Economic Issues with Ethanol

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Increased ethanol production is an important topic of discussion across the United States and especially in the Midwest. The increased price of crude oil and the decreased price of farm commodities are the driving forces behind this interest. Along with these two important drivers, the proposed elimination of methyl tertiary butyl ether (MTBE), ethanol's main competition, has increased the apparent demand for ethanol in the coming years.

The passage of the Clean Air Act amendment in 1990 promoted the use of ethanol. Ethanol is used primarily as an oxygenate and an octane enhancer for midgrade fuel blends. It is also used to extend the supply of gasoline refined from petroleum. Ethanol commonly is blended at a ten percent rate with gasoline in fuel. Renewable energy sources, including ethanol, will become vital for a fuel supply source as the worldwide petroleum supply diminishes.

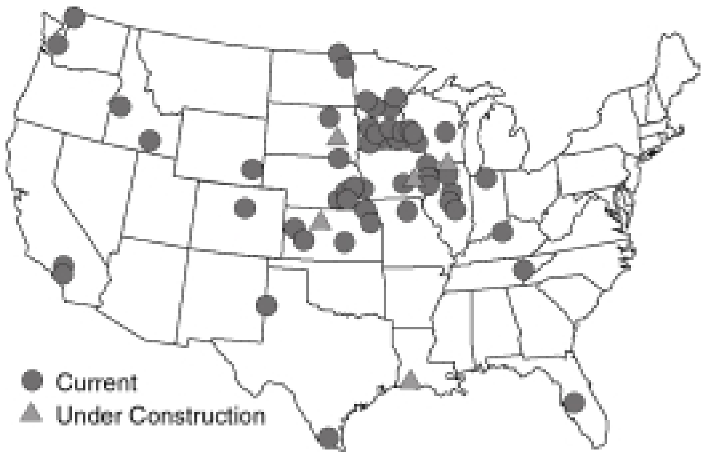
A concern with ethanol production in the past has been the belief that more total energy is used to produce ethanol than the amount of energy available in ethanol. A report from the USDA Economic Research Service Office of Energy shows this concern is unfounded and concludes that the net energy value of corn has a positive energy ratio of 1.24 due to technological advances in ethanol conversion and increased efficiency in farm production (Shapouri, et.al).

Another concern is that ethanol creates problems in engines. The Clean Fuels Development Coalition reports that all automobile manufacturers approve the use of ethanol in gasoline blends. Nearly all small engine manufacturers also approve the use of ethanol-blended fuel (Ethanol Fact Book).

Ethanol Production

There are currently 56 ethanol-producing plants in the United States with a capacity of nearly two billion gallons of ethanol produced per year. Most of these plants are located in the Midwest, although some are scattered across the country. Figure 1 shows the location of ethanol plants in the United States.

Figure 1: Ethanol Plants in United States



Source: Ethanol Producers and Consumers (www.ethanolmt.org/)

Table 1 lists the ethanol plants that are farmer-owned cooperatives. Many of these are in Minnesota and began producing ethanol in the mid-1990s. The production capacity is listed in million gallons per year (MGPY).

Table 1: Farmer-owned Ethanol Cooperatives

	State	MGPY		State	MGPY
Adkins Energy	IL	30	Golden Cheese	CA	3
AGP	NE	52	Golden Triangle	MO	15
Agri-Energy	MN	15	Heartland Corn Proc.	MN	10
Al-Corn	MN	17	Heartland Grain Fuel	SD	8
Central Minnesota	MN	15	Minnesota Corn Proc.	MN	32
Chippewa Valley Ethanol	MN	17	Minnesota Corn Proc.	NE	80
Corn Plus	MN	18	Minnesota Energy	MN	12
DENCO, LLC	MN	8	NE MO Grain Proc.	MO	15
Ethanol 2000	MN	15	Pro-Corn	MN	10
Exol, Inc	MN	15	Sunrise Energy	IA	5

Kansas currently has four established facilities that have been producing ethanol for a number of years. Their locations and production capacities are detailed in Table 2. Another ethanol plant, which began construction in Russell during 2001, has a projected production of 25 million gallons per year.

Table 2: Kansas Ethanol Plants

Midwest Grains	Atchison	15 MGPY
High Plains Corporation	Colwich	20 MGPY
Reeve Agri-Energy	Garden City	10 MGPY
ESE Alcohol	Leoti	1 MGPY
U.S. Energy*	Russell	25 MGPY
*Began construction in 2001		

The projected demand for ethanol might double or even triple by 2010 from the current amount produced. Ethanol facilities are expanding production to meet this demand. Currently, 34 of the existing ethanol plants are expanding their facilities, 10 plants are being constructed, 16 plants have approved construction and 25 plants are scheduled to begin construction in the next two years (Renewable Fuels Association).

Processing Ethanol

Two methods are currently used to produce ethanol from grain, wet milling and dry milling. Dry mills produce only ethanol, distillers grain and carbon dioxide. Wet mills also can produce corn syrup, high fructose corn syrup, corn starch and corn oil as well as other products. This means that the co-products produced with ethanol in a wet mill can have more value. The advantage of dry mills is that they are significantly less expensive to build and have similar operating costs. All ethanol plants in Kansas are dry mill facilities and most of the proposed plants in the U.S. will be dry mills.

Economic Output Factors

There are three potential output products produced from ethanol dry mills: ethanol, distillers grain and carbon dioxide. The price of ethanol and the relationship ethanol has with the wholesale gasoline market are the most significant factors for profitable ethanol production. However, the co-product produced with ethanol, distillers grains, is an important part of the total profitability of an ethanol plant. The marketing of distillers grains often determines how much profit an ethanol facility earns. A third product produced in ethanol plants, carbon dioxide, contributes very little towards profitability.

Ethanol

The price of ethanol is the most important factor when considering the profitability of an ethanol production facility. High ethanol prices up to the $1.77 per gallon received in January 2001 make substantial profits attainable. Only extremely high grain prices, such as the $5.00 per bushel price for grain in 1996, can cause significant losses in ethanol production when the price of ethanol is $1.77. Returns on investment approaching 50 percent are possible with low priced grain and $1.77 ethanol.

Table 3 shows the monthly average price of ethanol FOB Omaha, Nebraska.

Table 3: Monthly Ethanol Prices, FOB Omaha, Nebraska

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Omaha Average	US Average
1990	1.26	1.23	1.21	1.26	1.29	1.29	1.26	1.52	1.56	1.55	1.50	1.30	**$1.35**	**1.26**
1991	1.30	1.23	1.25	1.28	1.33	1.27	1.24	1.28	1.21	1.24	1.33	1.28	**$1.27**	**1.18**
1992	1.22	1.24	1.29	1.32	1.37	1.41	1.35	1.36	1.41	1.38	1.33	1.26	**$1.33**	**1.28**
1993	1.14	1.23	1.20	1.21	1.19	1.14	1.09	1.12	1.12	1.16	1.11	1.16	**$1.16**	**1.10**
1994	1.13	1.16	1.13	1.12	1.12	1.19	1.25	1.32	1.26	1.21	1.22	1.18	**$1.19**	**1.14**
1995	1.25	1.27	1.19	1.16	1.12	1.08	1.08	1.10	1.11	1.11	1.12	1.16	**$1.15**	**1.14**
1996	1.22	1.23	1.23	1.30	1.37	1.38	1.40	1.54	1.56	1.51	1.30	1.16	**$1.35**	**1.37**
1997	1.13	1.13	1.13	1.14	1.16	1.08	1.09	1.15	1.19	1.19	1.19	1.18	**$1.15**	**1.20**
1998	1.16	1.14	1.04	0.96	0.95	1.01	1.06	1.10	1.12	1.10	1.06	0.94	**$1.05**	**1.08**
1999	0.94	0.95	1.01	0.96	0.95	0.90	0.95	0.95	0.96	0.98	1.09	1.13	**$0.98**	**1.01**
2000	1.10	1.14	1.14	1.19	1.25	1.35	1.33	1.33	1.48	1.49	1.66	1.72	**$1.35**	**1.35**
2001	1.77	1.70	1.51	1.46	1.76	1.63							**$1.64**	
										1990-99 avg.			**$1.20**	**1.19**

The price of ethanol typically increases and decreases as it follows after the wholesale price swings of wholesale unleaded gasoline. Since ethanol has a federal excise tax exemption, the wholesale price of ethanol is usually about 50 cents above the wholesale price of gasoline. Figure 2 shows the average monthly price differences between ethanol and gasoline. The tax exemption for using ethanol is a credit fuel blenders receive for using ethanol in gasoline. The market price for ethanol is usually based on the gasoline price plus the blender's credit.

Figure 2: Price Differences Between Ethanol and Wholesale Unleaded Gasoline

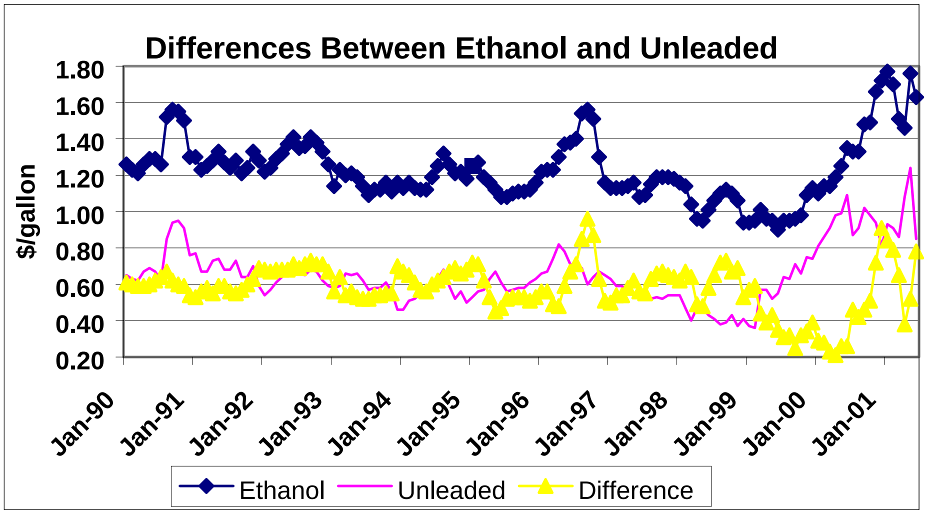
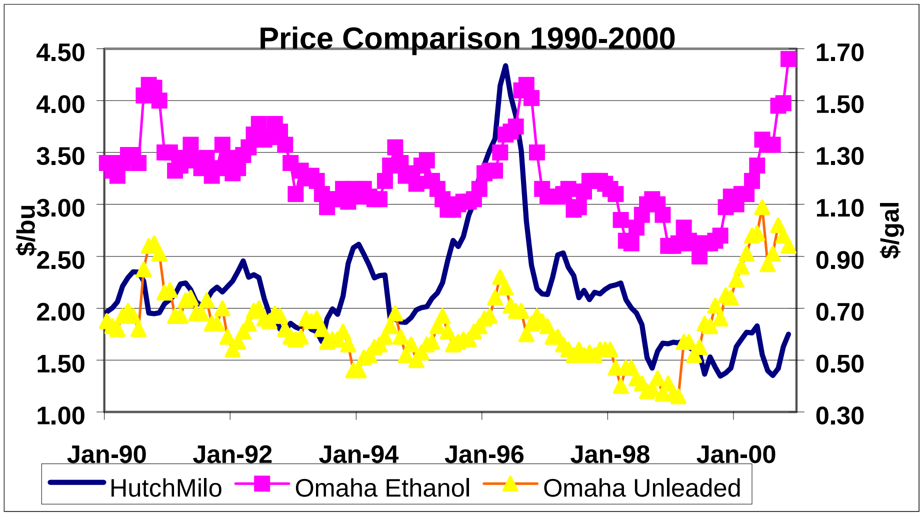


Figure 3 shows the relationship of ethanol, gasoline and the grain sorghum price. This figure shows that the price of ethanol rarely responds to the price of grain. An exception was in 1996 when grain prices were extremely high and the price of ethanol increased. Many ethanol plants stopped production when grain prices increased and the demand for ethanol exceeded the production supply.

Figure 3: Price Comparison Between Ethanol, Gasoline and Grain Sorghum



Distillers Grain

Distillers grain is produced as a co-product in ethanol production. The variety of decisions regarding the production and marketing of distillers grains are very important for ethanol-producing plants. A large quantity of distillers grain is produced each day and this is important both from a profitability standpoint and from a logistics standpoint. A 30 million gallons per year (MGPY) ethanol plant produces about 94,000 tons of dried distillers grains and solubles (DDGS) per year, which is nearly 270 tons every day. This amount requires about 180,000 head of livestock eating three pounds each day to consume all the DDGS produced. The maximum recommended amount of DDGS to feed is ten pounds per day and most feedlot managers prefer to feed closer to three pounds per day. Dairy, swine and poultry enterprises are other possible markets for DDGS.

DDGS is a 28 percent protein product that can be used as either an energy source similar to grain or as a protein source to replace some soybean meal. The price of DDGS is dependent on both grain and soybean meal markets.

If distillers grains are not dried, they are referred to as wet distillers grain (WDG). This product has interesting implications for profitable ethanol production. By not drying distillers grains, the total amount of natural gas used by an ethanol plant will be cut nearly in half. When natural gas price is high, this savings can be significant. On a 30 MGPY plant with natural gas costing $5.00, the savings from using half as much natural gas could be $4.7 million per year. Feedlot managers report that WDG is an excellent feed source that cattle readily prefer in their rations. However, a drawback to WDG is its three day shelf life during warm weather and a six day shelf life the rest of the year. WDG also is one-third dry matter and two-thirds water, making it feasible to transport WDG only about 60 miles from the ethanol production facility. If the distillers grains can all be marketed as WDG, capital construction costs can be significantly reduced by not installing dryers. However, most ethanol facilities invest in drying equipment because of the quantity of distillers grains produced. It could be risky to depend on marketing WDG everyday.

Carbon Dioxide

Large quantities of carbon dioxide are produced as a co-product during ethanol production. However, the profitability of capturing and marketing the carbon dioxide is very low. Only an easily accessible market warrants installing equipment to capture the carbon dioxide that can be produced. Even with an accessible market, the profitability of selling carbon dioxide is minimal because of the cost of installing specialized equipment.

Economic Input Factors

The major economic factors to consider for input costs of ethanol production are feedstock and energy related. The type, availability, and price of grain all factor into the profitability of producing ethanol. The energy costs include the price of natural gas and electricity, with natural gas being more critical for profitability.

Intermediate economic factors include the cost of labor both in operating expenses and administrative costs. These costs are directly related to economies of size for ethanol plants. The total cost of capitalization of the ethanol facility is also directly based on the facility size. The interest rate on borrowed debt and debt to equity ratio are intermediate economic factors to consider for ethanol production. Finally, transportation is another intermediate factor of concern.

Other minor economic input factors to consider include the cost of chemicals and enzymes, fresh water, waste effluent and denaturant. Minor economic concerns have little to do with either the location of a plant or the economies of size associated with large plants.

Grain Factors

Any type of grain containing starch can be used to produce ethanol. Corn is the grain of choice with over 95 percent of the ethanol produced in the United States using corn. In certain areas, grain sorghum, wheat and barley are also used for feedstocks. Out of condition grain, which is often significantly lower priced than premium grades of grain, may even be used in ethanol production.

Grain Price

The price of grain is by far the most important cost for ethanol production. When grain is priced low, ($1.60 per bushel), the grain feedstock price contributes about 50 percent of the total expenses. If grain is priced higher at $3.20 per bushel, the feedstock price will be almost 70 percent of total expenses. A $0.25 increase in the price of grain in a 30 MGPY ethanol facility increases expenses by about $3 million per year.

Figure 4 shows the historic price data for corn and grain sorghum from selected locations across Kansas. Figure 5 shows the historic price data from the National Agricultural Statistics Service. In Kansas, according to historical data, the lowest priced grain is usually in the northwest part of the state.

Figure 4: Selected Spot Grain Prices

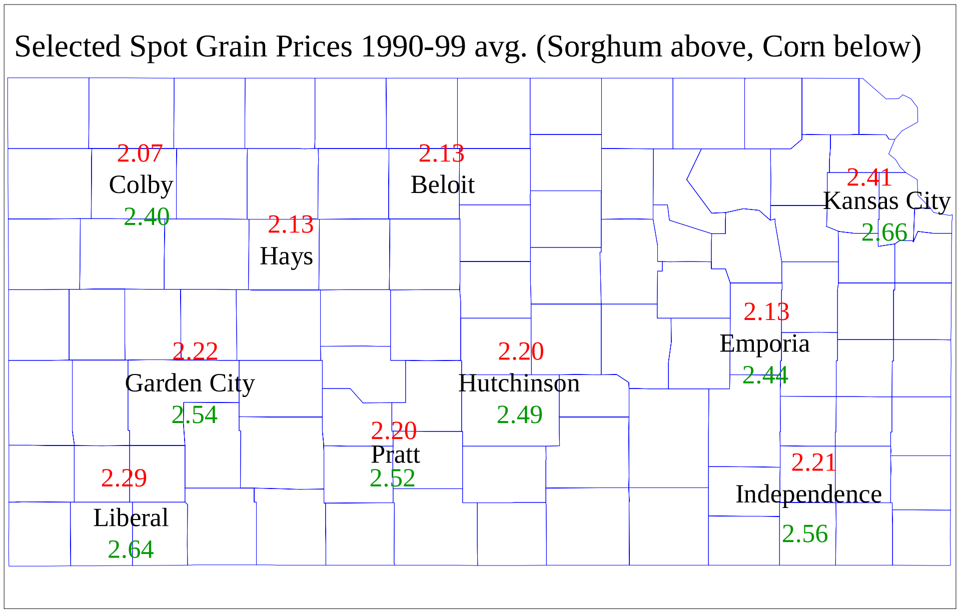
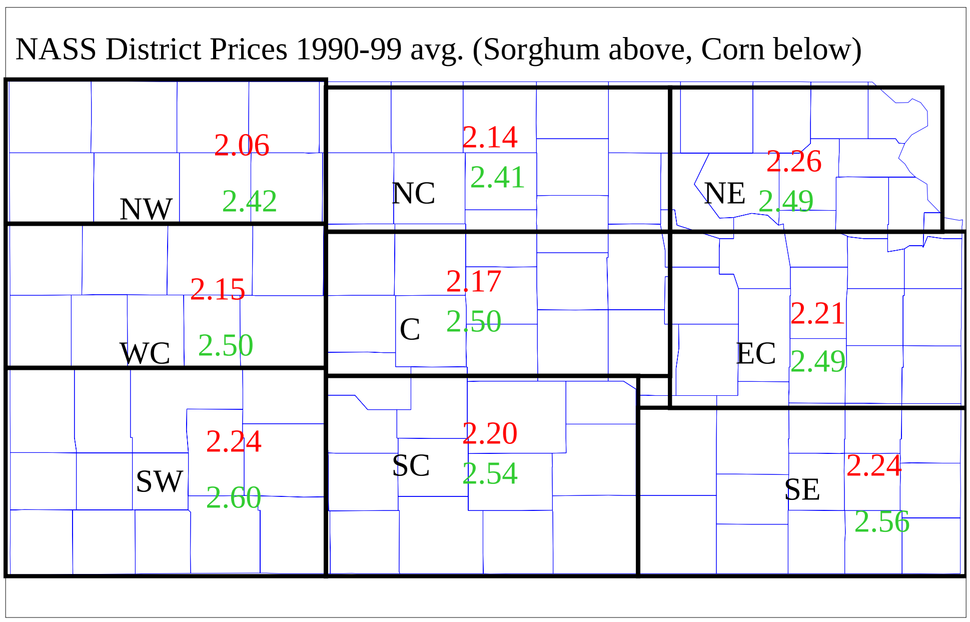


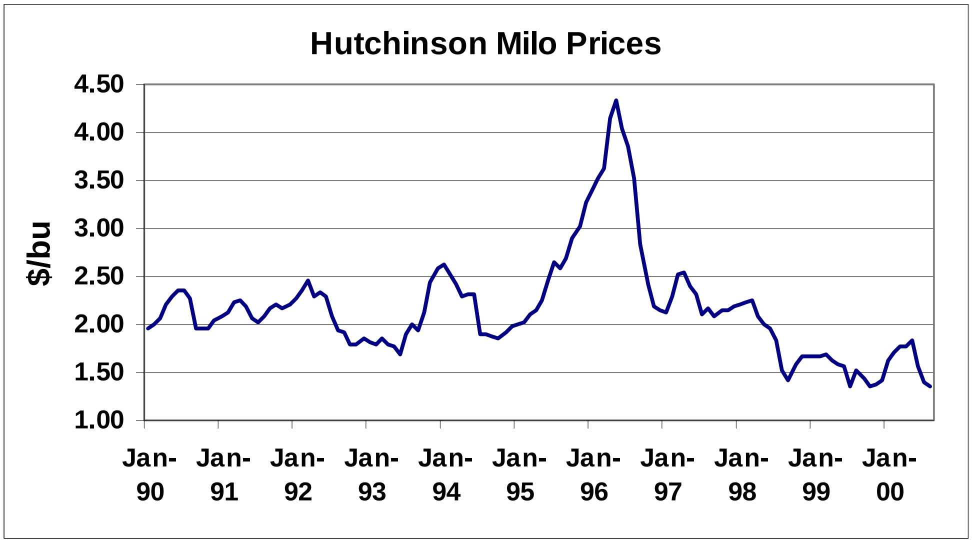
Figure 5: NASS District Prices



Source: National Agricultural Statistics Service

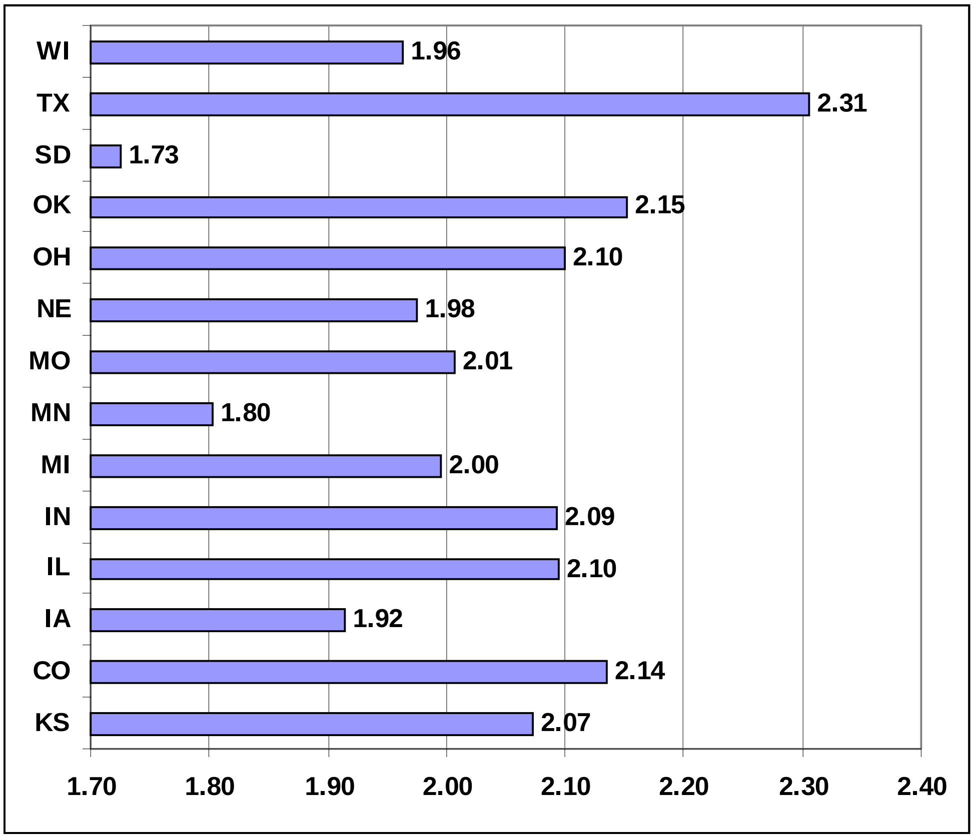
The price of grain sorghum in Kansas is generally discounted relative to the price of corn. The price difference from 1980 through 2000 was 36 cents per bushel premium for corn, which amounts to grain sorghum averaging 86 percent the price of corn (Hamman, Dhuyvetter, Boland). Figure 6 shows the monthly grain sorghum prices in Hutchinson from 1990 to 1999.

Figure 6: Monthly Price Averages for Hutchinson Grain Sorghum



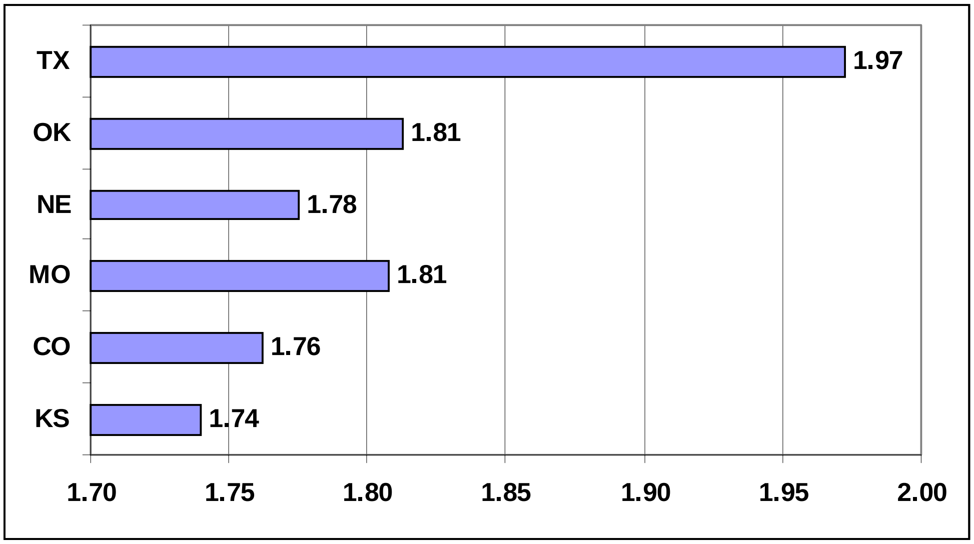
Figures 7 and 8 show the historical price for corn and grain sorghum in selected states from 1997 to 2000. It should be noted that these are average prices across each state. Often the prices within the different state districts vary greatly. Average Kansas corn price of $2.07 per bushel is higher than many other states. However, Kansas grain sorghum price of $1.74 per bushel is the lowest price in the U.S.and is similar in price to South Dakota's lowest priced corn ($1.73).

Figure 7: 1997-2000 Average Corn Prices in Selected States ($/bushel)



Source: National Agricultural Statistics Service

Figure 8: 1997-2000 Average Grain Sorghum Prices in Selected States ($/bushel)



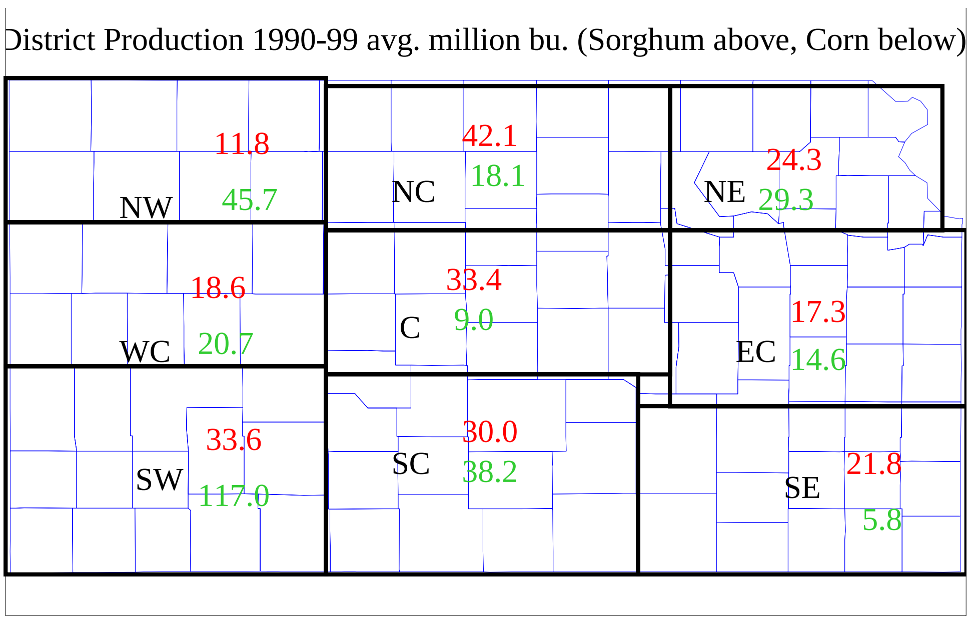
Source: National Agricultural Statistics Service

Grain Availability

Updated ethanol production technologies can potentially convert one bushel of grain into 2.8 gallons of ethanol. For a plant producing 30 million gallons per year, 10.7 million bushels of grain would be used each year. This is more than 30,000 bushels of grain per day if the plant is in operation for 350 days a year. Many ethanol processing facilities only have a limited amount of grain storage. Typically, three days of storage is common. Therefore, the availability of grain is of great importance.

Figure 9 shows Kansas' average corn and grain sorghum production by reporting district from 1990 to 1999. For comparison, Figure 10 shows how Kansas 2000 corn production compares with selected states and Figure 11 shows 2000 grain sorghum production for Kansas and selected states. Kansas, with 189 million bushels produced, was the leading state in grain sorghum production. Kansas produced 416 million bushels of corn and trailed many of the Corn Belt states in corn production.

Figure 9: District Production 1990 to 1999 for Corn and Grain Sorghum



Source: National Agricultural Statistics Service

Figure 10: 2000 Corn Production in Selected States (million bushels)

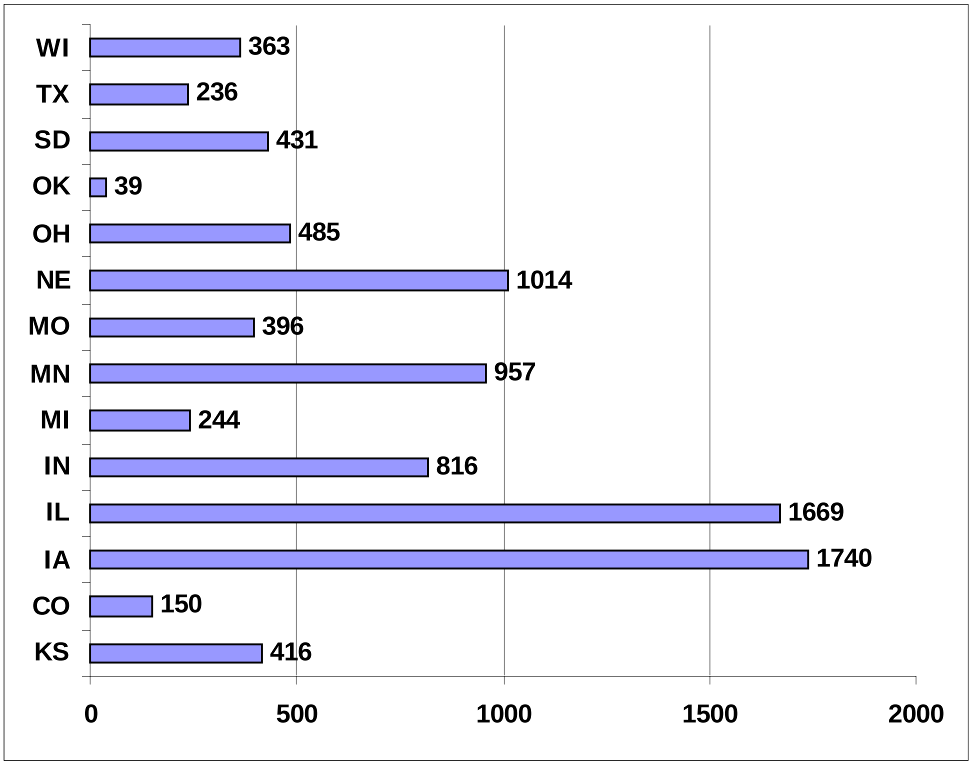
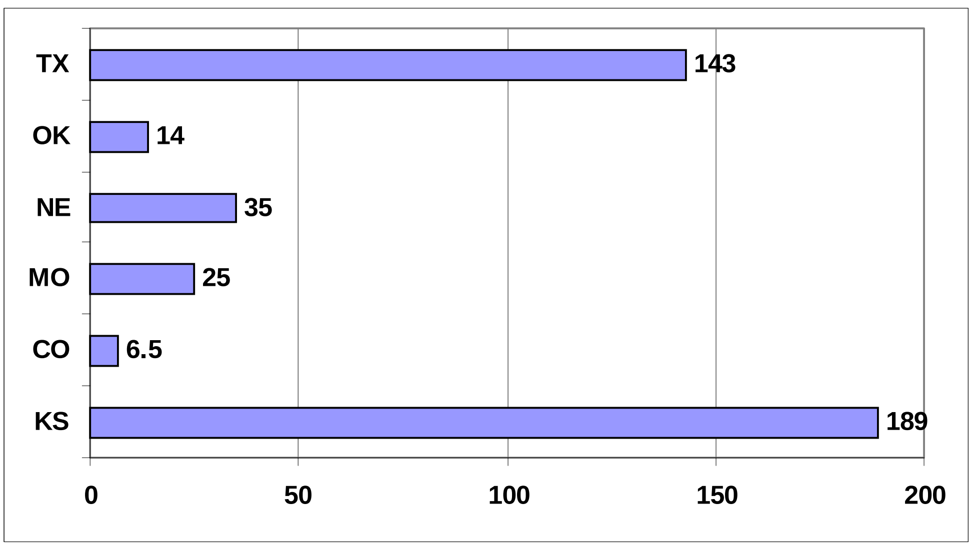


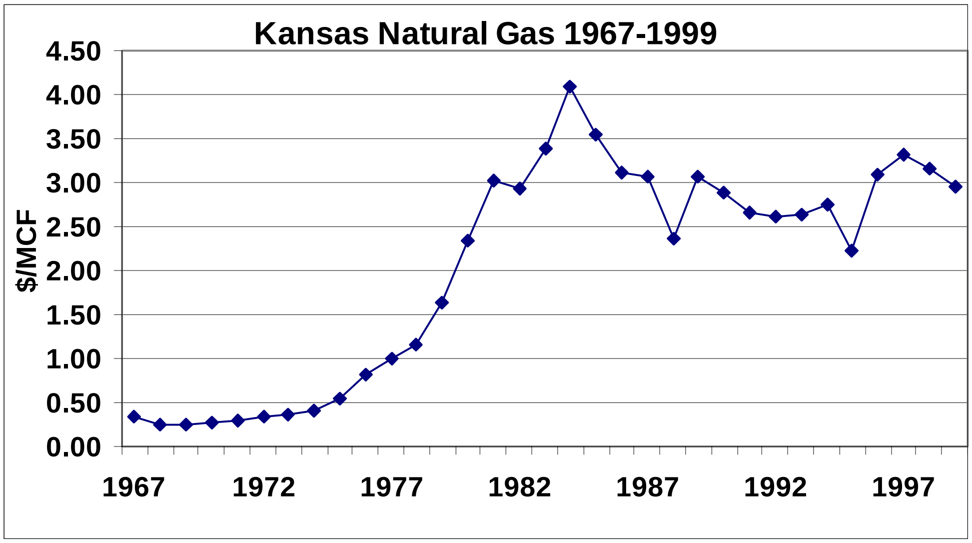
Figure 11: 2000 Grain Sorghum Production in Selected States (million bushels)



Energy Costs

The critical energy cost in ethanol production is the price of natural gas, which is used both to heat the mashed corn to produce ethanol and to dry the co-product, distillers grains to produce DDGS. Figure 12 charts the price of natural gas in Kansas from 1967 to 1999.

Figure 12: Kansas Natural Gas Prices ($/MCF)



The additional amount of natural gas used to dry distillers grains to produce DDGS is nearly the same as the amount used to produce ethanol. This fact helps to make the decision to sell DDGS or WDG an important part of the overall profitability for an ethanol facility.

The marked increase in the price of natural gas during the winter of 2000 to 2001 greatly affected the profitability of ethanol plants. An increase of $3.50 per thousand cubic feet (MCF) for a 30 MGPY plant producing all DDGS from distillers grains would amount to about $6.5 million in additional operating expenses. Therefore, marketing the distillers grains as WDG is more profitable (if an accessible market is available) since only about half as much total natural gas is consumed.

The historic price of electricity has not varied like the price of natural gas. Electricity operating costs for a 30 MGPY plant are nearly $2 million, but have very little effect in the decision to produce DDGS or WDG.

Energy expenses are one variable in site selection that can affect profitability. Some ethanol plants are able to lower their energy expenses by locating near existing manufacturing plants that produce excess steam or have some type of cogeneration possibilities.

A future technological improvement to watch for is methane production from feedlot wastes. With this technology nearby feedlots can produce methane, which can be used to replace current energy sources used to produce ethanol.

Transportation

The cost of transporting ethanol is related to the type of markets that ethanol production plants reach. Local ethanol markets use trucks and have transportation costs of about two cents per gallon. Marketing regionally typically has transportation costs of about seven cents per gallon. Either rail or truck can be used for shipping ethanol into a regional market. Reaching markets on the west or east coasts of the U.S. will have transportation costs of at least 13 cents per gallon.

Most of the ethanol produced in Kansas will be marketed to regional or national markets since Kansas used only about five million gallons of ethanol in 2001 out of the nearly 50 million gallons produced. For comparison, Nebraska used about 20 million gallons, Iowa used nearly 70 million gallons and Minnesota about 250 million gallons.

The denial of the California waiver for oxygenate additives to gasoline has brought forth many issues regarding transporting ethanol to California. The common method for California to receive MTBE was through ships. They do not currently have the infrastructure to receive great amounts of ethanol in railcar shipments. Many in the industry believe the most practical way to transport ethanol to California is to use river barges down to the Gulf Coast and then ship it on ships so it can be received in a similar manner as MTBE.

Geographically, Kansas ethanol production seems to have a transportation cost advantage to supply California when compared to other midwestern states since it is closer to California. However, this might not be a correct assumption because of the unique transportation problems involved with marketing ethanol into California.

Another suggestion is to ship grain to California or surrounding states and build the ethanol plants there. Much grain is already shipped to feedlots and dairies in that area and the distillers grains could have an available market.

Labor

Economies of size in ethanol production plants affect the total labor costs. Direct labor used in production does not vary with the size of the plant as much as the administration costs associated with the plant. In general, direct labor follows the amount of ethanol produced per year. However, small plants likely will have more personnel per gallon produced than will larger, more efficient plants. Administration expenses are much higher for small plants. Nearly the same amount of administration and maintenance personnel will be needed whether the plant is producing 10 MGPY or 100 MGPY.

Debt/Equity Ratio

A consideration for any new business is what percentage of owner equity and debt capital will go towards capitalization for the business. If 50 percent of the capitalization for a typical 30 MGPY ethanol facility is equity, then the debt/equity ratio is 1/1. Forty percent equity equates to a debt/equity ratio of 1.5. For example, a 1.5 ratio compared to a 1.0 ratio amounts to an average increase of about $260,000 per year when the interest rate is 8 percent.

Construction Costs

Construction costs for ethanol plants are directly related to the plant size. New plants will cost about $1.50 per gallon of ethanol capacity. When compared to a 40 MGPY plant, a 30 MGPY plant will probably cost about 10 cents a gallon more to construct and a 20 MGPY will cost about 20 cents more. For most practical purposes, there are not any significant lower construction costs for plants over 40 MGPY.

Interest Rate on Debt

For a 30 MGPY plant with a debt to equity ratio of 1.5, each one percent change in interest rate averages about $200,000 per year in interest expense.

Minor Economic Input Factors

Costs for chemicals and enzymes used in ethanol production have little to do with economies of scale. About eight cents per gallon of ethanol produced is required for all plant sizes.

Denaturant (gasoline) is added at a five percent rate to the finished ethanol product to distinguish the product from food-grade ethanol. The cost of denaturant is the current wholesale price of gasoline and is practically the same for all ethanol plants.

New technologies are influencing the cost of fresh water and waste effluent for ethanol production. Newer technologies currently available recycle water used in the plant so less fresh water is required. New and improved technologies also require less cost for waste effluent. Some new plants have technology engineered to recycle all of the waste effluent. These new technologies are available for all sizes of ethanol plants.

Other Important Economic Factors

Two other factors need to be considered when determining ethanol profitability. The first consideration is the competition threat from future technologies to produce ethanol from feedstocks other than grain. Converting other biomass forms such as woody products, herbaceous plants like switchgrass, municipal waste materials, and agricultural resources such as corn stalks, wheat straw and rice straw are factors to consider.

The second factor, which continues to be a major driving force in ethanol production, is government subsidies both from the federal government and state governments. The ethanol industry has survived in the past because of these government subsidies and they continue to be important factors.

Technology

Ethanol production from grain is a mature industry. Continued improvement in technology has increased the efficiency of ethanol production by increasing the amount of ethanol produced up to 2.8 gallons per bushel of grain. The operating costs to produce one gallon of ethanol continue to decrease. Much of this decrease comes from improved plant efficiency, which means less labor is required to run the plants.

A promising technology for the near future in dry milling will be the removal of the corn germ before ethanol is produced. The germ is processed into corn oil, a high value product, instead of discarding the corn germ in with the distillers grains. This process may reduce the cost of manufacturing ethanol by more than 10 cents per gallon (Johnston).

The threat of technology competition for the present ethanol production plants comes from developing technologies to derive ethanol from feedstocks other than grain. A few small plants currently produce ethanol from whey, paper waste, potato waste, and brewery waste.

A major threat comes from using feedstocks such as woody products, dedicated crops like switchgrass and poplar, agricultural residues including corn stalks, wheat and rice straw and municipal waste. One ton of these biomass products can produce about 100 gallons of ethanol. Scientists working on these technologies believe some of them will be readily available in the next few years. A pilot plant using wheat straw is already operating in Canada. It is projected that these innovative feedstocks will be able to produce ethanol with less operating costs than what is presently produced from grain. One advantage in these technologies is that a co-product produced is lignin, which can be used to produce all of the energy requirements for the ethanol plant. However, the specific costs associated with these potential technologies are unknown.

Subsidies

The ethanol industry in its current form would not have been developed without the significant assistance of government subsidies. The federal government continues to support the industry with subsidies and incentives.

The Energy Tax Act of 1978 created an exemption from federal excise taxes for gasoline blended with ethanol. The fuel blender receives either an excise tax exemption or an income tax credit. All gasoline currently has an excise tax of 18.4 cents per gallon, which is used for highway funds. If ethanol is mixed with gasoline, some of the excise tax is exempt. Currently, the exemption is 5.3 cents for a ten percent blend of ethanol in a gallon of fuel. The exemption started at 6 cents in 1978 and will decrease to 5.1 cents by 2007 when the exemption is legislated to expire. However, the excise exemption has been extended numerous times in the past.

There are other federal subsidies and incentives in place to encourage ethanol production. A "Small Producers Credit" established in 1990 and scheduled to sunset in 2007 encourages the development of new ethanol production facilities with 30 MGPY or less. An income tax credit of 10 cents per gallon for up to 15 million gallons each year is possible. This credit is only available if tax is due, however, it can be a pass-through credit for individual investors.

A recent incentive by the USDA has been a $300 million biofuels effort to increase ethanol production and other renewable biofuels such as biodiesel. This incentive provides payment for ethanol plants that increase the amount of ethanol produced from the preceding year. This program, which is in place for 2001 and 2002, could encourage an increase in ethanol production of nearly 900 MGPY if all of the incentives are realized.

State subsidies are another important part of ethanol production. Many states encourage production with different incentives for ethanol plants. For example, Minnesota has a state incentive program of 20 cents per gallon of ethanol produced and requires all gasoline to contain an oxygenate such as ethanol. These incentives usually are distributed directly to ethanol plants that meet the various requirements instead of increasing the market price of ethanol like the federal excise exemption. These state subsidies vary greatly across the country and are subject to change.

The 2001 Kansas legislature passed a bill supporting a state subsidy of five cents per gallon for existing ethanol production and 7.5 cents per gallon for new and expanded production. Specific rules and regulations must be met to qualify for this subsidy. The most significant regulation is that expanded production only qualifies if it is at least 5 MGPY, however, expanded production over 15 MGPY does not receive any subsidy. The total amount available for each year is also capped at $3.5 million.

PROFITABILITY AND SENSITIVITY ANALYSIS

When considering the economic issues of ethanol production, one needs to look at the profitability when using historical data and see how changes in assumptions affect the sensitivity of profitability.

Assumptions

The ethanol plant for this analysis is based on a 30 MGPY facility, which is the size of many proposed projects across the U.S. A plant this size has reached some of the economies of size attainable with larger plants.

The construction cost is projected to be $1.50 per gallon. A total capitalization of about $49.8 million includes working capital and contingency costs. With a debt to equity ratio of 1.25, 44.4 percent of the total capitalization costs is contributed by owners' equity of $22.1 million. The amount of borrowed debt is $27.7 million or 55.6 percent. This 1.25 debt to equity ratio is in the mid range of what lending institutions normally loan for a project of this size.

Owners' equity may come from individual business entities, a partnership such as a Limited Liability Company, a New Generation Cooperative (NGC) or a combination of these arrangements. If a NGC consisting of agricultural producers is the sole owner of the projected example, 2,210 producers will have an average investment of $10,000 each. NGC’s are usually organized with marketing agreements in place to supply grain needed for the ethanol plant. In this 30 MGPY facility, 11.1 million bushels of grain is used each year. This amounts to an investment of $1.99 per bushel if NGC members who are 100 percent owners of the facility supply all of the grain.

The price of grain is based on a market price producers would receive from a local elevator. An origination and transportation cost of 15 cents per bushel is then added to the base price. This figure is in the mid range of what could occur for an ethanol facility. If a NGC was the sole owner of a plant, the origination and transportation costs could be less than 15 cents per bushel. Since a 30 MGPY plant uses nearly 32,000 bushels of grain each day, the logistics of delivering grain often require some type of origination and transportation costs and the costs can be much higher than 15 cents per bushel.

Some general assumptions include: (1) construction takes 14 months, (2) production starts in month 15 at 30 percent capacity and ramps up to 100 percent capacity in month 21, (3) carbon dioxide is produced and sells for $7 per ton, (4) direct plant operating labor has 21 employees, (5) administration, clerical and maintenance labor has 12 employees, (6) all employee costs include additional benefits of 25 percent, (7) ethanol yield is 2.7 gallons per bushel of grain, (8) electricity costs $0.04/KwH and 4.0 KwH/bushel of grain is needed, (9) fresh water costs $1.50/1,000 gallons and 10 gallons/bushel grain, (10) waste effluent costs $1.50/1,000 gallons and five gallons/bushel grain, (11) the base use of natural gas including producing all DDGS is 0.11 MCF/bushel of grain (natural gas prices will vary in the profitability and sensitivity analysis), (12) chemicals and enzymes cost $0.08/ gallon of ethanol produced, (13) taxes and insurance cost $570 million per year, (14) maintenance and repairs cost $850,000 per year, (15) interest on the capital debt is eight percent (16) state subsidies of eight cents per gallon, (17) ethanol transportation costs are seven cents per gallon and (18) denaturant (unleaded gasoline) costs $0.50 less than the stated price of ethanol.

The historical price of ethanol is the wholesale price of ethanol at Omaha, Nebraska less a one-cent sales agent commission fee. Most ethanol facilities market their ethanol in combination with other plants or by some other type of business agreement with a marketing fee expense.

The DDGS price is related to the price of grain. For example, if grain is $1.75 per bushel, the price of DDGS is figured at $78.39 per ton. If grain is $2.50 per bushel, DDGS is $94.14 per ton. If WDG is produced in a sensitivity case, its dry matter price is the same price as DDGS, but half as much total natural gas is used.

Performance Measures

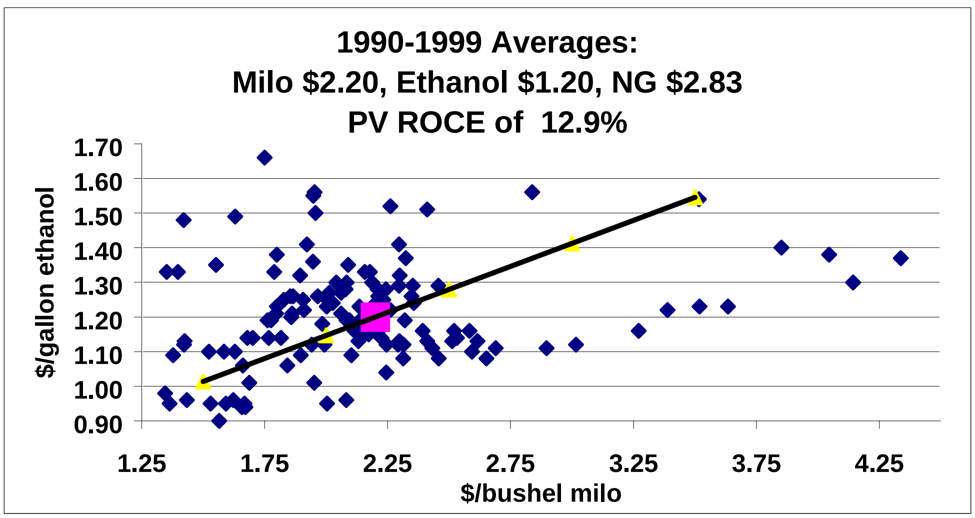
The profitability analysis for the different cases uses a projected income statement for the fourth year of production. This does not constitute an average for the first ten years because the first years of construction and startup production are less profitable than the years when the plant is in full production. The items compared are (1) Total Income, (2) Total Expenses and (3) Net Earnings.

The selected financial ratios compare the ten-year average for the projected ethanol plant facility. The ratios include: (1) Return on initial investment (ROI) before taxes, (2) Return on initial investment after a 40 percent tax for individual owners, (3) Distribution per bushel before taxes and (4) Distribution per bushel after a 40 percent tax for individual owners.

Case 1: 1990-99 Historical Data

The average prices for 1990 to 1999 are $1.20 per gallon of ethanol, $2.20 per bushel of grain sorghum and $2.83 per MCF of natural gas. The ten-year projected (ROI) before taxes, when using all the assumptions listed above and the 1990 to 1999 averages, is 12.9 percent. Figure 13 is a scatter gram plotted with the monthly ethanol prices and the monthly grain sorghum prices at Hutchinson, Kansas. A "profitability vector" of 12.9 percent is plotted on the graph to show the range of profitability with the monthly prices. This profitability is obtained with the assumptions listed above, which include the latest technological advances. Older ethanol plants might not be as efficient and would have a lower ROI.

Figure 13: 1990-1999 Averages for Ethanol, Milo and Natural Gas with a Profitability Vector



Profitability and Sensitivity Cases

Table 4 lists the cases by what major price factors are compared and then shows the profitability analysis and financial ratios. The first two cases use the historical average prices of ethanol and grain sorghum during the 1990s. Case 2 increases the price of natural gas to $5.00/MCF and shows how that affects profitability. Cases 3 through 5 increase the price of ethanol to $1.50 per gallon and compare different natural gas prices and their sensitivity. Cases 6 and 7 are figured with ethanol at $1.20 per gallon and grain at $1.70 per bushel and compare producing DDGS and WDG. Case 8 has ethanol price at $1.20 per gallon, grain price at $2.20 per bushel and the distillers grains is all marketed as WDG.

Table 4: Summary of Profitability and Sensitivity Cases

General assumptions do not change	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Ethanol ($/gallon)	1.20	1.20	1.50	1.50	1.50	1.20	1.20	1.20
Grain price ($/bushel)	2.20	2.20	2.20	2.20	2.20	1.70	1.70	2.20
Natural gas ($/MCF)	2.83	5.00	5.00	7.00	7.00	5.00	5.00	5.00
Distillers grain marketed as	DDGS	DDGS	DDGS	DDGS	WDG	DDGS	WDG	WDG
Production year 4								
Total Income (million $)	46.1	46.1	55.5	55.5	55.5	45.1	45.1	46.1
Total Expenses (million $)	42.4	45.0	45.5	47.9	43.7	39.5	36.4	42.0
Net Earnings (million $)	3.7	1.1	10.0	7.6	11.8	5.6	8.7	4.1
Before Tax								
10 Year Avg. ROI	12.9%	2.3%	37.6%	28.0%	44.8%	20.7%	32.6%	14.5%
10 Year Avg. Distribution/bushel ($/bu)	0.22	0.01	0.72	0.52	0.86	0.38	0.62	0.25
After 40% Tax								
10 Year Avg. ROI	7.7%	1.4%	22.6%	16.8%	26.9%	12.4%	19.6%	8.7%
10 Year Avg. Distribution/bushel ($/bu)	0.13	0.006	0.43	0.31	0.52	0.23	0.37	0.15

Case 2 shows that increasing natural gas to $5.00/MCF lowers the net earnings by $2.6 million and ROI before taxes is 2.3 percent. Cases 3 through 5 show that high priced ethanol ($1.50 per gallon) and moderate priced grain ($2.20 per bushel) is very profitable with high ROIs. Even with natural gas at $7.00/MCF, the ROI is still 28 percent. Comparing Case 4 and Case 5 shows the improved profitability that can be achieved by marketing WDG instead of DDGS. Case 6 and Case 7 are reasonably profitable with lower priced ethanol ($1.20 per gallon) and lower priced grain ($1.70 per bushel). Case 8 is similar to Case 2, but shows how important an ethanol plant's total profitability is related to finding a market for WDG.

Summary and Implications for Kansas Farmers

Increased ethanol production is an important topic of discussion across the United States and especially in the Midwest. The increased price of crude oil, the decreased price of farm commodities and the proposed elimination of MTBE are the driving forces behind this interest. Numerous factors contribute to the profitability of an ethanol production facility. These factors include: prices of ethanol and gasoline and their relationship, marketing distillers grain, feedstock price and availability, energy and transportation costs, subsidies and biomass technologies.

Let's examine how Kansas fits into these factors when compared with other states.

The price of ethanol is the most important factor in ethanol production. High ethanol prices usually mean high profits. Unfortunately, ethanol producers have little influence on ethanol prices. The price of ethanol has averaged nearly 50 cents above the wholesale price of gasoline. However, in the last two years, the average monthly difference per gallon between ethanol and gasoline has ranged from a low of 25 cents to a high of 91 cents. This fact shows it is important to keep government policies and public perception favorable for ethanol so that the market price will remain high, especially if the wholesale price of gasoline gets lower.

Kansas has an advantage over many areas in marketing distillers grains. The large feedlot industry in the state makes producing and marketing WDG instead of DDGS a distinct possibility. The increase in the Kansas dairy production industry also has the potential to help in marketing distillers grains.

The historical average price for grain sorghum in Kansas is nearly the lowest priced feed grain in the U.S. Since ethanol may be produced from any grain, Kansas has a competitive advantage with low priced grain sorghum and the fact that Kansas is the leading producer of grain sorghum in the U.S. However, Kansas is at a disadvantage in total feed grain availability when compared to other states. Kansas' total production of grain sorghum and corn ranks behind several states and the historical price of Kansas corn is higher than many other states.

A slight advantage exists for Kansas producers in regard to energy costs. If the technology for methane production becomes practical, Kansas will have a big advantage with its many large livestock enterprises. Methane could be used for the energy needs of an ethanol plant, especially if business partnerships could be established.

Transportation costs are currently a disadvantage for Kansas. The existing small demand for ethanol in Kansas means most of the ethanol produced in Kansas will be shipped to other markets. The potential ethanol market in California would seem to help Kansas if rail shipments could transport much of the ethanol needed. The present thought is that most of the ethanol for California will be shipped by barge to the Gulf Coast and delivered to California by ocean ships.

Federal subsidies do not give one area of the country any advantage. The USDA biofuels program helps ethanol projects that are expanding by 2002. The state subsidies provided in Kansas are better than some states, but not as high as other states.

The competition biomass technology could provide for grain based ethanol production might be a big advantage for Kansas if technologies can be developed to use wheat straw to produce ethanol. If biomass technology proves to be less expensive to produce ethanol than grain produced ethanol, ethanol production might become even more important for Kansas producers.

The increased demand for ethanol in the U.S. potentially could increase the price of corn and grain sorghum in Kansas. Kansas grain producers will benefit from expanded ethanol production in other states and in Kansas due to an expected increase in demand for grain and therefore higher grain prices.

Ethanol plants located where cost of grain and other production costs are relatively low and ethanol demand and subsidies are relatively high will be the most profitable. Current ethanol prices and grain prices make ethanol production very profitable. Most industries are not able to sustain this high profitability over the long run. Normally, economic theory suggests that the supply will eventually equal the demand and profitability will be more consistent with the past.

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