# The Economics Of Growing And Delivering Cellulosic Feedstocks In The Beaumont, Texas Area

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# The Economics Of Growing And Delivering Cellulosic Feedstocks In The Beaumont, Texas Area

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## Abstract

We estimate the contract prices that must be paid to grow cellulosic energy crops, and the costs of harvesting and transporting those crops in the Beaumont, TX area. Results indicate that the delivered price would range between $54 and $101 per ton of dry matter depending on the specific crop.

## Introduction

Annual production of ethanol for fuel in the United States has risen from 175 million gallons in 1980 to nearly 5 billion gallons in 2006 (Renewable Fuels Association (RFA)). While nearly all of the U.S. ethanol supply is currently derived from corn, concerns about environmental sustainability and potential impacts on the food supply chain have brought corn-based ethanol out of favor with some. Advanced biofuels such as cellulosic ethanol are expected to be the preferable long-term source of renewable energy (Council for Agricultural Science and Technology (CAST)). The recently enacted Energy Independence and Security Act of 2007, mandates that the United States produce 16 billion gallons of cellulosic biofuel by 2022, representing 44% of the total biofuel mandate (Wyant). The push for cellulosic ethanol has prompted the Department of Energy (DOE) to award millions in cellulosic research grants (DOE). The southeastern United States, from the upper coast of Texas to northern Florida, is viewed by some private sector grant recipients as potentially being the most agronomically favorable geographic region for cellulosic feedstock (biomass) production. However the economics of such production, particularly for newer varieties of energy-cane and sorghum, have yet to be fully explored. Tembo, Epplin, and Huhnke, and Mapemba and Epplin have studied similar economic issues pertaining to perennial grasses in Oklahoma.

The specific type of technology employed will potentially impact the type of biomass that the biorefinery must use as its primary input. The type of biomass used must be both environmentally and economically sustainable within the geographic area chosen for the biorefinery. Crop density (acres planted per square mile) and energy yield are two vital components in biomass choice (De La Torre Ugarte et al and English et al). The crop chosen must have adequate energy yield per acre (gallons of ethanol that can be produced), which is a function of the crop yield. Sufficient crop density of the chosen feedstock is also required so that transportation costs can be minimized, as it estimated that the cost of harvesting and transporting biomass can comprise up to 75% of the total cost of biomass production (CAST, Epplin et al, and Mapemba et al). Discussions with university agronomists have revealed two potential feedstocks, hybrid sugarcane (energy-cane), and hybrid sorghum, that may be most suitable for cellulosic ethanol production (Rooney). Varieties of each crop have been developed to maximize biomass yield per acre. Both crops are recognized for their relatively low input usage, and are especially suited for climates such as those found in the southeastern United States.

Agronomically, it may seem logical to grow these energy crops in areas where per acre yield is maximized (based on soil type, water availability, etc.), economics however may yield a different conclusion. The most productive farming regions posses more acreage of economically competitive crop alternatives for growers. While per acre yields of dedicated energy crops may be highest in a particular geographic area, the price that a biorefinery would have to pay a farmer to forgo his next best alternative and grow the dedicated feedstock may be economically prohibitive. Because of competing alternatives, perhaps "marginal" growing areas are better suited economically for energy feedstock production and bio-refinery location (Mapemba et al). Farmers in Beaumont, Texas have begun to ask whether the geographic, agronomic, and economic conditions present in the area make them suitable candidates to produce cellulosic feedstock, and if so, what types of specific energy crops should be pursued. Cursory examination of the area suggests that both hybrid sorghums and hybrid sugarcanes should grow well. Growers in the area have the technical expertise to grow energy crops, and rainfall is abundant. The availability of abundant and suitable farmland, which is close to potential refinery building sites, and the fact that relatively few economically viable crop options are available to growers, suggest that this area may be a wise choice for bio-refinery location.

## Economic Problem

What is the cost of growing, harvesting, and delivering cellulosic feedstocks to a biorefinery in the Beaumont, Texas area?

## Hypotheses

The contract price needed to induce farmers to grow energy crops will depend on the specific type of cellulosic feedstock produced due to differences in yield risk, technological expertise, and capital investment needed. Harvesting and transportation costs will depend heavily on bio-density, fuel prices, and the specific type of crop produced.

## Research Objectives

1. To estimate the contract price per ton needed for farmers to grow cellulosic feedstock and forgo their next best alternative in the Beaumont, TX area.
2. To estimate distributions of net returns to growers based on estimated contract prices.
3. To estimate the cost per ton to harvest and transport alternative cellulosic crops to a biorefinery located in the Beaumont, Texas area.

## Data and Methods

*Crops Choices (Energy and Non-Energy Alternatives)*

Agronomists, local producers, and ethanol industry representatives were consulted to determine the most potentially feasible types of cellulosic ethanol crops for the growing region (Rooney and Farm Panel). Feedstocks most attractive for this process are those that yield a high amount of cellulosic material per acre, including high biomass hybrids of sorghum and sugarcane. The most suitable sources of biomass were identified as hybrid sorghum hay (HS Hay), hybrid sorghum green chop (HS GC), high-biomass sorghum green chop (HB), and billeted, hybrid sugarcane (Cane)[1]. The farm panel also identified the most viable alternatives to growing dedicated energy crops for their geographic area. The most feasible non-energy choices were limited to cattle, rice, and pasture hay. It is assumed that all feedstocks will be grown in the surrounding area. Final delivered feedstock costs to the bio-refinery rely on a combination of factors including the contract prices paid to growers to attract the required amount of acreage, and harvest and transportation costs.

*Minimum Contract Prices to Induce Growing*

Once the alternative enterprises were identified, 2007 budgets were constructed to serve as a starting point for the analysis. Price, yield, and cost information for non-energy crop alternatives were provided by a panel of producers in the identified potential growing region (Farm Panel). Estimates of energy crop yields and costs of production were reached using a combination of information from the panel farmers, representatives from the cellulosic ethanol

1 Neither energy-cane nor the hybrid sorghums have been grown commercially on a large scale. Only test plots and other small scale operations have recorded yields of these "new" crops. Therefore, yield estimates are based on a relatively small data set. HB sorghum refers to a crop that is allowed to mature more thoroughly than the green chop or hay varieties, and is cut only once per season. The HB crop becomes more "woody" like cane and is therefore less resistant to lodging during harsh weather conditions than typical sorghum crops. However, the stalk diameter of HB sorghum is still considerably less than cane, so harvesting cost for the HB crop is lower. The HB type of crop is harvested similarly to typical green chop, but is assumed to be cut at 40% dry matter as opposed to green chop at 30%. Forage sorghum hay is assumed baled at 85% dry matter; energy-cane is harvested at 34% dry matter. Most likely a combination of harvesting types such as green chopping and haying will have to be used, because the crop must be stored for use during times when green chop harvesting is not possible due to soil conditions.

industry, and Agricultural Extension agronomists (Rooney and Farm Panel). While cattle was identified as a viable non-energy enterprise, the model did not posses a livestock component. It also became clear that both rice and pasture hay were yielding break-even results at best on average. With the guidance of the farm panel, it was determined that a target return of $50 per acre, which is equal to the cash rental rate, would have to be the basis for a minimum negotiated contract price ($/ton) for energy crop production. This targeted return would be adequate to draw acreage away from current production practices, including cattle, and into dedicated energy crops. Table 1 gives a summary of all the exogenous variables and assumptions used in this analysis, including the information received from the farm panel and the agronomists. Table 2 shows the 2007 budgets for both energy and non-energy crops. The Table 2 budgets are intended for farm-level analysis, therefore the energy crop budgets include only growing costs, because it is expected that the biorefinery will handle all harvesting and transportation (Farm Panel).

The December 2007 FAPRI baseline estimates for crop prices and input inflation rates were localized and applied to the 2007 budgets to estimate budgets for 2008-2012 (FAPRI). Based on these estimated budgets, which included expected yields, and targeted per acre net returns of $50, $60, $70, and $80, minimum contract prices were calculated for each energy crop for each year at each targeted level of net return.

*Estimated Returns to Growers*

Holding estimated contract prices constant (price risk removed), yield risk and input price risk were accounted for in the model using Monte Carlo simulation. Price risk for rice and pasture hay was also simulated using historical price data from FAPRI. Random shocks to yield were drawn from a multivariate GRKS distribution, while extreme weather shocks to yield were simulated using a Bernoulli random variable (Richardson, Klose, and Gray). Input price shocks were introduced using historical inflation rate data from FAPRI and simulated using a multivariate empirical distribution for each year (Richardson, Klose and Gray). The probability of an extreme weather shock occurring was based on historical data provided by the grower panel. The actual yield loss due to extreme weather depended on the particular crop, and was estimated by the Extension agronomists. The Monte Carlo simulations produced probabilistic forecasts of cumulative net returns (2008-2012) per acre for each energy and non-energy crop.

*Estimation of Harvest and Transportation Costs*

Interviews with ethanol industry representatives made it clear that the bio-refinery would be responsible for the harvesting and transportation costs for biomass (Farm Panel). Harvest costs per unit of feedstock were based on the 2004 Texas Custom Rates Statistics publication (NASS) and then adjusted using FAPRI baseline inflation estimates through 2012 (FAPRI).

Transportation costs per unit of feedstock were modeled as a function of the average distance hauled and the variable transportation cost per mile. The average distance hauled for each feedstock did not depend on stochastic yields, because the actual acreage contracted is a function of the expected yield at the time the contract is negotiated. Contracted acres needed was modeled as a function of the dry matter tons of each feedstock needed, the expected dry matter yields per acre, and the expected bio-density of each crop per square mile. Work done by McCarl was helpful in estimating the expected bio-densities (2000). Once total planted acres needed were estimated, average hauling distances were calculated using work done by French, which accounts for a square road system (1960). Variable transportation costs per mile were based on the 2004 Texas Custom Rates Statistics publication (NASS) and were adjusted using FAPRI baseline inflation estimates through 2012. Table 3 shows the 2007 budgets including harvest and transportation costs. Total delivered costs per ton of dry matter to the biorefinery for each feedstock were estimated by summing the contract price to grow, the harvest cost, and the transportation cost, all on a ton dry matter basis. Finally, costs to produce and deliver biomass were converted to a dollar per gallon of ethanol basis using a conversion rate of 90 gallons per ton of dry matter. The conversion rate is based on work done by the DOE, and has been used by English, Epplin, De La Torre Ugarte, Mapemba, Richardson, and others.

## Results

*Next Best Alternative Crops*

The cumulative distribution function (CDF) plots of simulated net returns per acre shown in Figure 1 show that both rice and pasture hay are essentially first-order stochastically dominated by the energy crops, except for a slightly longer upper tail. Recall however that a predetermined expected return of $50 is built into the contract prices for energy crops. The bottom-line is that neither rice nor hay are expected to be profitable (90% chance of a loss), and the opportunity costs to cattle are reflected in the $50 per acre target return. We conclude that the minimum contract price estimates are adequate to induce growing of energy crops versus next best alternatives.

*Estimated Contract Prices to Grow Feedstocks (2008-2012)*

The contract prices ($/ton DM) for all three of the sorghum crops continue to increase slightly each year and range from $23.23 to $26.79 depending on the targeted net return per acre (NR/Acre). Cane contract prices peak in 2008 at $32.22 due to one-time variable costs to establish the perennial crop (capital costs of establishment are spread over 7 years), and decline to $27.10 by 2012. High biomass sorghum has the lowest annual contract price per ton DM, while cane tends to cost approximately 12% more than the sorghum crops. The lower per year variable costs for cane do not compensate for the high establishment cost for the crop. The contract prices translate to a range of approximately $.25 to $.33 per gallon of ethanol, based on a conversion rate of 90 gallons per ton of dry matter. See Tables 4 and 5 for complete results.

*Estimated Returns to Growers (2008-2012)*

The CDF graphs of simulated net returns for each of the four energy crops are shown for both a targeted net return of $50 per acre per year and a targeted net return of $80 per acre per year in Figures 2 and 3. Cane is the stochastically dominant crop due to its lower yield risk and because it is less sensitive to rising variable input costs. Figure 4 shows the results of a Stochastic Efficiency with Respect to a Function (SERF) analysis, which indicates that cane is the preferred crop given the assumptions made (Hardaker, Richardson, Lien, and Schumann). The descriptive statistics for cumulative net returns per acre for the $50/acre/year target and the $80/acre/year target are shown in Table 6. Cane and HB sorghum have higher mean returns and less variability than the other two sorghum options. Based on the $50 target return, cumulative net returns per acre over the 2008-2012 period range from a low of -$1,481 for HS hay to a high of $953 for HS green chop. We recognize that a combination of all four energy crops would likely be grown to insure a year-round supply of biomass to the biorefinery.

*Delivered Cost to Biorefinery Including Growing, Harvesting, and Transportation (2008-2012)*

Table 7 shows the estimated harvest and transportation costs for each crop for each forecasted year. Both the harvest and transportation costs for HS hay are nearly twice that of the other types of sorghum crops. Harvest costs for cane are considerably higher than both HS GC and sorghum HB. Combined harvest and transportation account for approximately $75/ton DM for HS hay compared to $32/ton DM for HB. Table 8 shows the delivered prices for each feedstock, including growing, harvesting, and transportation on a $/ton DM basis, while Table 9 shows the same cost on a per gallon of ethanol basis. Due to the large differences in harvest and transportation costs, the delivered price for the HS hay is nearly twice that of the HB sorghum ($99/ton DM versus $56/ton DM). Both cane and HS hay cost the biorefinery approximately

$1.00 per gallon of ethanol, while HS green chop and HB cost approximately $.74 and $.62 per gallon respectively.

## Summary and Conclusions

Recent changes to U.S. energy policy indicate that the United States is committed to the successful, commercial introduction of cellulosic biofuels (Wyant). The economics of delivering biomass to biorefineries is the central theme of this paper. We use Monte Carlo simulation and farm panel data to estimate the expected potential returns to agricultural producers when growing dedicated energy crops. We also estimate the harvest and transportation costs of getting biomass from the farm to the biorefinery. We evaluate four types of energy crops including hybrid sorghum hay, hybrid sorghum green chop, hybrid high-biomass sorghum, and hybrid sugarcane.

Results suggest that dedicated energy crops can be a viable economic option for agricultural producers in the Beaumont, Texas area, assuming that the contract prices evaluated are attainable. Cane appears to be the most favorable crop from a farming perspective, because it is more resistant to the potentially harsh weather conditions and therefore has less yield variability than the sorghum crops. Cane is also less sensitive to changes in annual input costs. However, planting cane does require a relatively large capital commitment for establishment and gives the producer less planting flexibility than the direct seeded sorghum crops. Producers may prefer to take on more yield risk to gain more planting flexibility and to minimize capital outlay. Farmers should also note that contract prices based on expected outcomes can result in actual outcomes that are far less favorable, because of extreme weather conditions.

Due to the higher contract price that must be paid to cover the establishment costs for cane, the biorefinery can have the sorghum crops grown at less cost. However, because a consistent supply of biomass is needed year-round, a biorefinery will likely have to contract for a combination of the different energy crops. The high-biomass sorghum is the most economical crop to have grown.

Regardless of the energy crop, harvesting and transportation costs account for at least 50% and in some cases 75% of the total delivered cost to the biorefinery. Due to the relatively higher cost of harvesting and handling hay, the delivered cost of the hybrid sorghum hay is approximately 67% higher than the non-hay sorghum options. Stored hay, however, may be a favorable option for the biorefinery at times when other crops cannot be harvested. Cane also has a relatively high delivered price compared to the non-hay sorghum crops, because of its higher harvesting cost. High-biomass sorghum is the most economically favorable option for the biorefinery.

The results found in this analysis are generally similar to other studies after adjusting for differences in crops and time-frame. The contract prices calculated here are similar to those used by De La Torre Ugarte et al, English et al, and Epplin et al. While most of the previous economic research done in delivering biomass has focused on wood wastes and switchgrass, this research focuses on new hybrid varieties of sorghum and cane. If these new hybrids, particularly the high-biomass variety of sorghum, can deliver the proposed yields on a consistent, commercial basis, then these crops may offer a suitable biomass alternative once cellulosic fuel production becomes commercially viable.

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Table 1

**Exogenous Variables and Assumptions**

| | | | | | | |
|---|---|---|---|---|---|---|
| Year | 2007 | | | | | |
| Annual Biorefinery Output in Gallons | 25,000,000 | | | | | |
| Gallons Ethanol Per Ton Dry Matter | 90 | | | | | |
| Percent of Land Farmable in the Area (Decimal Form) | 0.9 | | | | | |
| Percent of Farmland Converted (Decimal Form) | 0.3 | | | | | |
| Operating Loan Rate (Decimal Form) | 0.1 | | | | | |
| Fraction of Year for Growing Portion of Operating Loan | 0.6667 | | | | | |
| Fraction of Year for Harvesting Portion of Operating Loan | 0.1667 | | | | | |
| Intermediate Term Loan Rate (Decimal Form) | 0.075 | | | | | |
| | | | | | | |
| Crop | Rice | Grass Hay | HS Hay | HS GC | HB | Cane |
| Crop Yield/Acre (Wet Ton) (Cwt for Rice) | 75.00 | 9.00 | 17.65 | 50 | 37.5 | 45 |
| Percent Dry Matter (Decimal Form) | | | 0.85 | 0.3 | 0.4 | 0.34 |
| Crop Rotation (Years) | | | 3 | 3 | 3 | 0 |
| Fixed Hauling Cost Per Acre | 0 | 0 | 0 | 0 | 0 | 0 |
| Hauling Cost Per Wet Ton (up to 1 mile) (Cwt for Rice) | 1.50 | 16.67 | 16.67 | 3.35 | 3.35 | 3.35 |
| Variable Hauling Cost Per Wet Ton Per Mile (over 1 mile) | 0 | 1.09 | 1.09 | 0.3 | 0.3 | 0.3 |
| Fixed Portion of Harvesting Cost Per Acre | 55 | 27 | 0 | 0 | 0 | 144 |
| Variable Harvest Cost Per Wet Ton | 0 | 36.67 | 36.67 | 6.47 | 6.47 | 10 |
| Other Revenue per Acre | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Establishment Costs ($ Per Acre) | | | | | | |
| Planting | | | | | | 660 |
| Herbicides | | | | | | 47 |
| Number of Years to Spread Establishment Cost | | | | | | 7 |
| | | | | | | |
| Variable Growing Costs ($ Per Acre) | | | | | | |
| Seed/Tech | 75 | 0 | 30 | 30 | 30 | 0 |
| Chemicals | 95 | 10 | 10 | 10 | 10 | 0 |
| Fertilizer | 120 | 123 | 55 | 55 | 55 | 27.5 |
| Labor | 40 | 12 | 20 | 20 | 20 | 12 |
| Fuel | 33 | 8 | 20 | 20 | 20 | 8 |
| Repair & Maintenance | 33 | 3 | 15 | 15 | 15 | 3 |
| Other/Custom/Irrigation | 80 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Direct Fixed Growing Expenses per Acre | 80 | 80 | 80 | 80 | 80 | 80 |
| Cash Rent | 50 | 25 | 50 | 50 | 50 | 50 |
| | | | | | | |
| Minimum Expected Return Needed per Acre | | | 50 | 50 | 50 | 50 |
| | | | | | | |
| Yield Parameters | | | | | | |
| Min | 50 | 6 | 10 | 26 | 20 | 30 |
| Mid | 75 | 9 | 17.65 | 50 | 37.5 | 45 |
| Max | 85 | 12 | 24 | 66 | 50 | 60 |
| Percent of Crop Recovered if Weather Disaster | 0.3 | 0.5 | 0.5 | 0.3 | 0.5 | 0.75 |
| | | | | | | |
| Probability of Disaster | 0.1 | | | | | |
| | | | | | | |
| FAPRI U.S. Baseline Estimates | | | | | | |
| Year | 2008 | 2009 | 2010 | 2011 | 2012 | |
| Rice Price ($/cwt) | 10.52 | 10.6 | 11.03 | 10.99 | 11.23 | |
| All Hay Price ($/ton) | 113.96 | 111.6 | 111.85 | 113.09 | 114.63 | |
| | | | | | | |
| FAPRI Projected Inflation Rates (Percent Change) | | | | | | |
| Agricultural Chemicals | 1.46 | 1.08 | 1.2 | 1.44 | 1.23 | |
| Seed | 3.91 | 3.62 | 2.38 | 1.83 | 1.66 | |
| Nitrogen Fertilizer | 5.78 | 8.44 | 1.94 | -1.34 | -1.17 | |
| Wage Rates | 4.82 | 4 | 2.6 | 2.24 | 1.58 | |
| Petroleum Fuel, Oils | 2.87 | 1.6 | 1.4 | -0.46 | -0.97 | |
| Repairs | 5.27 | 5.19 | 3.09 | 2.15 | 1.84 | |
| Interest | 4.92 | 5.13 | 5.24 | 5.3 | 5.33 | |
| Farm Services | 4.29 | 3.71 | 2.47 | 1.99 | 1.79 | |
| Rent | 4.27 | 2.21 | 1.31 | 0.91 | 0.32 | |
| Direct Fixed | -4.53 | -3.17 | -3.04 | -2.56 | -2.05 | |
| | | | | | | |
| | | | | | | |
| Beaumont Area Price Wedges | | | | | | |
| Rice | 0 | | | | | |
| Hay | -35 | | | | | |

Table 2

**Estimated Budgets for Beaumont, TX Area, 2007** **Growing Only (for Energy Crops)**

| Year | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 |
|---|---|---|---|---|---|---|
| Crop | Rice (Cwt) | Grass Hay (ton) | HS Hay (ton) | HS GC (ton) | HB (ton) | Cane (ton) |
| Average Annual Price | 11.03 | 86.00 | 18.89 | 6.80 | 9.07 | 8.10 |
| Yield per Acre | 75.0 | 9.0 | 18.0 | 50.0 | 37.5 | 45.0 |
| Market Revenue per Acre | 827.25 | 774.00 | 340.00 | 340.00 | 340.00 | 364.50 |
| Other Revenue per Acre | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total Non-Government Revenue per Acre | 827.25 | 774.00 | 340.00 | 340.00 | 340.00 | 364.50 |
| | | | | | | |
| Total Cash Cost for Establishment | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 130.00 |
| Planting | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 660.00 |
| Herbicides | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 47.00 |
| Number of Years to Spread Planting Cost | 0 | 0 | 0 | 0 | 0 | 7 |
| Establishment Cost Per Year | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 130.00 |
| | | | | | | |
| Total Variable Growing Costs/Acre | 507.73 | 166.40 | 160.00 | 160.00 | 160.00 | 53.87 |
| Seed/Tech | 75.00 | 0.00 | 30.00 | 30.00 | 30.00 | 0.00 |
| Chemicals | 95.00 | 10.00 | 10.00 | 10.00 | 10.00 | 0.00 |
| Fertilizer | 120.00 | 123.00 | 55.00 | 55.00 | 55.00 | 27.50 |
| Labor | 40.00 | 12.00 | 20.00 | 20.00 | 20.00 | 12.00 |
| Fuel | 33.00 | 8.00 | 20.00 | 20.00 | 20.00 | 8.00 |
| Repair & Maintenance | 33.00 | 3.00 | 15.00 | 15.00 | 15.00 | 3.00 |
| Other/Custom/Irrigation | 80.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Crop Insurance Premium ($/acre) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Interest on Operating Capital to Grow | 31.73 | 10.40 | 10.00 | 10.00 | 10.00 | 3.37 |
| | | | | | | |
| Direct Fixed (implements, tractors, etc) | 80.00 | 80.00 | 80.00 | 80.00 | 80.00 | 80.00 |
| | | | | | | |
| Cash Rent | 50.00 | 25.00 | 50.00 | 50.00 | 50.00 | 50.00 |
| | | | | | | |
| Total Growing Cost per Acre | 637.73 | 271.40 | 290.00 | 290.00 | 290.00 | 313.87 |
| | | | | | | |
| Harvesting, Hauling, Drying Cost per Acre | 185.89 | 515.51 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | | | |
| Net Return per Acre Before Government Payments | 3.63 | -12.91 | 50.00 | 50.00 | 50.00 | 50.63 |
| Loan Deficiency Payment | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Net Return per Acre Including LDP | 3.63 | -12.91 | 50.00 | 50.00 | 50.00 | 50.00 |
| | | | | | | |
| Dry Matter Percent (Delivered) | | 85% | 82% | 30% | 40% | 34% |
| Tons Dry Matter per Acre | | 7.7 | 14.8 | 15.0 | 15.0 | 15.3 |
| Price/Ton Dry Matter (Growing Only) | | | 23.04 | 22.67 | 22.67 | 23.82 |

Table 3

**Estimated Budgets for Beaumont, TX Area, 2007**

| Year | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 |
|---|---|---|---|---|---|---|
| Crop | Rice (Cwt) | Grass Hay (ton) | HS Hay (ton) | HS GC (ton) | HB (ton) | Cane (ton) |
| Average Annual Price to GROW ONLY (Based on Wet Yield) | | | 18.89 | 6.80 | 9.07 | 8.09 |
| Average Annual Price DELIVERED | 11.03 | 86.00 | 98.76 | 63.57 | 53.34 | 80.00 |
| Wet Yield per Acre | 85.23 | 9.00 | 18.00 | 50.00 | 37.50 | 45.00 |
| Dry Matter Yield per Acre DELIVERED (Dry Yield for Rice) | 75.00 | 7.65 | 14.84 | 15.00 | 15.00 | 15.30 |
| Cottonseed Price | | | | | | |
| Cottonseed Yield | | | | | | |
| **Market Revenue/Acre GROW ONLY** | | | **340.00** | **340.00** | **340.00** | **363.87** |
| **Market Revenue/Acre DELIVERED** | **827.25** | **774.00** | **1,465.72** | **953.56** | **800.17** | **1,223.97** |
| Other Revenue per Acre | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total Non-Gov Revenue/Acre GROW ONLY | | | 340.00 | 340.00 | 340.00 | 363.87 |
| Total Non-Gov Revenue/Acre DELIVERED | 827.25 | 774.00 | 1,465.72 | 953.56 | 800.17 | 1,223.97 |
| **Total Establishment Cost/Acre** | | | | | | **741.26** |
| Planting | | | | | | 660.00 |
| Herbicides | | | | | | 47.00 |
| Interest on Operating Capital for Establishment | | | | | | 34.26 |
| Number of Years to Spread Establishment Cost | | | | | | 7.00 |
| **Establishment Cost Per Year** | | | | | | **130.00** |
| **Total Variable Growing Costs/Acre** | **507.73** | **166.40** | **160.00** | **160.00** | **160.00** | **53.87** |
| Seed/Tech | 75.00 | 0.00 | 30.00 | 30.00 | 30.00 | 0.00 |
| Chemicals | 95.00 | 10.00 | 10.00 | 10.00 | 10.00 | 0.00 |
| Fertilizer | 120.00 | 123.00 | 55.00 | 55.00 | 55.00 | 27.50 |
| Labor | 40.00 | 12.00 | 20.00 | 20.00 | 20.00 | 12.00 |
| Fuel | 33.00 | 8.00 | 20.00 | 20.00 | 20.00 | 8.00 |
| Repair & Maintenance | 33.00 | 3.00 | 15.00 | 15.00 | 15.00 | 3.00 |
| Other/Custom/Irrigation | 80.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Crop Insurance Premium ($/acre) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Interest on Operating Capital to Grow | 31.73 | 10.40 | 10.00 | 10.00 | 10.00 | 3.37 |
| **Total Harvest/Hauling/Processing Cost/Acre** | **185.89** | **515.51** | **1,125.72** | **613.56** | **460.17** | **860.10** |
| **Total Harvesting Cost/Acre** | **55.00** | **357.03** | **660.06** | **323.50** | **242.63** | **594.00** |
| Fixed Portion of Harvesting Cost/Acre | 55.00 | 27.00 | 0.00 | 0.00 | 0.00 | 144.00 |
| Variable Harvest Cost/Unit | 0.00 | 36.67 | 36.67 | 6.47 | 6.47 | 10.00 |
| Total Variable Harvest Cost/Acre | 0.00 | 330.03 | 660.06 | 323.50 | 242.63 | 450.00 |
| **Total Hauling & Processing Cost/Acre** | **127.84** | **150.03** | **447.21** | **280.00** | **210.00** | **252.00** |
| Fixed Hauling/Processing Cost/Acre | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hauling/Processing Cost/Acre (up to 1 mile) | 127.84 | 150.03 | 300.06 | 167.50 | 125.63 | 150.75 |
| Hauling/Processing Cost/Ton (up to 1 mile) | 1.50 | 16.67 | 16.67 | 3.35 | 3.35 | 3.35 |
| Variable Hauling/Processing Cost/Unit/Mile (over 1 mile) | 0.00 | 1.09 | 1.09 | 0.30 | 0.30 | 0.30 |
| Average Miles Hauled | 1.00 | 1.00 | 8.50 | 8.50 | 8.50 | 8.50 |
| Total Variable Hauling/Processing Cost/Acre | 127.84 | 150.03 | 447.21 | 280.00 | 210.00 | 252.00 |
| Interest on Operating Capital for Harvest/Haul/Processing | 3.05 | 8.45 | 18.45 | 10.06 | 7.54 | 14.10 |
| Total Operating Interest | 34.78 | 18.85 | 28.45 | 20.06 | 17.54 | 51.73 |
| **Total Variable Production Costs/Acre DELIVERED** | **693.62** | **681.91** | **1,285.72** | **773.56** | **620.17** | **1,043.97** |
| **Direct Fixed (implements, tractors, etc)** | **80.00** | **80.00** | **80.00** | **80.00** | **80.00** | **80.00** |
| **Cash Rent** | **50.00** | **25.00** | **50.00** | **50.00** | **50.00** | **50.00** |
| **Total Costs/Acre GROW ONLY** | **637.73** | **271.40** | **290.00** | **290.00** | **290.00** | **313.87** |
| **Total Costs/Acre DELIVERED** | **823.62** | **786.91** | **1,415.72** | **903.56** | **750.17** | **1,173.97** |
| **Net Return/Acre Net of Government Payments GROW ONLY** | | | **50.00** | **50.00** | **50.00** | **50.00** |
| **Net Return/Acre Net of Government Payments DELIVERED** | **3.63** | **-12.91** | **50.00** | **50.00** | **50.00** | **50.00** |
| **LDP** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| **Net Return/Acre w/LDP GROW ONLY** | | | **50.00** | **50.00** | **50.00** | **50.00** |
| **Net Return/Acre w/LDP DELIVERED** | **3.63** | **-12.91** | **50.00** | **50.00** | **50.00** | **50.00** |
| **Crop Insurance Indemnity** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| **Net Return/Acre w/LDP + Indemnity GROW ONLY** | | | **50.00** | **50.00** | **50.00** | **50.00** |
| **Net Return/Acre w/LDP + Indemnity DELIVERED** | **3.63** | **-12.91** | **50.00** | **50.00** | **50.00** | **50.00** |
| **Delivered Price per Ton of Dry Matter** | | | 98.76 | 63.57 | 53.34 | 80.00 |
| **Delivered Price per Gallon of Ethanol (90 Gallons/ton DM)** | | | 1.10 | 0.71 | 0.59 | 0.89 |

Table 4

**Estimated Contract Price Grid to Grow Cellulosic Feedstock in Beaumont, TX Area (2008-2012)**

| 2008 | | Contract Price/Ton DM | | | | 2009 | | Contract Price/Ton DM | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NR/Acre | HS Hay | HS GC | HB | Cane | | NR/Acre | HS Hay | HS GC | HB | Cane |
| $50 | 23.67 | 23.26 | 23.23 | 30.25 | | $50 | 24.42 | 24.00 | 23.97 | 27.18 |
| $60 | 24.35 | 23.93 | 23.90 | 30.91 | | $60 | 25.10 | 24.67 | 24.64 | 27.84 |
| $70 | 25.03 | 24.60 | 24.56 | 31.56 | | $70 | 25.78 | 25.34 | 25.30 | 28.49 |
| $80 | 25.71 | 25.26 | 25.23 | 32.22 | | $80 | 26.46 | 26.00 | 25.97 | 29.14 |
| | | | | | | | | | | |
| 2010 | | Contract Price/Ton DM | | | | 2011 | | Contract Price/Ton DM | | |
| NR/Acre | HS Hay | HS GC | HB | Cane | | NR/Acre | HS Hay | HS GC | HB | Cane |
| $50 | 24.72 | 24.29 | 24.26 | 27.23 | | $50 | 24.74 | 24.32 | 24.29 | 27.17 |
| $60 | 25.39 | 24.96 | 24.92 | 27.89 | | $60 | 25.42 | 24.98 | 24.95 | 27.82 |
| $70 | 26.07 | 25.62 | 25.59 | 28.54 | | $70 | 26.10 | 25.65 | 25.62 | 28.48 |
| $80 | 26.75 | 26.29 | 26.26 | 29.19 | | $80 | 26.78 | 26.32 | 26.28 | 29.13 |
| | | | | | | | | | | |
| 2012 | | Contract Price/Ton DM | | | | | | | | |
| NR/Acre | HS Hay | HS GC | HB | Cane | | | | | | |
| $50 | 24.76 | 24.33 | 24.30 | 27.10 | | | | | | |
| $60 | 25.44 | 25.00 | 24.97 | 27.75 | | | | | | |
| $70 | 26.12 | 25.66 | 25.63 | 28.41 | | | | | | |
| $80 | 26.79 | 26.33 | 26.30 | 29.06 | | | | | | |

Table 5

**Cost to Ethanol Plant ($/Gallon of Ethanol) to Grow Feedstock in Beaumont, TX Area (2008-2012)**

Based on Conversion Rate of 90 Gallons per Ton Dry Matter

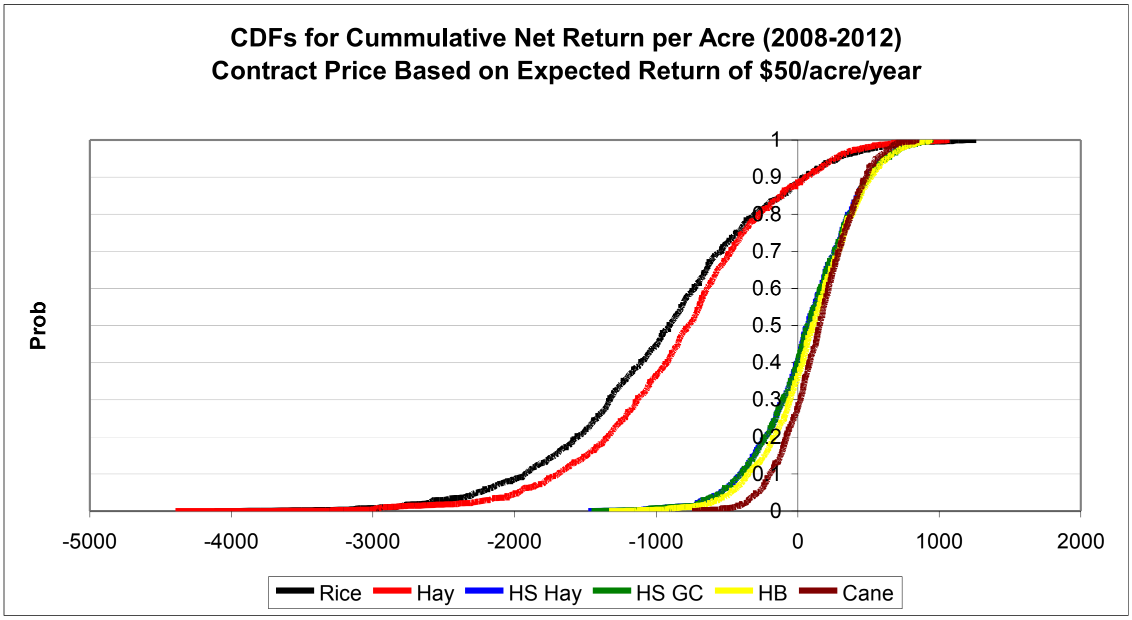
| 2008 | | $/Gallon Ethanol | | | | 2009 | | $/Gallon Ethanol | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NR/Acre | HS Hay | HS GC | HB | Cane | | NR/Acre | HS Hay | HS GC | HB | Cane |
| $50 | 0.2630 | 0.2585 | 0.2581 | 0.3362 | | $50 | 0.2714 | 0.2667 | 0.2664 | 0.3020 |
| $60 | 0.2705 | 0.2659 | 0.2655 | 0.3434 | | $60 | 0.2789 | 0.2741 | 0.2738 | 0.3093 |
| $70 | 0.2781 | 0.2733 | 0.2729 | 0.3507 | | $70 | 0.2865 | 0.2815 | 0.2812 | 0.3165 |
| $80 | 0.2856 | 0.2807 | 0.2803 | 0.3579 | | $80 | 0.2940 | 0.2889 | 0.2886 | 0.3238 |
| | | | | | | | | | | |
| 2010 | | $/Gallon Ethanol | | | | 2011 | | $/Gallon Ethanol | | |
| NR/Acre | HS Hay | HS GC | HB | Cane | | NR/Acre | HS Hay | HS GC | HB | Cane |
| $50 | 0.2746 | 0.2699 | 0.2695 | 0.3026 | | $50 | 0.2749 | 0.2702 | 0.2698 | 0.3019 |
| $60 | 0.2822 | 0.2773 | 0.2769 | 0.3098 | | $60 | 0.2825 | 0.2776 | 0.2772 | 0.3092 |
| $70 | 0.2897 | 0.2847 | 0.2843 | 0.3171 | | $70 | 0.2900 | 0.2850 | 0.2846 | 0.3164 |
| $80 | 0.2972 | 0.2921 | 0.2917 | 0.3244 | | $80 | 0.2975 | 0.2924 | 0.2920 | 0.3237 |
| | | | | | | | | | | |
| 2012 | | $/Gallon Ethanol | | | | | | | | |
| NR/Acre | HS Hay | HS GC | HB | Cane | | | | | | |
| $50 | 0.2751 | 0.2703 | 0.2700 | 0.3011 | | | | | | |
| $60 | 0.2826 | 0.2778 | 0.2774 | 0.3084 | | | | | | |
| $70 | 0.2902 | 0.2852 | 0.2848 | 0.3157 | | | | | | |
| $80 | 0.2977 | 0.2926 | 0.2922 | 0.3229 | | | | | | |

Table 6

**Descriptive Statistics of Simulated Cumulative 5-Year Net Returns Per Acre (2008-2012)**

| Contract Price Based on Expected Return of $50/acre/year | | | | | |
|---|---|---|---|---|---|
| | HS Hay | HS GC | HB | Cane | |
| Mean | 59.69 | 63.63 | 99.66 | 148.54 | |
| StDev | 358.06 | 358.64 | 337.90 | 259.90 | |
| CV | 599.90 | 563.64 | 339.06 | 174.98 | |
| Min | -1,480.77 | -1,456.91 | -1,331.61 | -745.93 | |
| Max | 934.15 | 953.27 | 950.78 | 857.17 | |
| | | | | | |
| Contract Price Based on Expected Return of $80/acre/year | | | | | |
| | HS Hay | HS GC | HB | Cane | |
| Mean | 198.86 | 203.13 | 242.16 | 294.78 | |
| StDev | 368.56 | 369.26 | 345.59 | 268.14 | |
| CV | 185.34 | 181.78 | 142.71 | 90.96 | |
| Min | -1,394.92 | -1,369.07 | -1,183.68 | -598.13 | |
| Max | 1,100.12 | 1,120.82 | 1,118.12 | 1,030.38 | |

Figure 1




Rice and hay prices are based on the December 2007 FAPRI Baseline adjusted for the Beaumont Area.

| | FAPRI December 2007 Baseline Prices | | | | |
|---|---|---|---|---|---|
| Year | 2008 | 2009 | 2010 | 2011 | 2012 |
| Rice ($/Cwt) | 10.52 | 10.60 | 11.03 | 10.99 | 11.23 |
| Hay ($/Ton) | 113.96 | 111.60 | 111.85 | 113.09 | 114.63 |

Figure 2

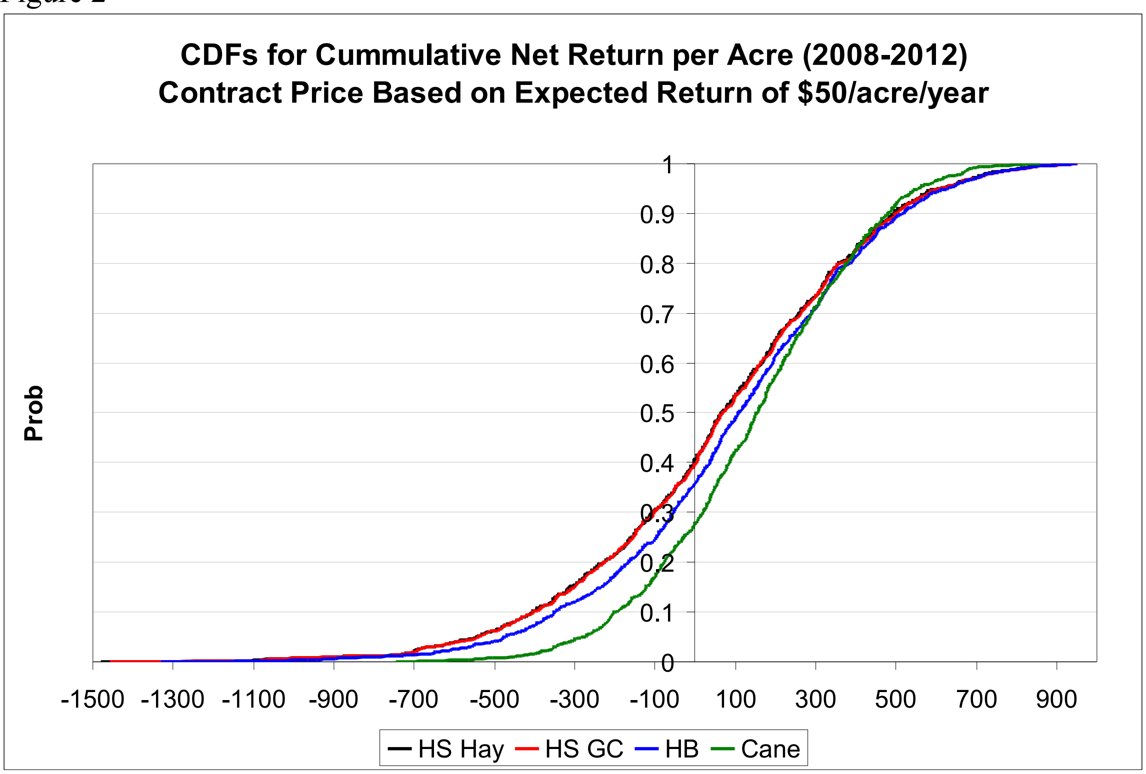


Figure 3

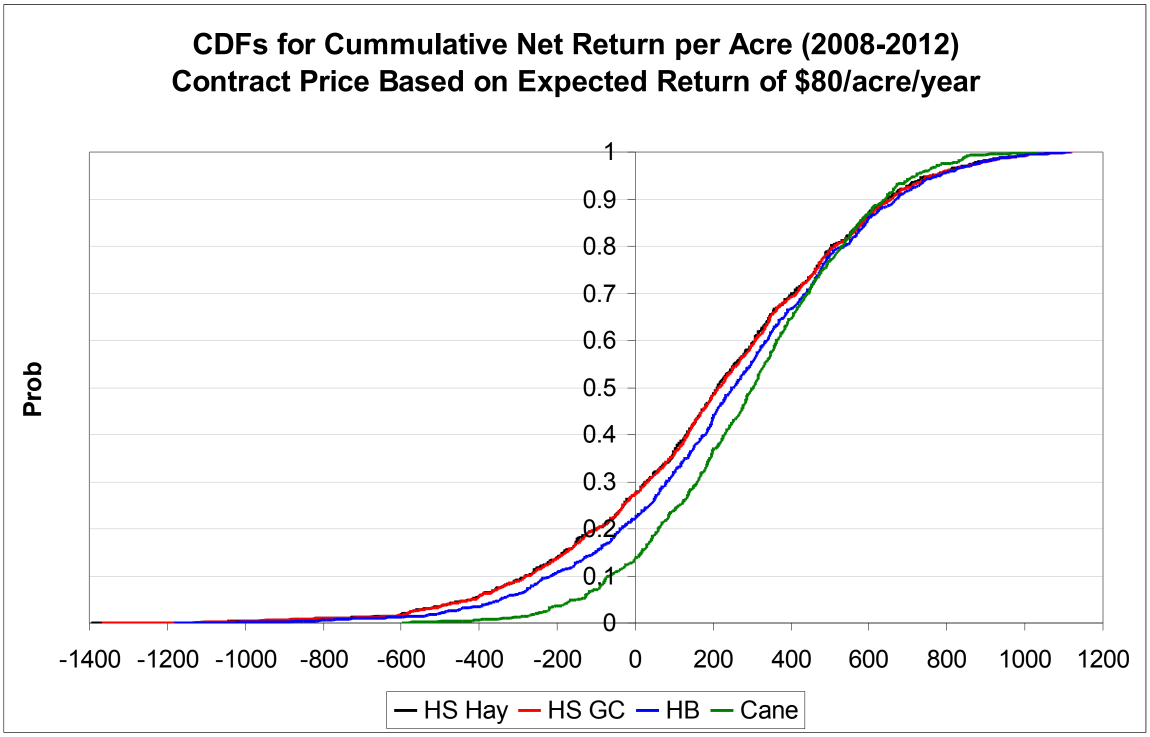



Figure 4

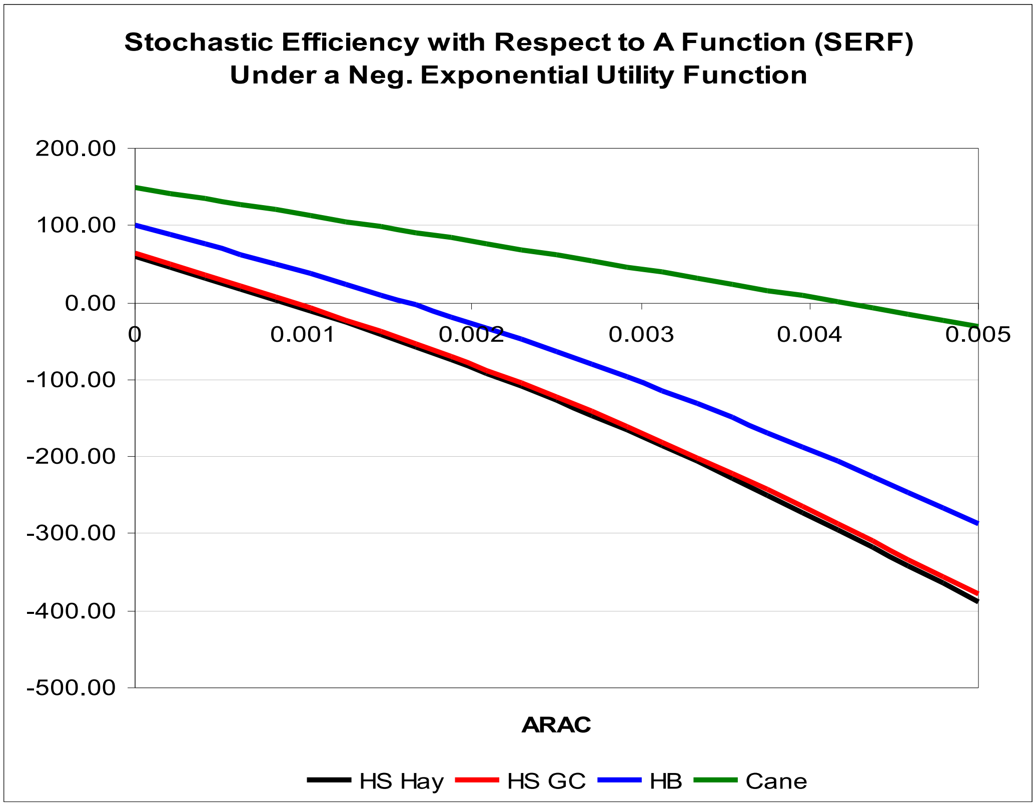


Table 7

**Harvest Cost ($/ton DM) Beaumont, TX Area (2008-2012)**

| | HS Hay | HS GC | HB | Cane |
|---|---|---|---|---|
| 2008 | 44.65 | 22.32 | 16.74 | 40.98 |
| 2009 | 44.37 | 22.18 | 16.64 | 40.73 |
| 2010 | 44.17 | 22.08 | 16.56 | 40.54 |
| 2011 | 43.66 | 21.83 | 16.37 | 40.08 |
| 2012 | 43.06 | 21.52 | 16.14 | 39.52 |
| | | | | |
| **Transportation Cost ($/ton DM) Beaumont, TX Area (2008-2012)** | | | | |
| | HS Hay | HS GC | HB | Cane |
| 2008 | 30.25 | 19.32 | 14.49 | 17.39 |
| 2009 | 30.06 | 19.20 | 14.40 | 17.28 |
| 2010 | 29.92 | 19.11 | 14.33 | 17.20 |
| 2011 | 29.58 | 18.89 | 14.17 | 17.00 |
| 2012 | 29.17 | 18.63 | 13.97 | 16.77 |

Table 8

**Estimated Delivered Prices for Cellulosic Feedstock in Beaumont, TX Area (2008-2012)**

| 2008 | | Delivered Price/Ton DM | | | | 2009 | | Delivered Price/Ton DM | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NR/Acre | HS Hay | HS GC | HB | Cane | | NR/Acre | HS Hay | HS GC | HB | Cane |
| $50 | 98.57 | 64.90 | 54.46 | 88.63 | | $50 | 98.86 | 65.39 | 55.01 | 85.19 |
| $60 | 99.25 | 65.57 | 55.13 | 89.28 | | $60 | 99.54 | 66.05 | 55.68 | 85.85 |
| $70 | 99.93 | 66.23 | 55.79 | 89.93 | | $70 | 100.22 | 66.72 | 56.34 | 86.50 |
| $80 | 100.61 | 66.90 | 56.46 | 90.59 | | $80 | 100.90 | 67.39 | 57.01 | 87.15 |
| | | | | | | | | | | |
| 2010 | | Delivered Price/Ton DM | | | | 2011 | | Delivered Price/Ton DM | | |
| NR/Acre | HS Hay | HS GC | HB | Cane | | NR/Acre | HS Hay | HS GC | HB | Cane |
| $50 | 98.80 | 65.48 | 55.15 | 84.97 | | $50 | 97.99 | 65.04 | 54.82 | 84.25 |
| $60 | 99.48 | 66.14 | 55.82 | 85.63 | | $60 | 98.67 | 65.70 | 55.49 | 84.90 |
| $70 | 100.16 | 66.81 | 56.48 | 86.28 | | $70 | 99.34 | 66.37 | 56.16 | 85.56 |
| $80 | 100.84 | 67.48 | 57.15 | 86.93 | | $80 | 100.02 | 67.04 | 56.82 | 86.21 |
| | | | | | | | | | | |
| 2012 | | Delivered Price/Ton DM | | | | | | | | |
| NR/Acre | HS Hay | HS GC | HB | Cane | | | | | | |
| $50 | 96.99 | 64.49 | 54.42 | 83.39 | | | | | | |
| $60 | 97.67 | 65.15 | 55.08 | 84.04 | | | | | | |
| $70 | 98.34 | 65.82 | 55.75 | 84.70 | | | | | | |
| $80 | 99.02 | 66.49 | 56.41 | 85.35 | | | | | | |

Table 9

**Cost to Ethanol Plant ($/Gallon of Ethanol) of Delivered Feedstock in Beaumont, TX Area (2008-2012)**

Based on Conversion Rate of 90 Gallons per Ton Dry Matter

| 2008 | | Delivered Price/Gallon | | | | 2009 | | Delivered Price/Gallon | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NR/Acre | HS Hay | HS GC | HB | Cane | | NR/Acre | HS Hay | HS GC | HB | Cane |
| $50 | 1.10 | 0.72 | 0.61 | 0.98 | | $50 | 1.0985 | 0.7265 | 0.6112 | 0.9466 |
| $60 | 1.10 | 0.73 | 0.61 | 0.99 | | $60 | 1.1060 | 0.7339 | 0.6186 | 0.9539 |
| $70 | 1.11 | 0.74 | 0.62 | 1.00 | | $70 | 1.1136 | 0.7413 | 0.6260 | 0.9611 |
| $80 | 1.12 | 0.74 | 0.63 | 1.01 | | $80 | 1.1211 | 0.7487 | 0.6334 | 0.9684 |
| | | | | | | | | | | |
| 2010 | | Delivered Price/Gallon | | | | 2011 | | Delivered Price/Gallon | | |
| NR/Acre | HS Hay | HS GC | HB | Cane | | NR/Acre | HS Hay | HS GC | HB | Cane |
| $50 | 1.0978 | 0.7275 | 0.6128 | 0.9441 | | $50 | 1.0887 | 0.7226 | 0.6092 | 0.9361 |
| $60 | 1.1054 | 0.7349 | 0.6202 | 0.9514 | | $60 | 1.0963 | 0.7300 | 0.6166 | 0.9434 |
| $70 | 1.1129 | 0.7423 | 0.6276 | 0.9587 | | $70 | 1.1038 | 0.7374 | 0.6240 | 0.9506 |
| $80 | 1.1204 | 0.7497 | 0.6350 | 0.9659 | | $80 | 1.1114 | 0.7448 | 0.6314 | 0.9579 |
| | | | | | | | | | | |
| 2012 | | Delivered Price/Gallon | | | | | | | | |
| NR/Acre | HS Hay | HS GC | HB | Cane | | | | | | |
| $50 | 1.0776 | 0.7165 | 0.6046 | 0.9266 | | | | | | |
| $60 | 1.0852 | 0.7239 | 0.6120 | 0.9338 | | | | | | |
| $70 | 1.0927 | 0.7313 | 0.6194 | 0.9411 | | | | | | |
| $80 | 1.1003 | 0.7387 | 0.6268 | 0.9484 | | | | | | |