The Evolving Ethanol Industry in the United States

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This paper discusses the likely growth in the production of ethanol from grain in the United States over the next 4 to 5 years. It describes how the costs of production have changed and some of the major factors that are likely to impact profitability and rate of growth in the industry over this period. It discusses co-product production and utilization, and the impact of expanding ethanol production on land use. The final section briefly discusses recent progress in the production of liquid fuels from cellulose.

Growth of Biofuels

Ethanol production has grown rapidly in the United States in recent years, increasing from 3.400 billion gallons in 2004 to 3.904 billion gallons in 2005 and 4.855 billion gallons in 2006 (Renewable Fuels Association). It is expected to grow even more rapidly over the 2007 through 2009 period, increasing from about 6.3 billion gallons in 2007 to 9.8 billion gallons in 2008, and to more than 12 billion gallons in 2009 (Krissek). The Renewable Fuels Association reported that the United States has120 biorefineries with 6.187 billion gallons of annual capacity on line on May 22, 2007. They also list an additional 77 plants and 8 expansions with a total capacity of 6.430 billion gallons as "under construction". Industry contacts confirm the plants under construction will bring ethanol capacity to over 12 billion gallons by September 2008 (Krissek). However, the enthusiasm to invest in a new ethanol plant has waned and major ethanol builders have "open slots" to begin building plants in 2008. The amount of production

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capacity added in each year after 2008 will be highly dependent on the investor's expectations of the industry's profitability at the time they make the investment decision.

Many factors will influence the profitability of the industry, but four appear to be particularly important. They are the policy incentives the Federal Government maintains that stimulate growth of the ethanol industry, the cost of the feedstock, the refiner's acquisition cost of crude oil and the market premium the industry pays for ethanol. These factors are considered below.

Policy

On August 8, 2005, President Bush signed The Energy Policy Act of 2005 into law. This Act included several important provisions for this discussion. 1) The act authorized the renewable fuels standard (RFS) that started at 4.0 billion gallons in 2006, increasing 0.7 billion gallons per year through 2010, and increasing to 7.4 and 7.5 billion gallons in 2011 and 2012, respectively. The RFS also provides that beginning in 2013, EPA must require not less than 7.5 billion gallons of ethanol be used per year of which at least 250 million gallons a year shall be cellulosic derived. 2) The Act eliminated the reformulated gasoline (RFG) 2.0 wt. % oxygenate standard, but it enhanced the air quality standards established in the RFG program. Thus the Act provided more flexibility for refiners, while maintaining the emphasis on improving air quality. 3) The Act continues the federal winter oxygenate program. 4) Perhaps the greatest impact of the Act on short run profitability of the ethanol industry was the provision that did not ban the use of methyl tertiary butyl ether (MTBE) as an oxygenate, but also did not create liability protection or a remediation fund. This caused the petroleum industry to replace MTBE with ethanol in producing reformulated gasoline, expanding the quantity of ethanol demanded at historic prices.

The Energy Policy Act of 2005 also increased the limitation size on the Small Ethanol Producer Credit form 30 to 60 million gallons per year. A credit of $0.10 per gallon of ethanol can be taken on the first 15 million gallons produced per year providing the plant does not produce more than 60 million gallons per year. The tax credit, set to expire 12/31/2010, is capped at $1.5 million per year per producer.

The Volumetric Ethanol Excise Tax Credit (VEET) was passed as part of the American Jobs Creation Act of 2004. It provides a tax refund of $0.51 per gallon of ethanol blended with gasoline payable to the blender. The policy also provides that $0.184 per gallon of ethanol blend fuel is paid to the Highway Trust Fund to help maintain the country's roads. This policy, set to expire 12/31/2010, has a major impact on the ethanol industry's profitability as we will discuss below.

The United States imposes an ad valorem tariff of 2.5% of the product value on imported ethanol. In addition the United States imposes a secondary duty of $0.54 per gallon. The industry argues that the secondary duty is necessary to offset the VEET payment on imported ethanol. Without it the VEET payment would subsidize ethanol production in other countries. However, some countries are exempted from the secondary duty. Some of the bilateral trade agreements, like the North American Free Trade Agreement, permit ethanol to enter the United States duty free provided the ethanol is fully produced with feedstocks from those countries. Congress has also created the Caribbean Initiative and the Andean Trade Preference Act that permit ethanol produced from those countries to enter the United States without paying the secondary tariff. The authority for the $0.54 per gallon duty is set to expire 12/31/2008.

Grain Ethanol Production Costs

The standard ethanol plant being built in the Upper Midwest in 2007 is a natural gas fired plant that processes corn and produces denatured ethanol, dried distillers grains with solubles (DDGS) and CO_2. Most Midwest plants sell two products, denatured ethanol and DDGS, but do not have a market for the CO_2 which is vented. The standard plant has a rail siding and 10 days of storage capacity for corn, ethanol and DDGS. The initial investment includes funds to pay for the legal fees associated with the project, purchase of the building site, obtaining the required permits, developing the water supply, the dirt work, building the plant, starting the plant, and the initial operating capital (usually 10 percent of the total). Some of the newer technologies, such as fractionation, are not commonly included in the new plants being built.

Investment Costs

While this general description of a standard plant has not changed much over the past two years, the investment cost per gallon has increased, the size of the "small plants" being built has increased, and the economies of scale are greater than they were two years ago. In the 2003 through early 2005 period, the standard plant had a nameplate capacity of 40 million gallons per year (mgpy) and produced about 48 mgpy. The size of this "small plant" has increased to 60 mgpy and a much larger proportion of the plants being built are of a larger size. We estimated the investment costs in the 2003 – 05 period to be $1.25 per gallon of annual capacity for a plant producing 48 million gallons per year and

$0.97 per gallon of annual capacity for a plant producing 120 million gallons per year (Tiffany and Eidman, and Nicola). By the end of 2006, these costs had increased substantially. A generic grain ethanol plant producing 60 million gallons per year has investment costs of $1.875 per gallon of output, while a plant producing 120 million gallons per year has investment costs of $1.50 per gallon of annual capacity. Thus, the current initial investment in a 60 million gallon plant is about $112.5 million, and the investment in building a 120 million gallon plant is $180 million. The major reasons for the increase in the initial investment are the higher costs of stainless steel, copper, and concrete; and the additional costs construction firms incur when they must manage a larger number of projects in a given amount of time. These investment costs are expected to be greater if the plant adds additional features , such as fractionation, more storage capacity, or a siding to load and unload unit trains.

Cost Per Gallon

The cost of ethanol production for alternative conditions was estimated with the ethanol success spreadsheet (Tiffany and Eidman).The analysis assumes 2.75 gallons of anhydrous (2.81 gallons of denatured) ethanol and 18 pounds of DDGS are produced per bushel of corn. When corn is $2.00 per bushel, the price of DDGS is assumed to be equal to the price of corn ($0.0357/lb. or $71.43 per ton). The analysis assumes the cost of natural gas is $8.00 per million btus.

The net cost per gallon for the two sizes of plant is shown in Table 1 for alternative prices of corn and two rates of return on equity capital. The breakeven cost (0% rate of return on equity) per gallon when the price of corn is $2.00 per bushel is $1.19 for the smaller plant and $1.14 for the larger plant (Table 1). The larger plant has lower capital, and labor and management costs per gallon, making the difference of about $0.05 per gallon. As the rate of return on equity is increased, the difference in cost between the two sizes of plant increases. At a 12% rate of return on equity, the difference is $.08 per gallon, because the smaller plant requires a larger amount of equity per gallon of capacity. These economies are greater than the $0.035 Nicola found in 2005 because of the higher capital cost. The larger plant may also have lower marketing, transportation and risk management costs per gallon, but no effort was made to quantify those differences. It should be noted that the small producer tax credit of $1.5 million could offset 2.5 of the 4 to 5 cents. Even with this credit, the remaining economies suggest the larger plants have a competitive advantage in producing ethanol for what is a commodity market.

Table 1: Estimated Production Costs for New Construction

	0 % Return on Equity		12 % Return on Equity	
Corn Price $/ Bushel	60 Million Gallons Per Year $/Gallon	120 Million Gallons Per Year $/Gallon	60 Million Gallons Per Year $/Gallon	120 Million Gallons Per Year $/Gallon
2.00	1.19	1.14	1.32	1.24
3.00	1.44	1.40	1.57	1.49
4.00	1.70	1.66	1.83	1.75
5.00	1.96	1.91	2.09	2.00
6.00	2.21	2.16	2.34	2.25

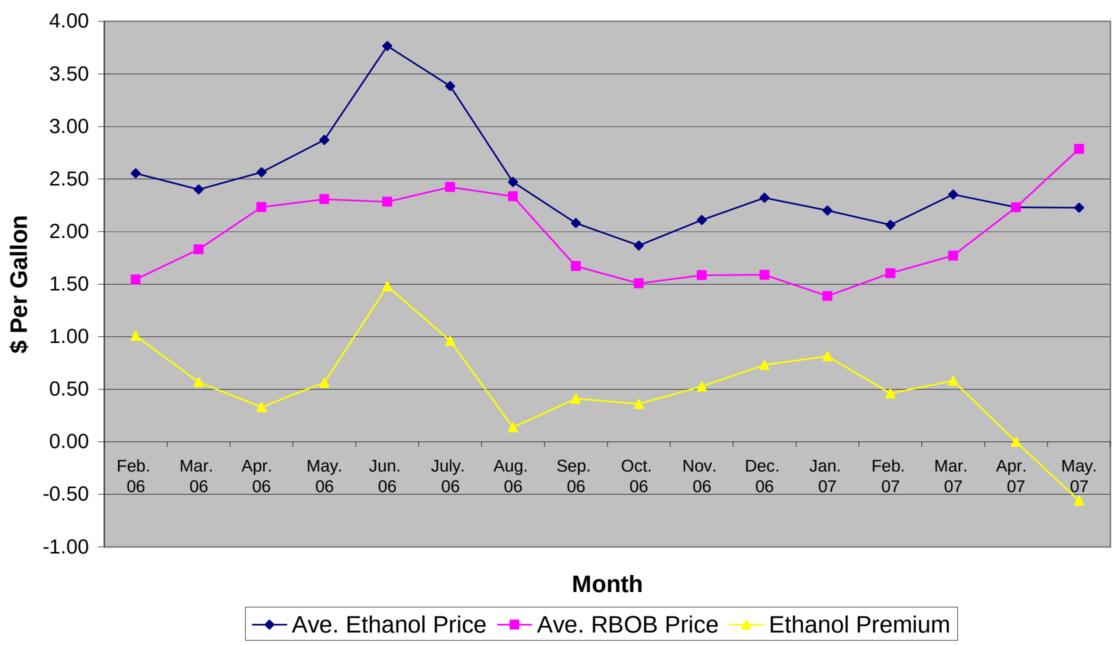
The price of corn has a major impact on the cost of producing ethanol. The net cost of ethanol increases $0.356 as the cost of corn increases $1.00 per bushel if the price of DDGS remains $71.43 per ton. However, the net increase in the cost per gallon is only $0.24 if the price of DDGS increases in proportion to the price of corn. The markets suggest the price of DDGS follows the corn price, but not in proportion. Thus, the net cost per gallon for alternative corn prices in Table 1 assumes the price of DDGS increase by 90 percent of the increase in the corn price. This results in a net increase of $0.256 per gallon of ethanol for each $1 increase in the price of corn.

The cost per gallon is sensitive to many other factors. One of the more important is the price of the boiler fuel. This analysis assumes the plant uses 34,000 Btu per gallon of ethanol produced, and the impact of a $1 change in the price of natural gas is $0.034 per gallon of ethanol. Thus, raising the cost of natural gas from $8 to $10 per million Btu would raise the cost per gallon of ethanol in Table 1 by $0.068.

Ethanol Prices

Denatured ethanol has three attributes that give it value as a motor fuel: the energy content, which is about 2/3 of gasoline; a relatively high octane of 113, enabling it to be used as an additive to enhance octane in gasoline; and a relatively high oxygen content of 33 % by weight making it useful as an additive to produce cleaner burning gasoline. Ethanol has sold at a higher price per gallon than regular gasoline throughout the past decade because of its value as an additive. This premium reached an all time high during 2006 as petroleum companies replaced MTBE with ethanol in most reformulated gasoline. The U.S. ethanol industry expanded rapidly in an effort to supply the surge in demand, but record ethanol prices were recorded as the industry worked its way through this transition period. The average monthly ethanol and RBOB[2] price per gallon for Chicago is shown in Figure 1. The average monthly ethanol premium in Chicago peaked at $1.48 per gallon in June 2006 and averaged $ 0.64 during that calendar year. The ethanol premium declined during the first quarter of 2007 as the domestic supply of ethanol increased. The premiums for April and May are difficult to interpret because unexpected interruptions of refinery operations (due to forced maintenance and fires) resulted in lower inventories of RBOB, raising the price above the level implied by the refiner acquisition cost of crude oil. Inventories of RBOB are expected to return to more normal levels by the end of the summer of 2007, returning the markets for ethanol and RBOB to a more normal relationship.

Figure 1. Monthly Average Ethanol and RBOB Prices at Chicago
February 2006 through May 2007

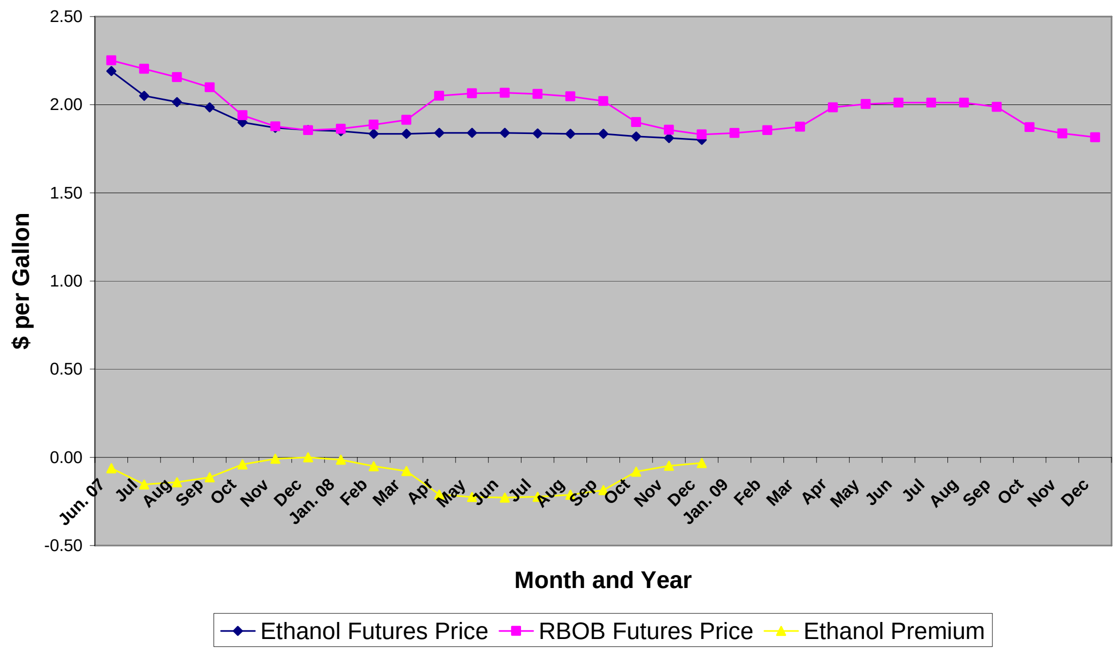


[2] RBOB is the acronym for reformulated gasoline blendstock for oxygen blending. RBOB is the wholesale blendstock that is suitable for the addition of ethanol at the truck rack.

As the domestic ethanol industry expands production above 6 billion gallons per year, the demand for ethanol as an oxygenate is expected to be met and the ethanol premium is expected to decline. The domestic industry reached this production level during May 2007, and the futures markets reflect a much different relationship between ethanol and RBOB than the industry has experienced historically. Figure 2 compares the May 31, 2007 futures settle price of RBOB and ethanol for June 2007 through December 2008. Notice that the ethanol price declines throughout this period. The declining prices for RBOB for June through August reflect the expected increase in inventory levels of RBOB. The data from September 2007 through August 2009 display the expected seasonal pattern for RBOB, with higher prices during the period refiners are producing gasoline for the driving season (April through September) and lower prices during the remainder of the year. The data also indicate that the monthly futures price of RBOB exceeds the futures price of ethanol over the next marketing year for corn, September 2007 through August 2008. In contrast to the large premium paid for ethanol during 2006 and early 2007, the average ethanol premium implied by these two series of futures prices is \$-0.117 per gallon during September 2007 through August 2008. The average futures prices for ethanol from September 2007 forward are approximately equal to the value of the btu content, 2/3 of the RBOB price, plus the ethanol excise tax credit of \$0.51 per gallon.

This analysis suggests we should evaluate the profitability of the industry for the foreseeable future based on the value of its btu content plus the excise tax credit with little if any ethanol premium. The resulting annual average RBOB and ethanol prices for alternative levels of crude oil prices are given in Table 2. The ethanol energy value is 2/3 of the RBOB price and increases as the price of crude oil increases. Adding the constant excise tax credit of $0.51 per gallon, however, results in a price of ethanol that is greater than RBOB at $40 per barrel, about equal at $50 per barrel, and less as the price of crude oil moves to higher levels.

Figure 2. Ethanol Premiums Implied By Futures Markets June 2007 Through December 2009



How Much Can Ethanol Plants Pay for Corn?

There has been a great deal of concern about the ability of dry grind ethanol plants to compete for corn, raising the price of corn in world markets. Livestock and poultry producer associations have recommended an end to ethanol subsidies, particularly the elimination of the ethanol excise tax credit. Environmental groups and those focused on reducing world hunger have raised concerns about subsidies for ethanol because of its impact on environmental externalities of producing more corn, and the impact on world food prices. How much can ethanol plants pay for corn and how would eliminating the ethanol excise tax credit change that amount?

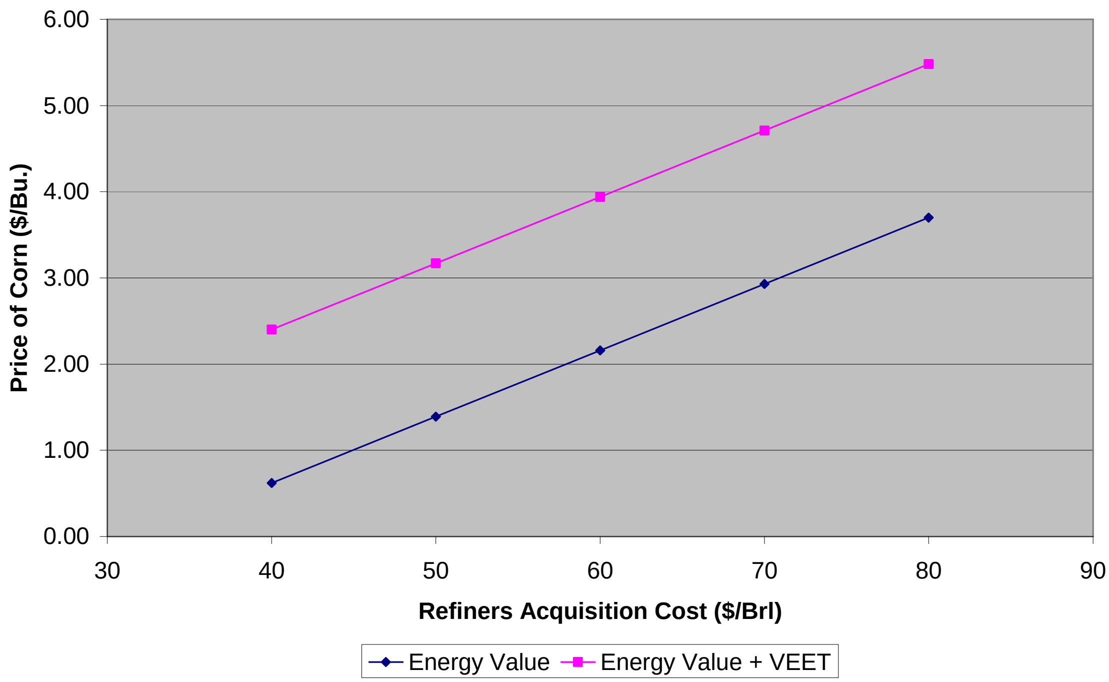
The amount a 60 million gallon ethanol plant can pay for corn and achieve a 12 % rate of return on equity is shown in Figure 3. The graph indicates a new plant selling at the energy value of ethanol could pay $2.16 per bushel and have a 12% rate of return

Table 2: Estimated Average Wholesale RBOB Price and Corresponding Ethanol Prices

Refiners Acquisition Cost $/Barrel	Wholesale RBOB Price $/Gallon	Ethanol Energy Value $/Gallon	Ethanol Energy Value plus Excise Tax Credit $/Gallon
40	1.24	0.83	1.34
50	1.54	1.03	1.54
60	1.84	1.23	1.74
70	2.14	1.43	1.94
80	2.44	1.63	2.14
Average RBOB Price $/Gallon = 0.0370 + 0300* Price Crude Oil/Brl.			

on equity. Selling at the energy value plus the excise tax credit the plant would achieve a 12 % rate of return when corn reached $3.94 per bushel. As Figure 3 illustrates, the amount a plant can pay is sensitive to any differences in the cost of producing ethanol and to the price the plant receives. For example, a 120 million gallon plant has production costs that are $0.08 less per gallon, and it could pay $0.31 more per bushel and achieve a 12% rate of return. Similarly, a $0.10 increase (decrease) in the price a plant receives per gallon of ethanol sold will increase (decrease) the amount a plant can pay for corn $0.38 per bushel. An ethanol premium would increase the amount a plant could pay, while the cost of marketing and transportation to move ethanol from the plant to the market could decrease the price the plant receives.

Figure 3. Corn Price Resulting in a 12% Return to Equity



The price of crude oil has a major impact on the amount an ethanol plant can pay for corn. If the plant is receiving the energy value for the ethanol, it could pay $0.62 per bushel for corn when the price of crude oil is $40 per barrel, increasing to $3.70 per bushel when crude oil costs $80 per barrel. Given the historic corn prices in the United States, these data suggest the industry would not be very competitive for corn when the price of oil is less than $60 per barrel. A plant receiving the energy value plus the ethanol excise tax credit could pay $2.40 per bushel when oil is $40 per barrel, increasing to $5.48 per bushel when crude oil is $80 per barrel.

Co-Product Production and Utilization

The production of co-product feeds is expanding in parallel with the increase in ethanol. Dry grind facilities process 80.5% of the corn used to produce ethanol, while wet milling processes the remaining 19.5%. Each bushel of corn processed by dry grind facilities produces 17.5 pounds of distillers dried grains with solubles (DDGS), while wet milling produces 12.4 pounds of corn gluten feed, 3.0 pounds of gluten meal, and 1.57 pounds of corn oil. The current combination of wet and dry grind facilities produce 2.76 million metric tons per billion gallons of ethanol. If the industry produces 6.4 billion gallons of ethanol in 2007, it will also produce over 17 million metric tons of co-product feeds. Increasing annual ethanol production to 12 to 14 million gallons will boost co-product feed production to 33.1 to 38.6 million metric tons.

As ethanol prices decline and ethanol plant managers search for ways to increase revenue, they are likely to adopt some new technologies that will enable them to produce a wider range of outputs from the corn they process. These technologies reduce the amount of co-product feeds that are produced by dry grind ethanol plants. Removal of the corn oil from thin stillage and using the corn oil as feedstock to produce biodiesel may be one way to increase the revenue per bushel of corn processed. Adoption reduces the amount of DDGS per bushel to about 16 pounds and reduces the fat content. If all dry grind ethanol plants adopted this technology the aggregate output of the co-product feeds would be reduced from 2.76 to 2.56 million metric tons per billion gallons of ethanol.

A second technology that may alter the amount and composition of co-product feeds produced is fractionation. Fractionation will enable the plant to convert 4 pounds of pericarp and the starch to ethanol, capture the oil for biodiesel or other uses, and produce about 11.9 pounds of higher protein feed. If all dry grind ethanol plants adopted fractionation, it would reduce the co-product feed output from the current combination of wet mill and dry grind plants from 2.76 to about 2.04 million metric tons per billion gallons of ethanol. The adoption of these technologies will result in a wider array of co-products and reduce the total quantity.

The major use of these co-products is for livestock feed and the potential market appears to be expanding. Animal nutritionists are exploring the value of wet (WDGS) and dry distillers grains and exploring how feeding higher amounts affect performance and quality of the different species. They are also finding DDGS are a good supplement for lower quality feeds like corn stover, grasses and straw in feeding ruminant animals that are not being fed for maximum production (dry dairy cows, beef cows and heifers). In 2006 Cooper reported that feeding the maximum recommended rate (20% of dry mater for dairy and swine, 40 % for beef, and 10 % for poultry) to the nation’s grain consuming animals would utilize 3.8 million metric tons for dairy, 18.4 million metric tons for beef, 8.7 million metric tons for pork, and 5.7 million metric tons for poultry, a total of 36.6 million metric tons per year. In 2007 Klopfenstein and Erickson estimated potential use by dairy to be 16 million tons, while beef, swine and poultry could use 39, 8.7 and 6.9 million tons, respectively, for a total of 70.6 million metric tons per year. Of course not all livestock in the country have access to a low-priced source of wet and dry DGS, which suggests the adoption rate will be much less than 100%. However, the recent estimates indicate the domestic industry will provide a growing market for these co-product feeds as ethanol production expands.

The quantity of DDGS exported by the U.S. declined from 1.8 million metric tons in 2005 to 1.5 million metric tons in 2006, a decline of about 16%. The amounts exported in 2006 went primarily to the European Union (8%), Canada (37%), Mexico (15%), and Asia (20%). Sales to Canada and the European Union increased during 2006, while sales to Mexico declined.

In addition to feed uses, non-feed uses of DDGS are being developed. Plants are experimenting with burning the thin stillage, or the distillers grains, or both to provide process heat in ethanol plants. Other plants are experimenting with gasification of the DDGS to produce syngas either to substitute for natural gas in fueling the plant or for use as a feedstock to produce more ethanol. Other proposed uses are to produce wallboard and other construction materials, and for use as fertilizer.

Given that the DDGS are located at the ethanol plant and that natural gas prices are a major uncertainty in managing an ethanol plant, it appears that combustion and producing syngas will provide a floor for DDGS prices. Livestock feeding and exports will need to bid the DDGS away from the plant after this technology becomes commercially available. The industry may go through some periods of excess supply of DDGS during the rapid expansion, but low prices are likely to lead to rapidly expanded use, making the low price periods relatively short.

Impact on Land Use

The projected ethanol production by calendar year presented earlier in this paper was used to estimate the ethanol production and corn use by corn marketing year

(September of the crop production year through August of the following year). The projections increase from 6.0 billion gallons in the current year to 12.5 billion gallons in 08/09 (Table 4). The rate of increase in the last two years shown depends on investors' expectations about future profitability. The projections of corn production and use shown here suggest the average farm level price of corn will remain under $3.50 per bushel. If that occurs, building additional capacity is expected to be profitable and the industry will continue expanding. I have projected increases of 0.5 billion gallons per year for each of the last two years, bringing production to 13.5 billion gallons in 2010/11. The acres of corn planted in 07/08 are from the June Acerage report (USDA, 2007c). The acres planted in future years were calculated to produce enough corn to meet all projected uses and provide carryovers sufficient to keep average farm level corn prices below $3.50 per bushel. Long-run trend line yields were assumed in calculating corn production. While many have suggested corn yields will increase more rapidly, the dramatic increase in planted acres in 2007 is being achieved by shifting land from a corn-soybean rotation to continuous corn and by planting corn on acres (taken out of cotton and rice) that are expected to have lower corn yields. These changes will tend to pull down the average corn yield, making achievement of trend line yields over the next several years a challenge. The percentage of the corn crop used in ethanol production, shown in the last line of Table 4, is projected to increase from 20.4 % in 2006/07 to 35.9% in 2010/11.

The increase in corn acreage will result in a significant reduction in soybean production in 2007/08 and beyond. The USDA June Acreage report estimates that planted acreage is down about 15% in 2007 from 2006, and that more of the soybean acreage in 2007 is double crop production and plantings in areas where yield tends to be below the U.S. average. These observations suggest production may be down more than 15%. The USDA Baseline projects that soybean acreage will decrease by modest amounts as corn acreage increases over coming years (USDA, 2007a). The report also projects that soybean oil needs can be met by increasing the amount of the crush over time as the domestic demand for soybean oil grows. This results in lower exports of soybeans, and soybean oil in future years, but increasing exports of soybean meal.

Table 3. Projected Ethanol Production and the Corn Acreage Required to Supply Projected Uses

Crop Marketing Year	06/07	07/08	08/09	09/10	10/11
Projected Ethanol Production (Bill. Gal)	6.00	9.5	12.5	13.0	13.5
Corn For Ethanol Production (Bill. Bu.)	2.150	3.393	4.464	4.643	4.821
Corn Yield per Harvested Acre (Bu.)	149.1	150.3	152.6	154.5	156.4
Acres of Corn Planted (Million Acres)	78.3	92.9	92.9	93.4	93.4
Acres of Corn Harvested (Million Acres)	70.6	85.4	85.4	85.8	85.8
Production (Billion Bushels)	10.535	12.836	13.032	13.256	13.419
Ethanol Use/Production (Percent)	20.4	26.4	34.3	35.0	35.9

Cellulosic Ethanol

There are currently several pilot plants around the country to produce cellulosic ethanol, but there are currently no commercial sized plants. Several companies claim to have a process that can produce cellulosic ethanol at a competitive cost to grain ethanol, but no company has been willing to finance the first commercial plant and no commercial lender has been willing to provide the capital to build a plant based on unproven technology.

Earlier this year the Department of Energy announced an agreement to invest $385 million in six biorefinery projects over the next four years. Combined with the industry share, $1.2 billion will be invested in six refineries. When fully operational, the six biorefineries are expected to produce 130 million gallons of cellulosic ethanol per year. The investment costs are quite high per gallon of capacity because these are development projects.

The six biorefineries, selected from a larger group of proposals for the government funding, are listed in Table 4. The six plants are located across the country and plan to use a wide range of cellulosic feedstocks.

Some of the plants will use biochemical processes, some will use thermochemical processes, and one will use both. Biochemical methods require an initial process to separate hemicellulose and cellulose from the lignin. Enzymes are used to convert cellulose to sugars, which are fermented to produce ethanol. The lignin and any unconverted cellulose and hemicellulose are used to produce steam for plant heat and to generate electricity. Each of the biochemical plants have a somewhat unique process using their patented enzymes, which should provide data on the relative efficiency and other advantages and disadvantages of the several processes.

Thermochemical processes gasify the biomass to produce syngas and the syngas is used either to replace natural gas as a boiler fuel or as a feedstock to produce ethanol. Ethanol can be produced either using Fisher-Tropsch processes or using a biological path by offering the synthesis gas to selected bacteria (Bredwell, Srivastava and Worden, and Spath and Dayton).

These six projects cover a broad range of feedstocks and variations in the two general types of technology that have been discussed in the literature. Notice that most of the plants are not scheduled to become operational until 2010 and 2011, indicating this process will take some time. It will probably take an additional couple of years to tweak

Table 4.Commercial Cellulosic Plants Being Partially Funded By DOE

Company	Location	Feedstock	Technology	Plant Completion
Abengoa Bioenergy	Colwich, KS	Corn stover, wheat straw, milo stubble, switchgrass	Thermochemical & Biochemical	2011
ALICO	LaBelle, FL	Yard, wood & vegetable waste	Thermochemical	2010
BlueFire Ethanol	Corona, CA	Green waste & wood waste from landfills	Biochemical	End of 2009
Broin	Emmetsburg, IA	Corn fiber, cobs & stalks	Biochemical	2010
Iogen	Shelley, ID	Wheat, barley & rice straw, corn stover, switchgrass	Biochemical	2010
Range Fuels	Treutlin Co. GA	Wood residues & wood based energy crops	Thermochemical	2011

and adjust the processes to improve efficiency, and hopefully some of the technologies will prove to be commercially feasible. For those that are considered commercially feasible, two additional years will be required to build a second version of the plant to verify the investment and operating costs before construction of multiple plants using a given technology can begin. This scenario suggests we should not expect to have more than about 400 million gallons of cellulosic ethanol produced per year before 2015.

In addition to the government subsidized construction, some other companies are indicating they will move ahead to build commercial cellulosic ethanol plants. For example a California company, Colusa Biomass Energy Corporation, announced they will bring their first 12.5 million gallon plant on line in California in 2008 to produce ethanol from rice straw. They plan to build 10 additional plants of the same size by 2012, 2 in California, 4 in Arkansas and 4 in Texas. All are to produce ethanol from rice straw.

These developments are very important steps in the development of a cellulosic ethanol industry. It is particularly noteworthy that major companies in the ethanol industry are making sizeable investments in these developmental plants, suggesting we should learn a great deal about the ability to produce cellulosic ethanol at competitive costs with ethanol from starch and sugar within the next 5 to 7 years.

Concluding Comments

The dramatic increase in U.S. ethanol production over the next two years is expected to decrease the ethanol premium and profitability of ethanol plants. Lower rates of return on invested capital are expected to pressure managers to increase revenue. Experimentation with several new technologies may provide possibilities to raise revenues and reduce/control costs. These include removal of corn oil from thin stillage for sale to the biodiesel industry, fractionation, and using DDGS and biomass for boiler fuel to reduce and stabilize costs. We can expect to see increasing of all of these technologies over the next several years.

Periods of lower profitability that follow several years of rapid growth in an industry are often characterized by a wave of consolidations that are intended to reduce management, marketing, transportation, financing and risk management costs. Many industry observers speculate that the ethanol industry is entering such a period and that consolidation will reduce local ownership of the ethanol production industry. Farmers currently own 49 of the 120 ethanol plants with 34% of industry capacity (Renewable Fuels Association). Of the 85 plants under construction, 13 with 12% of the capacity are owned by farmers. Thus the industry is moving to less local ownership as it builds new facilities, and any consolidation of farmer owned plants is likely to reduce it even more.

Against this backdrop Congress is debating the appropriate policy measures to support development of the industry. Proposals include providing funding for loan guarantees used to help pay for development, construction and retrofitting of biofuel projects; funding for research and development of systems to produce and deliver cellulosic crops to conversion facilities; funding to study the feasibility of dedicated ethanol pipelines; and legislation to increase the availability of E 85 pumps across the country. A provision to allow production of cane and beat sugar for ethanol feedstock is being considered. This proposal would set marketing allotments “for domestic human consumption” of sugar, allowing the production of sugar “for other than domestic human consumption.”

Congress must also decide whether to extend the secondary tariff on imported ethanol. The current authorization ends 12/31/2008. It is also debating whether to increase the RFS, requiring the petroleum industry to purchase a larger quantity of ethanol. Finally, it must decide whether to extend the volumetric ethanol excise tax credit by the close of 2010. Decisions on each of these policies will impact future profitability and the rate of growth of the industry after 2009.

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