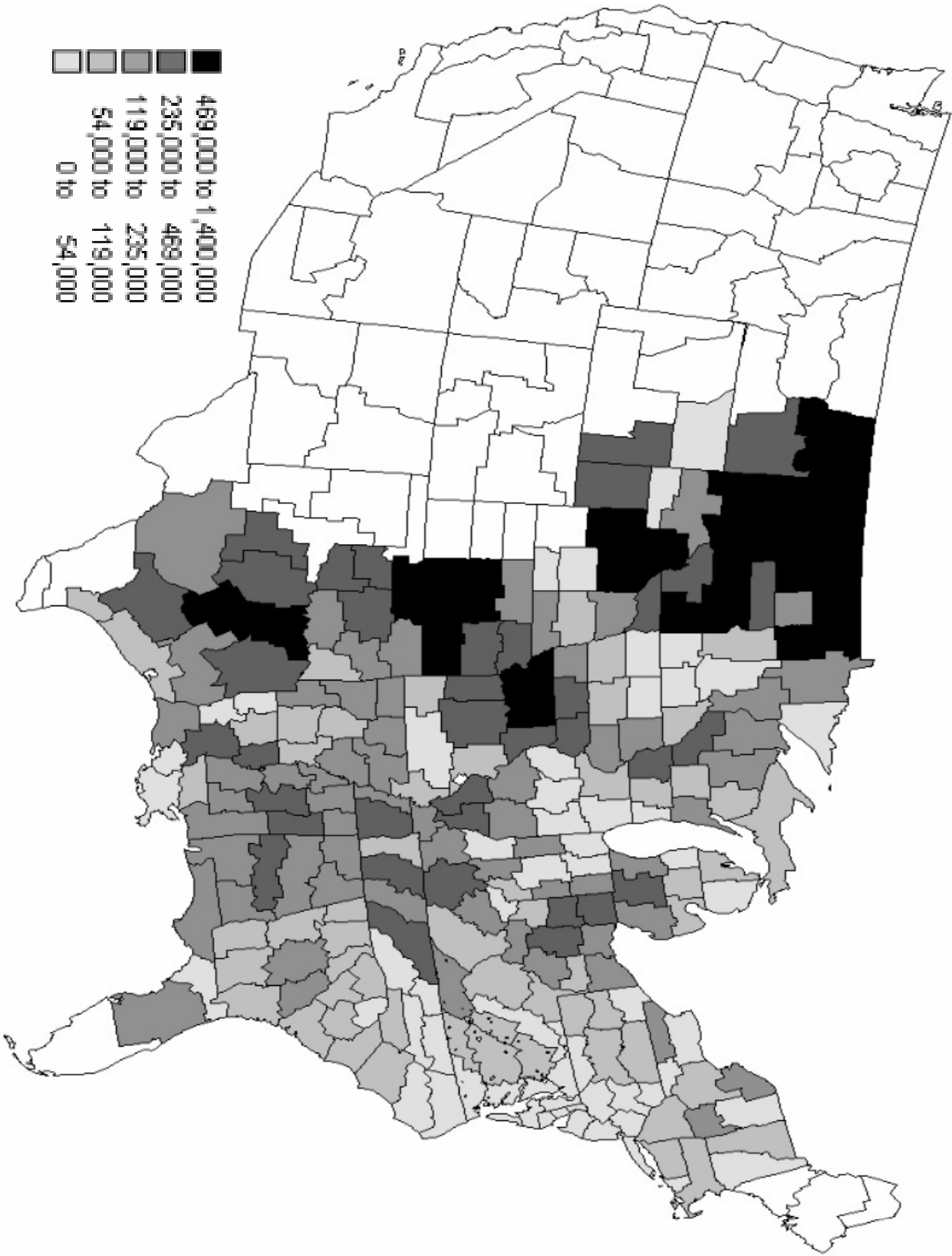


Figure 5. Changes in Crop Prices
Comparing historical and switchgrass scenarios

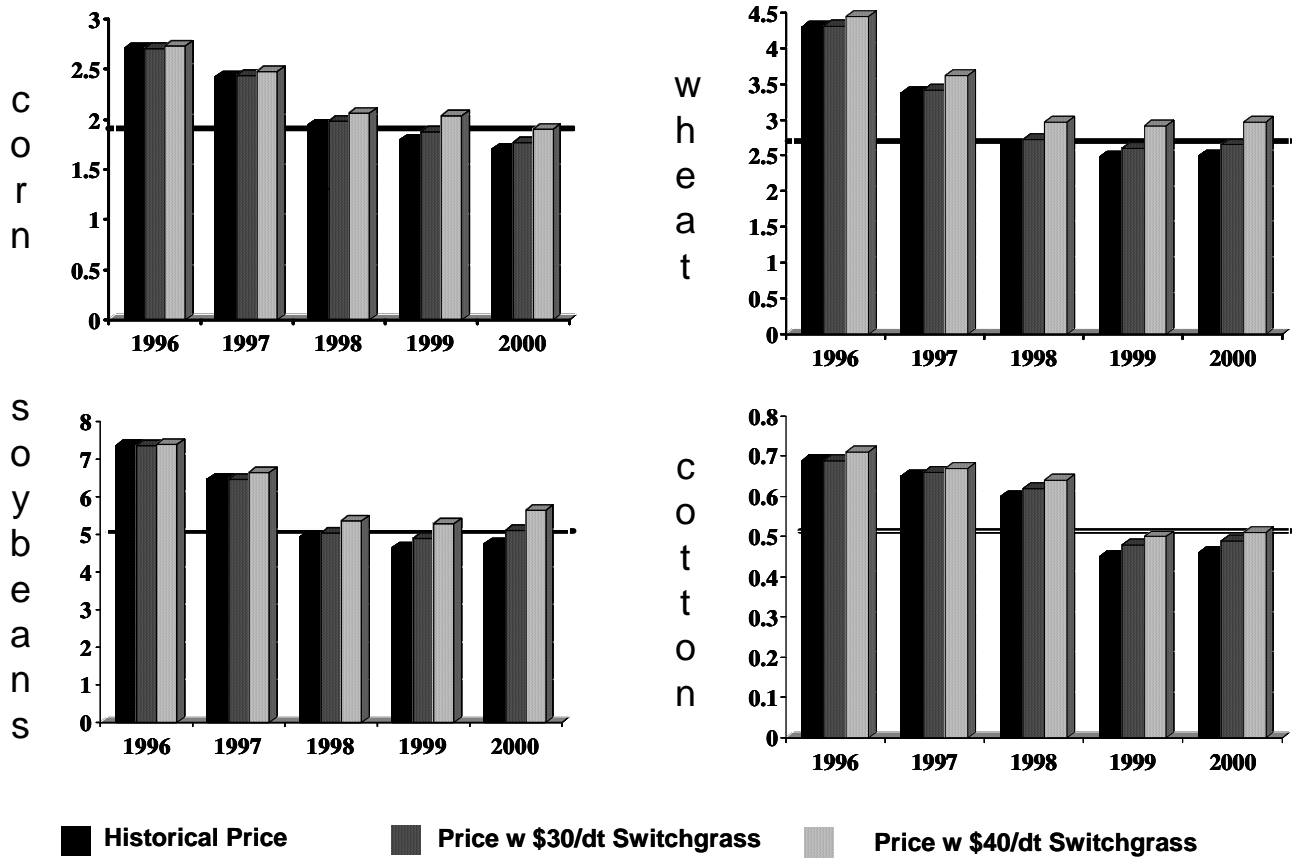


Figure 6
 Comparing Actual vs. What If Scenarios
 Annual Average 1996 -2000

		Actual	Bioenergy	Scenario
			\$30 / dt	\$40 / dt
Switchgrass Acreage	mil. acres	-	9.42	22.23
Market Returns	mil. \$	21,547	22,579	25,102
Loan Deficiency Payments	mil. \$	1,888	952	206
Emergency Payments	mil. \$	3,903	3,903	3,903
Total returns	mil. \$	27,338	27,434	29,211

Figure 7
Bottom Line
Annual Average 1996 -2000

		Bioenergy	Scenario
		\$30 / dt	\$40 / dt
Government Savings	mil. \$	936	1,682
Change in Total Returns	mil. \$	(96)	1,873
Potential Switchgrass Subsidy	\$ / dt	56.5	50.6