

Economic Analysis of Biomass Sorghum for Biofuels Production in the Texas High Plains

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Introduction

Biomass Sorghum hybrids are being developed and evaluated by Texas AgriLife Research in College Station, TX. Promising hybrids identified were evaluated in the Panhandle in irrigated and dryland trials to determine their suitability to the semiarid growing areas of the Texas High Plains. The development of alternative sources to efficiently produce biofuels is essential to meet the Renewable Fuel Standards (RFS) which calls for an annual production of 36 billion gallons of renewable fuels by 2022. Of the 36 billion gallons, 15 billion gallons is to come from grain based ethanol with the remaining 21 billion gallons coming from a combination of advanced biofuels and cellulosic ethanol production.

Biomass sorghum research trials were conducted in 2009 and 2010 at the Texas AgriLife Research Station - Bush Farm located 8 miles west of Amarillo, TX to evaluate the production potential of biomass sorghum hybrids in the Texas High Plains. In these trials, yield potential of various varieties was evaluated as well as optimal seeding rates. The objective of this study was to identify the costs associated with the production of biomass sorghum and to determine the cost per gallon of ethanol produced by using biomass sorghum as the input.

Data and Methods

Scientists conducting the trials were asked to identify the Best Management Practices (BMPs) for growing biomass sorghum including farming operations performed. Enterprise budgets for biomass sorghum were constructed utilizing the BMPs identified. Research on irrigated biomass sorghum was conducted using furrow irrigation. However, cultural practices were modified to reflect the more common pivot irrigation that is found on the Texas High Plains for budgeting purposes. A three year average of prices was utilized to evaluate direct expenses to dampen volatility caused by annual fluctuations in input prices due to market conditions. Texas AgriLife Extension Budgets were used to estimate the fixed and variable costs of farming operations generally performed by producers. Custom rates were utilized as a proxy for all other field and harvest operations.

Results

Enterprise budgets developed for both irrigated and dryland biomass sorghum production are located in Appendix A. The budgets developed for biomass sorghum included all costs up to the farm gate, therefore, hauling costs from the farm gate to the processing plant were not

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considered. The method employed to harvest biomass sorghum may vary depending on the type of processing plant. Some plants would prefer a drier product for which haying would be appropriate while other plants would like a wetter product to process. In the budgets, the cost of silage harvesting is assumed which corresponds to harvesting the wetter product.

The total cost per acre to produce biomass sorghum under irrigation was estimated at \$615.78, Table A1. The budgeted yield based on the irrigated biomass sorghum trials was 7.5 dry tons per acre. Potential ethanol yield is calculated assuming a conversion rate of 80 gallons ethanol per dry ton; which was 600 gallons/acre. Harvest & haul, fertilizer, and irrigation were the largest components of the direct cost (\$496.90) accounting for 28.68%, 28.25%, and 15.37% of the direct expenses respectively, Table A1.

The total cost per acre to produce biomass sorghum under dryland condition was estimated at \$249.61, Table A2. Harvest & haul, and fertilizer were the largest components of the direct cost (\$208.49) accounting for 29.62%, and 26.71% of the direct expenses respectively, Table A2. Based on trial data, a yield of 3.25 dry tons per acre was used in the dryland biomass sorghum budget. Assuming a conversion rate of 80 gallons ethanol per dry ton, ethanol production was expected to be 260 gallons per acre.

Yield sensitivity analysis

A sensitivity analyses was completed due to yield variation between varieties, replications and the years that yield data was taken. The sensitivity analyses were performed for both irrigated and dryland biomass sorghum varying the budgeted yield from 75% to 150%. The calculated yields of irrigated biomass sorghum were 5.63, 7.50, 9.38, and 11.25 dry tons per acre and of dryland biomass sorghum were 2.44, 3.25, 4.06, and 4.88 dry tons per acre under the assumed yield percentages of 75%, 100%, 125%, and 150% respectively, Table1.

Table 1. Production Costs for Irrigated and Dryland Biomass Sorghum under Various Yields

Irrigated Biomass Sorghum					
Yield	Dry tons/Acre	Wet tons/Acre	TC (\$/dry ton)	Ethanol gallons/Acre	TC (\$/gallon)
75%	5.63	18.09	103.14	450.00	1.29
100%	7.50	24.12	82.10	600.00	1.03
125%	9.38	30.14	69.48	750.00	0.87
150%	11.25	36.17	61.07	900.00	0.76
Dryland Biomass Sorghum					
75%	2.44	7.84	96.07	195.00	1.20
100%	3.25	10.45	76.80	260.00	0.96
125%	4.06	13.06	65.24	325.00	0.82
150%	4.88	15.68	57.54	390.00	0.72

Note: One dry ton of biomass sorghum was estimated to produce 80 gallons of ethanol

Transforming the expenses into a cost per dry ton produced allows for direct cost comparison between irrigated and dryland biomass sorghum. Converting the budgeted total cost to produce irrigated biomass sorghum at the 7.50 dry ton yield resulted in a cost per dry ton of \$82.10. Varying the yield resulted in a range of costs of \$61.07 at the 150% level to \$103.14 per dry ton at 75% of budgeted production, Figure 1. The cost per dry ton to produce biomass

sorghum under dryland conditions was somewhat less than the irrigated. The sensitivity analysis for dryland biomass sorghum resulted in costs of \$96.07, \$76.80, \$65.24, and \$57.54 per dry ton under the assumed yield percentages of 75%, 100%, 125%, and 150% respectively.

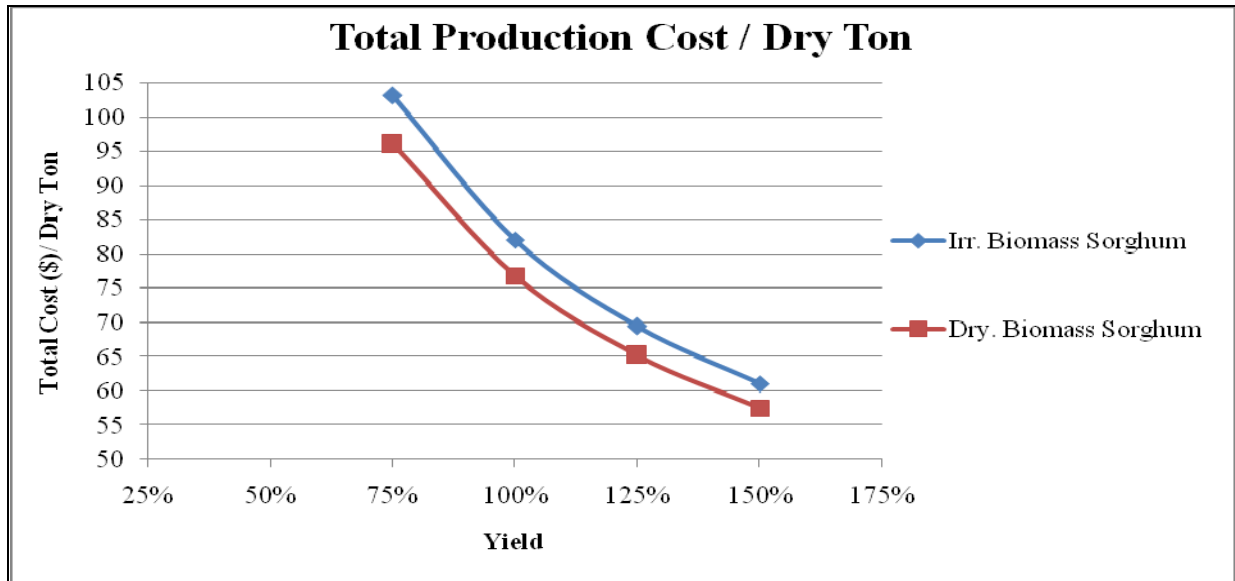


Figure 1. Irrigated and Dryland Biomass Sorghum Total Production Cost per Dry Ton at Various Yields

It is assumed that 80 gallons of ethanol can be processed from every dry ton of production. The yield sensitivity analysis conducted resulted in expected ethanol production from irrigated biomass sorghum of 450, 600, 750, and 900 gallons per acre and the dryland biomass sorghum sensitivity analysis resulted in 195, 260, 325, and 390 gallons per acre being produced under the yield scenarios of 75%, 100%, 125%, and 150% of budgeted production respectively, Figure 2.

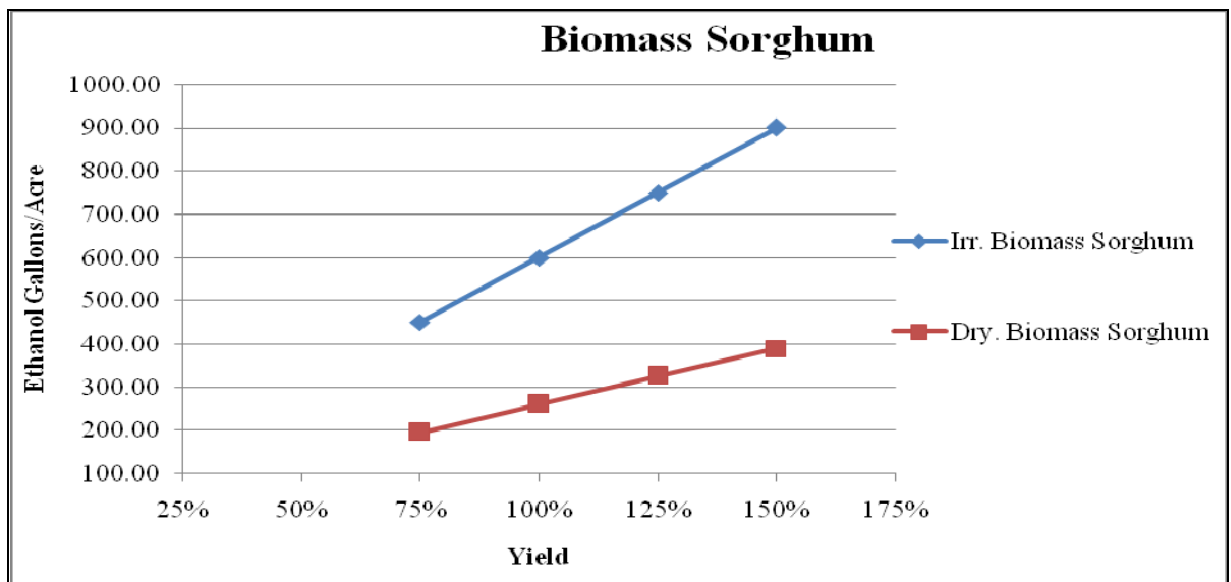


Figure 2. Irrigated and Dryland Biomass Sorghum Ethanol Yield per Acre at Various Yields

Appendix A.

Table A1. Estimated Cost of Biomass Sorghum Production per Acre, Sprinkler Irrigated
Powered by Natural Gas, 2011

ITEM	UNIT	PRICE	QUANTITY	AMOUNT
		dollars		
PRODUCTION				
Biomass sorghum	wet tons		24.12	
	dry tons		7.50	
Ethanol	gal		600.00	
DIRECT EXPENSES				
SEED				
Seed – biomass sorghum	lb.	3.50	6.25	21.88
FERTILIZER				
Fert (N) - liquid	lb.	0.58	150.00	87.00
Fert (P) - liquid	lb.	0.89	60.00	53.40
HERBICIDE				
Atrazine + appln.	acre	9.90	1.00	9.90
CUSTOM				
Fert appln.	acre	5.00	1.00	5.00
harv & haul - biomass sorghum	ton	5.91	24.12	142.52
FIELD OPERATIONS				
Tandem disc	acre	12.00	1.00	12.00
Sweep plow	acre	6.84	1.00	6.84
Sweep plow	acre	6.84	1.00	6.84
Planted	acre	13.20	1.00	13.20
HAND LABOR				
Implements	hour	10.20	0.15	1.53
IRRIGATION LABOR				
Center Pivot	hour	10.20	0.83	8.47
DIESEL FUEL				
Tractors	gal	2.41	2.43	5.86
GASOLINE				
Pick Up	gal	2.60	3.02	7.85
NATURAL GAS				
Center Pivot	ac-in	7.60	10.05	76.38
REPAIR & MAINTENANCE				
Implements	acre	6.28	1.00	6.28
Tractors	acre	6.08	1.00	6.08
Pick Up	acre	0.24	1.00	0.24
Center Pivot	ac-in	2.03	10.05	20.40
INTEREST ON OP. CAP.	acre	6.00%	1.00	5.24
TOTAL DIRECT EXPENSES				496.90
FIXED EXPENSES				
Implements	acre	10.26	1.00	10.26
Tractors	acre	9.62	1.00	9.62
Pick Up	acre	0.40	1.00	0.40
Center Pivot	acre	33.60	1.00	33.60
Cash rent – biomass sorghum	acre	65.00	1.00	65.00
TOTAL FIXED EXPENSES				118.88
TOTAL SPECIFIED EXPENSES				615.78

Table A2. Estimated Cost of Biomass Sorghum Production per Acre, Dryland, 2011

ITEM	UNIT	PRICE	QUANTITY	AMOUNT
		dollars		
PRODUCTION				
Biomass sorghum	wet tons		10.45	
	dry tons		3.25	
Ethanol	gal		260.00	
DIRECT EXPENSES				
SEED				
Seed - biomass sorghum	lb.	3.50	2.80	9.80
FERTILIZER				
Fert (N) - liquid	lb.	0.58	50.00	29.00
Fert (P) - liquid	lb.	0.89	30.00	26.70
HERBICIDE				
Atrazine + appln.	acre	9.90	1.00	9.90
CUSTOM				
Fert appln.	acre	5.00	1.00	5.00
harv & haul - biomass sorghum	ton	5.91	10.45	61.76
FIELD OPERATIONS				
Tandem disc	acre	12.00	1.00	12.00
Sweep plow	acre	6.84	1.00	6.84
Sweep plow	acre	6.84	1.00	6.84
Planted	acre	13.20	1.00	13.20
HAND LABOR				
Implements	hour	10.20	0.31	3.16
DIESEL FUEL				
Tractors	gal	2.41	2.45	5.90
GASOLINE				
Pick Up	gal	2.60	2.01	5.23
REPAIR & MAINTENANCE				
Implements	acre	5.81	1.00	5.81
Tractors	acre	5.02	1.00	5.02
Pick Up	acre	0.16	1.00	0.16
INTEREST ON OP. CAP.	acre	6.00%	1.00	2.17
TOTAL DIRECT EXPENSES				208.49
FIXED EXPENSES				
Implements	acre	8.66	1.00	8.66
Tractors	acre	7.22	1.00	7.22
Pick Up	acre	0.24	1.00	0.24
Cash rent – biomass sorghum	acre	25.00	1.00	25.00
TOTAL FIXED EXPENSES				41.12
TOTAL SPECIFIED EXPENSES				249.61