Production Profitability of Ethanol from Alternative Feedstocks in the Texas Panhandle

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Selected Paper prepared for presentation at the Southern Agricultural Economics Association 44th Annual Meeting, Birmingham AL, February 4-7, 2012

This research was supported in part by the Ogallala Aquifer Program, a consortium between USDA-Agricultural Research Service, Kansas State University, Texas AgriLife Research, Texas AgriLife Extension Service, Texas Tech University, and West Texas A&M University.

Abstract:

The potential of three feedstocks: grain sorghum, sweet sorghum, and switchgrass for ethanol production in the top 26 counties of the Texas Panhandle Region is analyzed using yield and production costs of feedstock, processing cost of feedstock, final demand for ethanol, farm to wholesale marketing margin, and the derived demand price of feedstock. The calculated economic returns per acre of grain sorghum, sweet sorghum, and switchgrass are -$45.37, -$410.19, and -$150.17 respectively under irrigated condition and -$38.25, -$145.09, and -$29.04 respectively under dryland condition.

The evaluation in this study demonstrates that ethanol production from grain sorghum, sweet sorghum, and switchgrass in the Texas Panhandle Region is not economically feasible given the current price for ethanol in Texas. This is consistent with the status of the ethanol industry in the Texas Panhandle.

Key Words: Ethanol production, Texas Panhandle, Grain sorghum, Sweet sorghum, and Switchgrass, Feedstock

JEL Classification: Q16, Q25, Q27, and Q42

Introduction:

There is an increasing need for energy throughout the world. Given current consumption trends, world energy demand is estimated to grow more than 50% by 2030 (EIA 2008). As the economy grows, the energy requirement also grows. Traditional liquid fuels evolved from fossil resources are presently, and are predicted to continue to be, a dominant energy source, given their remarkable role in the transportation sector (EIA 2008). The rising prices of traditional energy fuels and increased scientific and political discussions of evaluating alternative energy sources have resulted in growth of support for developing ethanol as a replacement or substitute fuel. The goal is to develop an energy structure for the future that is renewable, sustainable, convenient, cost-effective, economically feasible, and environmentally safe. The availability of oil at low prices has retarded the research study and interest in alternative fuels. Current geopolitical, environmental, and economical changes have led to an increasing interest in an alternative fuel source, preferably renewable and cost-effective.

Triggered by high oil prices, government subsidies and energy policies, a large expansion in ethanol production, along with research and innovation to develop second generation biofuels is underway in the United States. This increased focus on ethanol and other biofuels is an important element of United States economic, energy, environmental, and national security policies. The recent resurgence of interest in ethanol production has spurred various stakeholders to request an unbiased analysis of the economic ethanol production potential in Texas.

There has been increased interest in ethanol production recently for following reasons:

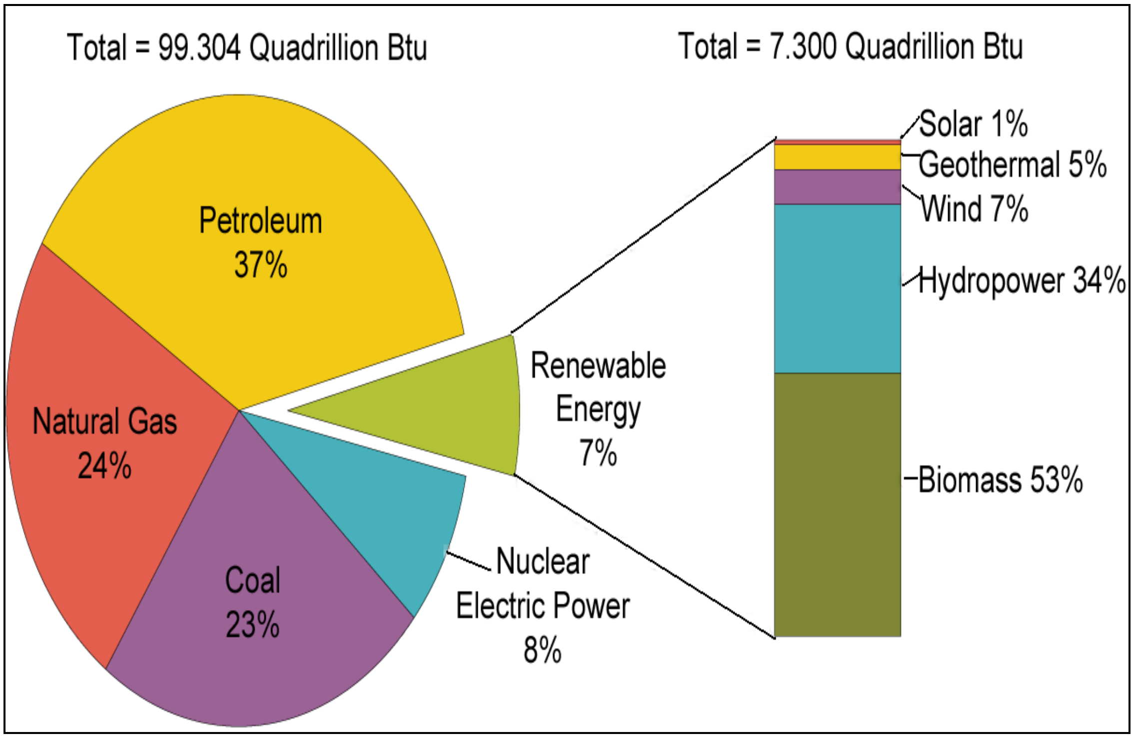
1) The inconsistency in the political situation, the continued conflict in the Middle East and the reliance on foreign oil has many in the United States looking for a more dependable, renewable, and domestic fuel source.

2) Ethanol production would boost depressed commodity prices and provide producers with ethanol feedstocks byproducts.
3) The finding that Methyl Tertiary Butyl Ether (MTBE), a widely used oxygenate that has been linked to groundwater contamination and is likely to be banned nationwide, increases interest in substituting ethanol as an oxygenating agent, and
4) Local, State, and Federal officials see ethanol production as a source of business activity and tax base.

Ethanol is a clean burning, high octane, renewable fuel that can be made from grains or other biomass sources such as sweet sorghum, switchgrass, wood chips, and other plant residues. Production of renewable fuels would contribute to our goal of reducing nation's dependence on imported oil. Achieving the production goals for bio-ethanol production will require appropriate and promising bioenergy feedstocks with supplementation from agricultural crop residues.

The overall contribution of renewable energy is only 7% of the whole energy supply of the United States, Figure 1. Fifty-three percent of the renewable energy comes from biomass. Petroleum energy (37%), natural gas (24%), and coal (23%) account for the greatest contribution in the nation's whole energy supply. Solar (1%), geothermal (5%), wind (7%), and hydropower (34%) are other sources of renewable energy that contribute in the nation's energy supply.

These fossil fuels are a limited source of energy due to their depletion by time and non-renewable characteristics. At this stage of increasing depletion of non-renewable energy sources there is a great need to have alternative renewable energy sources. They play an important role in the supply of energy. When renewable energy sources are used, demand for fossil fuels is reduced.



Source: U.S. Energy Information Administration, Annual Energy Review 2008.

Figure 1. Role of Renewable Energy Consumption in the Nation's Energy Supply, 2008

Biofuels have evolved as an alternative energy source to fossil fuels by substituting bioethanol and biodiesel for gasoline and diesel respectively. They have been considered as alternative sources of energy due to their capacity to offset the reliance on foreign oil and potential to moderate climate change (Pacala and Socolow 2004). Currently bioethanol is being produced on a large scale, especially in the United States and Brazil. Sugarcane is the major feedstock used in Brazil for ethanol production based on sugar to ethanol technology, while the United States uses corn as a major feedstock for ethanol production utilizing starch to ethanol technology. In the United States there are ongoing technology developments to produce ethanol from sugar and cellulose based feedstocks.

Research Objectives:

Feasibility of any ethanol production methodology for the Texas Panhandle Region depends on the basis of economics of selected feedstock, current situation of selected feedstock production, current production levels and yields of selected feedstock, estimated net value residual to selected feedstock. Therefore, the research objective of this study is to evaluate the economic feasibility of three ethanol production methods in the Texas Panhandle: starch to ethanol, sugar to ethanol, and cellulose to ethanol. The three feedstocks associated with the three methods are grain sorghum, sweet sorghum, and switchgrass respectively.

Production Potential of Selected Feedstocks in the Texas Panhandle:

The choice of feedstock used to produce ethanol is based primarily on the availability, potential, and cost of alternative feedstock crops in the region. Presently corn is the predominant feedstock being used in the ethanol production process. Corn accounts for approximately 97% of the total ethanol produced in the United States.

Grain sorghum is an important grain crop in the Texas Panhandle Region. It can be grown under both irrigated and dryland conditions. Average (2005-2009) harvested acres of irrigated grain sorghum are 104,600 acres with 9,358,000 bushels of grain production and harvested acres of dryland grain sorghum are 154,480 acres with 6,811,000 bushels of grain production for the given study area.

Sweet sorghum and switchgrass production is in the experimental stage in the Texas Panhandle and surrounding region. There are no published statistics reporting the production of either sweet sorghum or switchgrass in the Texas Panhandle.

Materials and Methods:

Since there is no market for sweet sorghum or switchgrass in the Texas Panhandle Region, it is not possible to determine a price directly. It is necessary to base the analysis on the final demand for ethanol. It is then possible to estimate the derived demand price for the feedstock used in the production of ethanol from the maximum price that a rational processor would be willing to pay for the feedstock input by subtracting the farm-to-wholesale marketing margin from the final demand price. Total gross income from the production of the feedstock is then calculated by measuring the yield per acre in gallons of ethanol produced by the feedstock and multiplying by the derived demand price. The feasibility of ethanol production from each feedstock is then estimated by subtracting the total production cost per acre from the gross income per acre to determine the return over specified costs and economic return.

The study area includes the top 26 counties of the Texas commonly known as the Texas Panhandle. The area is in a rectangular shape bordered by New Mexico to the west and Oklahoma to the north and east. The crop growing season averages between 200 to 217 days per year. The average annual rainfall averages between 17 to 20.5 inches. Corn, wheat, and grain sorghum are the important feed grain crops in the Texas Panhandle. Cotton is the most important fiber crop in this region, Table 1. The five year average (2005-2009) for harvested acres of corn, wheat, cotton, and grain sorghum in the study area are 643,000 acres, 1,266,800 acres, 436,000 acres, and 357,700 acres respectively. Average total production for the four major crops are 131,042,000 bushels of corn, 45,755,250 bushels of wheat, 763,420 bales of cotton, and 21,558,600 bushels of grain sorghum, Table 1.

Table 1. Harvested acres and Production of major crops: Corn, Wheat, Cotton, and Grain Sorghum in the 26 counties in the Texas Panhandle, 2005 - 2009

Year	Corn		Wheat	
	Harvested (1000 acres)	Production (1000 bushels)	Harvested (1000 acres)	Production (1000 bushels)
2005	559.6	106,543	1,570.3	55,996
2006	523.1	101,202	545.3	14,061
2007	733.4	154,292	1,797.6	79,045
2008	686.7	141,228	1,153.9	33,919
2009	711.9	151,945	-	-
Average	643.0	131,042	1,266.8	45,755

Year	Cotton		Grain Sorghum	
	Harvested (1000 acres)	Production (bales)	Harvested (1000 acres)	Production (1000 bushels)
2005	585.5	1,052,700	345.4	22,207
2006	574.2	1,019,700	294.4	14,636
2007	340.2	677,700	396.9	26,121
2008	337.2	503,700	431.2	23,514
2009	342.5	563,300	320.6	21,239
Average	436.0	763,420	357.7	21,559

Source: National Agricultural Statistics Service (2005-09)

Yield levels of selected feedstocks in the Texas Panhandle Region used in the analysis are irrigated grain sorghum 134 bushels/acre and dryland grain sorghum 36 bushels/acre, Table 2. Switchgrass yields under irrigated and dryland condition are 4.4 dry tons/acre and 1.4 dry tons/acre respectively. Sweet sorghum yields under irrigated and dryland condition are 25 wet tons/acre and 12.35 wet tons/acre, respectively.

Table 2. Yields of Selected Feedstocks used in the analysis for the Texas Panhandle Region

Feedstock	Yield/acre	
	Irrigated	Dryland
Grain sorghum	134 bushels	36 bushels
Sweet sorghum	25 tons (wet)	12.35 tons (wet)
Switchgrass	4.4 tons (dry)	1.4 tons (dry)

Ethanol Production Assumptions for Selected Feedstocks:

One bushel of sorghum grain produces about 2.9 gallons of ethanol (Trostle 2008); one ton of fresh sweet sorghum stalks produces about 8.7 gallons of ethanol (Bean et al. 2009; Marsalis 2010); and one ton of dried switchgrass produces about 78 gallons of ethanol (Holcomb and Kenkel 2008). The Farm-to-Wholesale Marketing Margin includes all of the costs associated with the conversion of alternative feedstocks from the farm to get the final product ethanol. These costs include administrative, capital, transportation, pretreatment, pressing, fermentation, distillation, storage costs and return on investment. The Estimated Derived Demand Price per gallon of ethanol for each feedstock is obtained by subtracting the Farm-to-Wholesale Marketing Margin per gallon from the wholesale price of ethanol per gallon as shown in Table 3.

Table 3. Farm-to-Wholesale Marketing Margin and Derived Demand Price for three feedstocks in the Production of Ethanol

Feedstock source	Price of Ethanol ($/E-100 gallon)	Farm-to-Wholesale Marketing Margin per gallon ($)	Derived Demand Price per gallon ($)
Grain sorghum	1.81	0.57	1.24
Sweet sorghum	1.81	1.06	0.75
Switchgrass	1.81	0.91	0.90

Note: The Texas price of ethanol is $1.81/E-100 gallon (Kment 2010)

Results and Discussion:

Concern over high fuel prices, volatility in fuel prices, and dependence on foreign oil to meet energy demand in the United States have led to interest in development of alternative renewable fuels. This study, as part of the USDA-ARS Initiative, Ogallala Aquifer Program, evaluates the economic feasibility of ethanol production from three alternative feedtocks in the Texas Panhandle.

Grain Sorghum:

Although there is a market price for grain sorghum at the farm level available, the derived demand price for sorghum in the production of ethanol is estimated so that all alternatives follow the same protocol. Starting with the Final Demand Price for ethanol of $1.81 per gallon in Texas, the Farm-to-Wholesale Marketing Margin of $0.57 is subtracted to obtain the maximum farm level Derived Demand Price for grain sorghum of $1.23. Given the price of ethanol of $1.81, this is the maximum price that a rational processor would be willing to pay for the amount of grain sorghum needed to produce one gallon of ethanol, Table 3.

Evaluations are performed for both irrigated grain sorghum production and dryland grain sorghum production. Production levels are determined from the five year average yield per acre for grain sorghum in the Texas Panhandle multiplied by the conversion rate of 2.9 gallons of ethanol obtained from a bushel of grain sorghum. Production costs and input prices are obtained from the 2010 planning budgets developed by the Texas AgriLife Extension Service for District1.

The irrigated grain sorghum alternative yield of 134 bushels per acre converts to an ethanol production of 388.6 gallons per acre. Given the maximum Derived Demand Price per gallon of ethanol of $1.23, this corresponds to a total gross income of $477.98 per acre (Table 4).

Total production cost is $413.35 per acre. Subtracting total production cost from gross income gives a net return of $64.63 per acre. In order to determine the economic return to all resources, Irrigated Cash Rent of $110 per acre is subtracted. The economic return to Irrigated Grain Sorghum production for the production of ethanol is -$45.37, Table 5.

Table 4. Feedstock Production Cost and Gross Income per Acre for Selected Feedstocks

Feedstock	Feedstock Production Cost/acre		Gross Income/acre	
	Irrigated	Dryland	Irrigated	Dryland
Grain sorghum	$413.35	$141.66	$477.98	$128.41
Sweet sorghum	$462.71	$193.07	$162.53	$72.98
Switchgrass	$349.05	$102.32	$308.88	$98.28

Note: Total Gross Income = Derived demand price X gallons of ethanol produced/acre

Table 5. Yield and Economic Returns per Acre for each Feedstock

Feedstock	Yield	Ethanol (gallons/acre)	Economic returns ($/acre)
Grain sorghum	(bushels/acre)		
Irrigated	134	388.6	-$45.37
Dryland	36	104.4	-$38.25
Sweet sorghum	(wet tons/acre)		
Irrigated	25	216.7	-$410.18
Dryland	12.35	97.3	-$145.09
Switchgrass	(dry tons/acre)		
Irrigated	4.4	343.2	-$150.17
Dryland	1.4	109.2	-$29.04

The dryland grain sorghum alternative yield of 36 bushels per acre converts to an ethanol production of 104.4 gallons per acre. Given the maximum Derived Demand Price per gallon of ethanol of $1.23, this corresponds to a Total Gross Income of $128.41 per acre. Total expenses are $141.66 per acre. Subtracting total expenses from total gross income gives a net return of -$13.25 per acre. In order to determine the economic return to all resources, Dryland Cash Rent of

$25 per acre is subtracted. The economic return to Dryland Grain Sorghum production for the production of ethanol is -$38.25, Table 5.

Sweet Sorghum:

Since there is no market for sweet sorghum at the farm level, the Derived Demand Price for sweet sorghum in the production of ethanol is estimated. Starting with the Final Demand Price for ethanol of $1.81 per gallon in Texas, the Farm-to-Wholesale Marketing Margin of $1.06 is subtracted to obtain the maximum farm level Derived Demand Price for sweet sorghum of $0.75. Given the price of ethanol of $1.81, this is the maximum price that a rational processor would be willing to pay for the amount of sweet sorghum needed to produce one gallon of ethanol, Table 5. Evaluations are performed for both irrigated sweet sorghum production and dryland sweet sorghum production. Production levels are determined from the average ethanol yield per acre reported by the experimental trials at Bushland, Texas and Clovis, New Mexico, Table 6.

Table 6. Yield of Sweet Sorghum and Ethanol Produced per Acre from TAMU Experiment Station at Bushland, TX and NMSU Experiment Station at Clovis, New Mexico, 2008-2009

Sweet sorghum	Irrigated			Dryland		
	Bushland	Clovis	Mean	Bushland	Clovis	Mean
Fresh weight (T/A)	21.50	28.30	24.90	7.00	17.70	12.35
Brix value	14.30	15.60	14.95	17.36	17.20	17.28
Ethanol@65% (Gal/A)	182.40	251.00	216.70	68.60	126.00	97.30
Ethanol@95% (Gal/A)	270.30	-	-	104.00	-	-
Seasonal precipitation (inch)	8.50	14.10	11.30	8.50	13.30	10.90
Irrigation (ac-inch)	22.80	8.70	15.75	5.30	0.00	-

Note: T/A = Tons/Acre, Gal/A = Gallons/Acre, 65% = 65% Juice recovery, 95% = 95% Juice recovery
Source: Bean et al. 2009, Marsalis 2010

Production costs and input prices are based on 2010 planning budgets developed by the Texas Agrilife Extension Service for District 1 which are modified to reflect the input levels and cultural practices reported for the experimental trials.

The irrigated sweet sorghum alternative has a yield of 216.7 gallons of ethanol per acre. Given the maximum Derived Demand Price per gallon of ethanol of $0.75, this corresponds to a Total Gross Income of $162.53 per acre. Total Specified Expenses are $462.71 per acre. Subtracting Total Specified Expenses from Total Gross Income gives a net return of -$300.18 per acre. In order to determine the economic return to all resources, Irrigated Cash Rent of $110 per acre is subtracted. The economic return to Irrigated Sweet Sorghum production for the production of ethanol is -$410.18, Table 5. This considers only the value of the ethanol produced while no values have been established for the bagasse byproduct for the Texas Panhandle.

The dryland sweet sorghum alternative has a yield of 97.3 gallons of ethanol per acre. Given the maximum Derived Demand Price per gallon of ethanol of $0.75, this corresponds to a Total Gross Income of $72.98 per acre. Total Specified Expenses are $193.07 per acre. Subtracting Total Specified Expenses from Total Gross Income gives a net return of -$120.09 per acre. In order to determine the economic return to all resources, Dryland Cash Rent of $25 per acre is subtracted. The economic return to Dryland Sweet Sorghum production for the production of ethanol is -$145.09, Table 5.

Switchgrass:

Since there is no market for switchgrass at the farm level, the Derived Demand Price for switchgrass in the production of ethanol is estimated. Starting with the Final Demand Price for ethanol of $1.81 per gallon in Texas, the Farm-to-Wholesale Marketing Margin of $0.9108 is subtracted to obtain the maximum farm level Derived Demand Price for switchgrass of $0.90.

Given the price of ethanol of $1.81, this is the maximum price that a rational processor would be willing to pay for the amount of sweet sorghum needed to produce one gallon of ethanol, Table 3. Evaluations are performed for both irrigated switchgrass production and dryland switchgrass production. Production levels are determined from the average ethanol yield per acre reported by the experimental trials at Etter, Texas and Tucumcari, New Mexico, Table 7. Production costs and input prices are based on 2010 planning budgets developed by the Texas Agrilife Extension Service for Districts 6 and 10 which are modified to reflect the input levels and cultural practices reported for the experimental trials and input prices and adjusted cultural practices reported for District1.

Table 7. Yield of Switchgrass and Ethanol Produced per Acre from TAMU Experiment Station at Etter, TX and NMSU Experiment Station at Tucumcari, New Mexico, 2009

Switchgrass	**Blackwell Switchgrass**				
	Full			**Limited**	**Dryland**
	Etter	**Tucumcari**	**Mean**		
Yield (DT/A)	4.90	3.90	4.40	2.50	1.40
Ethanol (Gal/A)	382.20	304.20	343.20	195.00	109.20
Precipitation (inch)	5.82	-	5.82	-	5.82
Irrigation (ac-inch)	14.70	-	14.70	-	0.00

Note: DT/A = Dry Tons/Acre, Gal/A = Gallons/Acre
Source: Buttrey et al. 2009, Lauriault 2010

The irrigated switchgrass alternative has a yield of 343.2 gallons of ethanol per acre. Given the maximum Derived Demand Price per gallon of ethanol of $0.90, this corresponds to a Total Gross Income of $308.88 per acre. Total Specified Expenses are $349.05 per acre. Subtracting Total Specified Expenses from Total Gross Income gives a net return of -$40.17 per acre. In order to determine the economic return to all resources, Irrigated Cash Rent of $110 per acre is subtracted. The economic return to Irrigated Switchgrass production for the production of ethanol is -$150.17, Table 5.

The dryland switchgrass alternative has a yield of 109.2 gallons of ethanol per acre. Given the maximum Derived Demand Price per gallon of ethanol of $0.90, this corresponds to a Total Gross Income of $98.28 per acre. Total Specified Expenses are $102.32 per acre. Subtracting Total Specified Expenses from Total Gross Income gives a net return of -$4.04 per acre. In order to determine the economic return to all resources, Dryland Cash Rent of $25 per acre is subtracted. The economic return to Dryland Switchgrass production for the production of ethanol is -$29.04, Table 5.

Conclusion:

Rising energy costs, increasing demand for energy, instability in oil exporting countries, and concerns for the environment stimulate interest in fuels such as ethanol. As gasoline prices continue to increase and more pressure is put on the government to invest in or encourage production of alternative fuels, farmers, businesses, cooperatives, and investors have shown more interest in the feasibility of producing ethanol.

Most of the studies analyzing the feasibility of producing ethanol concentrated on corn in an array of geographical locations. The economic feasibility of ethanol production from grain sorghum, sweet sorghum, and switchgrass have not been adequately tested in the Texas Panhandle.

The evaluation in this study demonstrates that ethanol production from selected alternative feedstocks: grain sorghum, sweet sorghum, and switchgrass in the Texas Panhandle Region is not economically feasible given the current price for ethanol in Texas. Economic returns per acre of grain sorghum, sweet sorghum and switchgrass under irrigated condition are -

$45.37, -$410.18, and -$150.17 and under dryland condition are -$38.25, -$145.09, and -$29.04 respectively. This is consistent with the status of the ethanol industry in the Texas Panhandle. An increase in the price of ethanol would seem to justify a reevaluation of the economic feasibility; however since any increase in the price of ethanol would occur only with an increase in the prices of energy inputs to the production process, the economic feasibility is not assured. Decrease in production cost and increase in productivity may present possibilities for achieving an economic feasibility.

Sufficient information is not available to evaluate these crop alternatives as water saving cropping alternatives for the Texas Panhandle. Need for future research to determine the production per acre at various level of water application is needed to assess the optimal level of irrigation to apply to these crops. Reevaluation of these alternative feedstocks for ethanol production should be done when more research information is available.

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