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SC090

Economic Feasibility of Biofuel Crops in Florida: Sugarcane on Mineral Soils [1]

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Introduction

The use of arable land to produce crops for energy has led to an intense debate over the last few years. Many people believe that biofuel crop production will increase the demand for agricultural land at the expense of natural ecosystems, may increase global warming, and may consume large quantities of water that may turn green energy into a major threat to resources.

Despite the environmental and food concerns, there appears to be a general consensus that biofuel crops are here to stay and that they represent one of the best ways to ameliorate energy shortages until the scientific community can create more efficient and environmentally benign sources of renewable energy. This new alternative has brought an inherent value to agriculture that was previously missing. It is anticipated that governments and agencies will increase the level of funding and investment in biomass research to fully investigate its potential value and impact.

The primary target should be to prioritize research efforts that promise to increase yields of food and energy production on the same amount of land.

Florida has caught the attention of several firms that have developed technologies to convert crop biomass into energy. Many proponents of renewable energy see a comparative advantage in "the Sunshine State" in terms of energy crop production. The University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) is currently involved in a multitude of research projects in this area under the leadership of the Florida Institute for Sustainable Energy (http://www.energy.ufl.edu). Previous EDIS documents have explored the issue from an agronomic standpoint for sweet sorghum, elephant grass, and others.

We present the results of preliminary studies conducted to determine the economic potential of several types of energy crops identified as suitable for agricultural production in the state of Florida. This fact sheet focuses on sugarcane (*Saccharum officinarum* L.) and provides estimates of costs and returns to produce ethanol from sugarcane, rather than sugar. These preliminary estimates should guide researchers as to whether sugarcane varieties are economically feasible to be considered for biofuel/energy production. A similar fact sheet analyzes growing energycanes, which are crosses of commercial sugarcane (*Saccharum*

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officiarum L.) with *Saccharum spontaneam L.* (http://edis.ifas.ufl.edu/SC089).

Production Potential

With nearly one century of experience with growing sugarcane for processing it into raw and refined sugar in Florida, the industry has only recently found itself in the midst of serious discussions about harvesting the crop for energy. Prior to this, early evaluations of biomass production from field trials at the Everglades Research and Education Center (EREC) had been limited in scope and were funded by the Battle Institute in the 1980s. Today, work to develop higher biomass sugarcane varieties is underway through the joint germplasm development program between UF/IFAS and the United States Department of Agriculture (USDA) in Canal Point.

Indeed, there exists great potential for ethanol production from sugarcane. During the 2009–2010 season, 12.263 million tons of sugarcane were harvested from 375,000 acres (about 80% on organic soils and 20% on mineral soils), for an average yield of 32.7 tons per acre. This would have the potential of producing over 240 million gallons of ethanol. The latter figure represents the potential production if the entire sugar industry were to convert to ethanol production. In such a scenario, more modest production would be expected in the early stages; planting sugarcane for energy would likely take place mainly on marginal soils, which we believe would not have a significant impact on the overall sugar production figures for some time.

Assumptions of the Study

A four-year cycle of sugarcane is assumed to be grown on a 640-acre (usually referred to as a "one section") farm. The farm is broken down by sections for management decisions. Since the hypothetical farm is assumed to be an established farm, there are no development costs to defray. The soil is classified as mineral (sand). There are 16 blocks of 40 acres each. There are 14 ditches 0.5 miles long (7 miles total), and 2 one-mile-long seepage canals. Total area on roads, canals, and ditches equals 65 acres. Therefore, net acreage equals 575. The net acreage is equally distributed in five parts (1 fallow land, 1 plant cane, and 3 stubble crops) of 115 acres each, except for the plant cane, which has 10 acres devoted to seed cane, and the remaining 105 acres to regular production.

Methodology and Data Sources

An enterprise budget was developed with agronomic and cost data, with the objective of estimating production costs and projecting gross and net returns. Data were obtained from several sources: interviews with sugarcane producers, information from a recent enterprise budget published by UF/IFAS (Roka, Alvarez, and Baucum 2009), and information on prices provided by local dealers of agricultural inputs, including custom rates charges. Because numerous costs change with purchased product prices (fertilizers, pesticides, fuel, etc.), growers and others using this document are encouraged to utilize their own updated costs in the budgets to follow.

A base yield of 32 net tons of sugarcane per acre and an equivalent ethanol production of 19.5 gallons per net ton of sugarcane being processed at 50 cents per pound were assumed. The price of sugar was set at the average of the four years preceding this study, or 22.34 cents per pound. Sensitivity analyses were conducted to reveal changes resulting from different levels of crop yields, input prices, ethanol processing costs, and ethanol prices. In the latter case, scenarios at $1.80, $2.25, and $2.90 per gallon prices of ethanol were used to estimate the impact of prices above, near, and below prices at the time of this analysis. Break-even ethanol prices were calculated for different scenarios.

Production Costs

A summary version of the enterprise budget is shown in Table 1. Preliminary results show that it costs $1,061 per year to grow one acre of sugarcane for energy in a four-year cycle. The total cost figure includes variable ($851) and overhead costs ($210). The break-down of variable costs includes $9.50 for fallow land maintenance and $57.03 for land preparation. Planting activities account for $83.80 per acre. The former costs have been prorated for a four-year crop cycle. All cultural activities performed represent $312.40, to which we added $87.57 for miscellaneous expenses, and $77 for interest of the capital used in the previous activities. Harvesting activities (cutting, loading, and hauling to the mill) represent $224.

The overhead expenses totaling $210 include supervising and vehicles, farm maintenance, irrigation, taxes and assessment, and a land charge.

The relative importance of total costs provides insights into the future economic potential of sugarcane as an energy crop (Table 2). For example, land preparation and planting account for almost 57 percent of total costs, followed by fertilizers with 36 percent, harvesting with 21 percent, and chemicals with 10 percent. The share of overhead expenses is 20 percent. A sensitivity analysis, showing increases and decreases by activity at 5 percent intervals is also presented (Table 2).

In sugarcane production, replanting is perhaps the most economically important decision due to the high cost. When total expenses are considered, as opposed to the prorated per year cost, replanting includes $228 for land preparation and $335 for planting, for a total of $563 per acre. It becomes obvious that this involves 53 percent of the total costs, showing how expensive that decision can be.

Another type of sensitivity analysis is shown in Table 3, where the profitability of sugarcane produced for sugar (assumed at 22.34 cents per pound) is analyzed at three levels of biomass yields. Results show that at the basic case of 32 net tons per acre, net returns per acre amount to $12. A lower yield of 28 net tons per acre results in a negative return of $94 per acre, and a 36-ton yield shows a net return of $119 per acre, per year.

There is no doubt about the importance of the energy component in sugarcane growing. Comparing the previous returns from growing sugarcane for sugar with those obtained from ethanol production show the potential of this crop to produce energy. There seem to be positive economic returns at some combinations of biomass yields and ethanol prices, assuming that 19.5 gallons of ethanol are obtained per net ton of sugarcane. The only exception is when the price of ethanol is $1.80 per gallon (Table 4). However, a break-even price of $2.05 per gallon is present at the 36-ton yield per acre, $2.20 per gallon at the 32-ton yield, and $2.39 at the 28-ton yield.

The above results are depicted in Figure 1, which shows the relative profitability of the different scenarios analyzed at three ethanol prices and sugar selling at 22.34 cents per pound. This analysis shows that, under the assumptions and cost structure of this study, ethanol production is not economically feasible when ethanol prices are at $1.80 per gallon; at $2.25 per gallon, sugar and ethanol are almost equal when biomass yields are at 32 net tons per acre and beyond; however, when ethanol prices are at $2.90, the profitability of ethanol production is much higher at the three levels of biomass yields.

In summary, with an eye toward ethanol prices in the mid-$2 range and above, processors and growers may want to more fully consider the economic feasibility of producing sugarcane as a biofuel crop for the purposes of ethanol production. Stakeholders should take note, however—even if this enterprise starts gingerly developing on marginal soils, we must caution that as more acres of sugarcane land

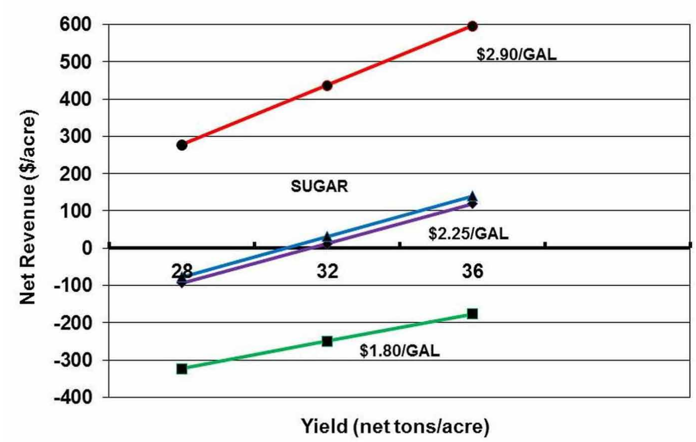

Figure 1. Sugarcane: Relative profitability at three ethanol prices and sugar at 22.34 cents per pound

are devoted to ethanol, sugar production for food uses will decline, likely causing an increase in sugar prices above the 22 cents average price used here.

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Table 1. Estimated per acre costs of cultural activities performed on a one-section (640-acre) sugarcane farm on mineral (sand) soils of southern Florida, 2010

Activity	Unit	# Years	Rate	# Times	Price	$/Acre/Year
Fallow land maintenance						
Herbicide + surfactant	quart	1	2	2	7.50	30.00
Herbicide application	dollar			2	4.00	8.00
Total						38.00
Prorated Total		0.25				9.50
Land preparation						
Soil testing and consulting	dollar	1		1	1.11	1.11
Disking	dollar	1		3	15.00	45.00
Lime (dolomite) application	dollar	1		1	5.00	5.00
Lime material	ton	1	1.00	1	28.00	28.00
Laser leveling[a]	dollar	1		1	60.00	60.00
Calcium silicate slag	ton	1	1.50	1	56.00	84.00
Slag application	dollar	1		1	5.00	5.00
Total						228.11
Prorated Total		0.25				57.03
Planting						
All related activities[b]	$/acre	1		1	170.00	170.00
Seed cost	$/acre		5.00	1	25.00	125.00
Insecticide[c]	lb/acre	1	15.00	1	2.00	30.00
Micronutrients[d]	lb/acre	1	20.00	1	0.51	10.20
Total						335.20
Prorated Total		0.25				83.80
Cultural activities						
Nitrogen[e]	pound	4	43.53	4.25	0.60	111.00
P2O5[f]	pound	4	50.00	1	0.60	30.00
K2O[g]	pound	4	45.00	4.25	0.60	114.75
Chemical applications	dollar	4	1.00	2	4.00	8.00
Herbicide (pre-emergence)[h]	quart	4	3.00	1	3.00	9.00
Herbicide (pre-emergence)	gallon	4	1.00	1	16.50	16.50
Herbicide (post-emergence)[i]	quart	4	3.00	1	3.00	9.00
Herbicide (post-emergence)	pint	4	2.00	1	3.00	6.00
Oil (surfactant)	quart	4	1.00	1	1.65	1.65
Mechanical cultivation[j]	dollar	4	1.00	1	6.50	6.50
Total						312.40
Miscellaneous[k]	dollar					87.57
Interest[l]	dollar					77.06
Harvesting activities						
Harvest, load, and haul[m]	gross tons	4	32.00	1.00	7.00	224.00
Total variable costs						851.36
Overhead activities						
Supervising and vehicles	gross acre			1	10.00	10.00
Road and ditch maintenance	gross acre			1	5.00	5.00
Pumping and water control	gross acre			1	50.00	50.00
Taxes and assessments	gross acre			1	70.00	70.00

Activity	Unit	# Years	Rate	# Times	Price	$/Acre/Year
Land charge	gross acre			1	75.00	75.00
Total	dollar					210.00
TOTAL COSTS						1,061.36

[a] Done to one-half of the 115 acres on fallow every year.

[b] It includes cutting seed cane ($30/new planted acre); furrowing, dropping, chopping, and covering ($130/acre); and fuel costs provided by the farmer ($10/planted acre), which equals $170 per planted acre.

[c] 15 pounds of insecticide applied in the furrow at plant covering, thus no application cost is charged.

[d] 20 pounds applied only once during the crop cycle.

[e] 200 pounds in plant cane in 5 splits; 4 splits of 45 pounds each for each of the 3 stubble crops, for an average of 185 pounds per year.

[f] 50 pounds in plant cane and 50 pounds in the first split in each ratoon crop.

[g] 225 pounds in plant cane in 5 splits; 4 splits of 45 pounds each for each of the 3 stubble crops, for an average of 191.25 pounds per year.

[h] Pre-emergence every year: 1 gallon of pendimethalin (Prowl®) and 3 quarts of atrazine.

[i] Post-emergence every year: 2 pints of 2,4-D and 3 quarts of atrazine plus 1 quart of oil surfactant.

[j] One per year.

[k] At 10% of above variable costs.

[l] At 8% of total variable costs before harvesting.

[m] Biomass yield assumed in the basic case equals 32 net tons per acre. The figure was adapted from experimental results and grower inputs. For comparison purposes, the average official yield figure for both muck and sand soils during the four seasons 2006–2009 was 35.15 net tons per acre. The 32 net tons also reflect the 80/20% split of sugarcane acreage between muck and sand soils. Acres harvested per year: 345 (115 x 3) + 105 = 450/4 = 112.5.

Table 2. Sensitivity analysis of costs per activity of the basic case (biomass yield of 32 net tons per acre), excluding those belonging in another category to avoid double-counting

Variation	Land Prep	Planting	Fertilizers	Chemicals	Harvest	Overhead	Total
20% +	319	402	454	123	269	252	1274
15% +	306	385	435	117	258	242	1221
10% +	293	369	416	112	246	231	1167
5% +	279	352	397	107	235	221	1114
Basic case	**266**	**335**	**378**	**102**	**224**	**210**	**1061**
5% –	253	318	359	97	213	200	1008
10% –	239	302	340	92	202	189	955
15% –	226	285	321	87	190	179	902
20% –	213	268	302	82	179	168	849

Table 3. Relative profitability of sugarcane produced for sugar at three levels of biomass yields

Biomass Yield[a]	**Gross Returns**[b]	**Costs**		**Molasses Credit**[e]	**Net Returns** ($/acre/year)
		Growing[c]	Processing[d]		
36	1853	1089	690	45	119
32	1647	1061	613	40	12
28	1441	1033	537	35	–94

[a] The basic case plus and minus 4 tons (see Table 1 for sources of data).

[b] Gross returns: Biomass yield × 230.36 pounds of sugar per net ton (average of the four seasons 2006–2009), and 1,608,500 short tons of sugar produced on 396,000 acres of sugarcane × 22.34 cents per pound.

[c] Taken from the calculations on the enterprise budget.

[d] At 8.309 cent per pound as was the average for 2003–2005 seasons, where the hauling cost was not included since it is already charged in the harvesting item in the budget (Shapouri, Salassi, and Fairbanks 2006: 15). The formula is biomass yield × pound of sugar per ton x cost of processing per pound.

[e] At 0.545 cent per pound × biomass yield × pound of sugar per net ton of cane (Shapouri, Salassi, and Fairbanks 2006: 15).

Table 4. Relative profitability of sugarcane produced for ethanol at three levels of biomass yields and three levels of ethanol prices

Biomass Yield[a]	Gallon Ethanol/ ton of cane[b]	Price/ Gallon Ethanol[c]	Gross Revenue	Total Costs		Net Returns	Breakeven Price
				Growing	Processing[d]		
36	19.5	2.9	2036	1089	351	596	2.05
36	19.5	2.25	1579	1089	351	139	2.05
36	19.5	1.8	1264	1089	351	–176	2.05
32	19.5	2.9	1810	1061	312	437	2.20
32	19.5	2.25	1404	1061	312	31	2.20
32	19.5	1.8	1123	1061	312	–250	2.20
28	19.5	2.9	1583	1033	273	277	2.39
28	19.5	2.25	1228	1033	273	–77	2.39
28	19.5	1.8	983	1033	273	–323	2.39

[a] The basic case plus and minus 4 tons (see Table 1 for sources of data).

[b] This yield figure is widely used (see Shapouri, Salassi, and Fairbansk 2006: 17).

[c] Calculated from http://e85prices.com/florida.html.

[d] At $0.50 per pound of ethanol processed. Shapouri, Salassi, and Fairbanks (2006: 23) report $0.558 per gallon of ethanol processed in the United States. Morris (2008: 82) uses $0.56 per gallon. After adjusting Brazil's figures (Coelho 2005) for higher labor costs in Florida, Rahmani and Hodges (2009: 2) estimate the processing cost at $0.50 per gallon.

Note: Processing costs do not include depreciation and other infrastructure costs for building the distilling plant. There are no figures available for Florida, and the purpose of this exercise is to compare the production costs of the raw material.