



American Crystal Sugar Company: Making Ethanol from Sugar Beets?

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Abstract

The objective of the case is to have students analyze policy factors regarding the possibility of using sugar beets as an ethanol feedstock. Jim Horvath, CEO of American Crystal Sugar Company, is preparing a presentation for his cooperative's annual meeting. Students are asked to consider various economic factors that impact the supply and demand for ethanol and how sugar beet ethanol is produced.

Key Words: agribusiness, cooperatives, ethanol, sugar beets

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Jim Horvath, president of American Crystal Sugar Company (ACSC), looked out the window of his corner office in Moorhead, Minnesota.¹ It was November 2007 and the snow was beginning to stay on the ground. The annual meeting of his cooperative was next week and he was compiling a list of items that he wanted to address to the cooperative's membership. Trade issues and public policy were always an integral part of the sugar industry in the United States. However, this year there was another issue rising to the surface. The dramatic increase in the number of ethanol plants that were being created due to tax credits and other economic incentives had increased the price of corn above \$3.50 per bushel.

Jim was a native of Milwaukee (Pates). In his early 20s, he set a goal of becoming a president of a company. Horvath had a bachelor's degree in finance and master's degree in business from the University of Wisconsin in Milwaukee. He started his career in 1969 with Miller Brewing Company. Horvath became Miller's director of treasury operations, director of accounting and, finally, director of information technology. In 1985, he became vice president of finance for ACSC. In 1998, Horvath was named president. A trademark of Jim's management style was his honesty and openness with the producers who were the shareholders of the cooperative.

American Crystal Sugar's membership had inquired whether it was feasible to make ethanol from sugar beets. Jim was reading a report done recently on this subject and was going to touch on it in his address to the membership. Different people had different thoughts about the matter and Jim needed to think through the rhetoric and address the issue honestly with the membership.

Economic Issues Affecting U.S. Sugar Policy in 2007

Three big issues affected U.S. sugar policy in 2007. These were a new Farm Bill, full implementation of the 1994 North American Free Trade Agreement (NAFTA) provisions and free trade obligations. All three of these issues affected his discussion with the membership regarding manufacturing ethanol from sugar.

2007 Farm Bill

The future of beet sugar and pulp prices wholly depends on U.S. sugar policy and policies of other nations (Brester and Boland). This intervention takes the form of providing a minimum price for sugar that is greater than the world price for sugar. A tariff-rate quota restricts the supply of sugar that can be imported into the United States. In addition, loans are provided to sugar processors through the USDA's Commodity Credit Corporation. The sugar is pledged as collateral on these loans. In the event that the price of sugar is lower than the loan rate, the processors can forfeit their sugar to the U.S. government rather than pay their loans in cash. Thus, this loan rate is the price floor for U.S. sugar. The 2002 Farm Bill authorized the development of a system of marketing allotments for domestic sugar production. This system of allotments enabled the USDA to restrict domestic sugar sales such that prices were maintained at or near price support levels. It was anticipated that these provisions would be renewed in the 2007 Farm Bill. The sugar industry was seeking to have any excess sugar produced above the allotment to be purchased by USDA at taxpayer's expense and sold to ethanol manufacturers.

NAFTA Provisions

On January 1, 2008, full implementation of NAFTA eliminated all customs duties for sweetener trade between Mexico and the United States. The equilibrium price and quantities of sugar produced in the United States and Mexico will depend on the relative costs of production, transportation and other market factors. A preview of how this implementation will affect U.S. sugar prices may have occurred in July 2006. At this time the USDA announced that 425 metric tons of sugar would be allowed duty-free access to the United States from Mexico through the end of 2007, equivalent to 5 percent of average domestic U.S. production in 2005 to 2006 (USDA). The average monthly raw sugar price declined 12 percent, from 23.52 to 20.76 cents per pound, in the second half of 2006 as compared to the first half, and remained at this level as of November 2006. A price drop of this magnitude is unusual for sugar. Between 1960 and 2005, raw sugar prices changed about two percent, on average, between the first and second half of the year.

Jim thinks these episodes are likely to become more common. He knows that, since corn-based sweeteners are relatively cheaper than sugar, corn sweeteners from the United States are likely to be exported to Mexico and displace the refined sugar currently used in Mexico to produce other products, such as beverages and candy. The displaced sugar would then be less expensive than refined sugar produced in the United States, making it attractive for importation. It would be possible for Jim to quantify the effects of these changes on the amount of sugar ACSC members would be able to produce and the associated returns (Abler et al.).

Free Trade Obligations

In recent years, Presidents Clinton and Bush had pushed hard for free trade agreements with other countries. Such agreements eliminated [tariffs](#), [quotas](#) and preferences on most or all [goods](#) traded between the two countries. Congress voted to give each president Trade Promotion Authority to sign treaties that would then be voted up or down without any changes. Several such treaties, most notably, the Central America Free Trade Agreement--Dominican Republic (CAFTA-DR) provided for importation of sugarcane outside the import quota as prescribed in the Farm Bill. Thus, excess sugar could enter the United States and disrupt the supply management system that cost U.S. taxpayers an estimated \$2 billion per year according to a U.S. Government Accounting Office report. Sugar beet production had a large impact on land prices and was a high-value crop wherever it was grown (Taylor and Brester).

The Process of Ethanol Production

Most existing ethanol production processes rely on the fermentation of starches and sugars found in raw cane sugar (Brazil), corn (U.S.) or rapeseed (EU). Jim has wondered if sugar beets are a viable source of ethanol feedstock. The extraction of sugar from sugar beets results in additional co-products, including pressed pulp that could be converted into pellets or sold wet as a feed; high-potassium molasses (raffinate), which was used in feed manufacturing and road deicing; high-sugar molasses; and betaine (Hofer). Ethanol could be produced from the entire sugar beet or simply the sugar beet pulp.

All biological production of ethanol is based on the metabolism of simple sugars, such as glucose, galactose and, xylose. One source of materials for ethanol production is sugar beets. On

a dry matter basis, sugar beet pulp contains 20 percent cellulose, 25 to 30 percent hemicellulose and 25 to 35 percent pectin. Sucrose, free fatty acids and proteins make up much of the remaining 15 to 30 percent. An ethanol production process based purely on cellulose, therefore, would be highly inefficient. To improve efficiency, the process must make use of a higher percentage of the total dry matter found in sugar beet pulp.

The Economics of Ethanol Production Facilities

Production of ethanol in the United States is based primarily on grain as a feedstock. Currently, the most profitable U.S. feedstock is corn, requiring approximately 0.01 tons of corn to produce one gallon of ethanol. By comparison, 0.04 tons of sugar beets are needed. Based on an average market price for corn of \$2.16 per bushel during 2003 the 2005 time period, research indicates that the estimated net feedstock cost per gallon of ethanol produced from corn is \$0.53 for a dry mill plant and \$1.58 per gallon from sugar beets (Table 1). As farm prices in the 2007-2008 crop year exceed \$5.00 in principal U.S. markets, these costs have increased. Research also indicates that production costs associated with using sugar beets as the feedstock are more than double those of producing ethanol from corn (Table 2).

Potential facility designs for ethanol production from beet pulp depend on construction of fermentation and distillation facilities on the site of existing sugar beet processing plants. The ethanol facilities would be designed to take the pulp directly from the waste output of the sugar extraction process and introduce it to the enzymatic breakdown in a batch-based ethanol production process. The fermentation vat would produce batches of output (approximately 15 percent alcohol by volume) that would be pumped into a surge tank for distillation in a continuous flow distilling process. The distillation process would link into the sugar plant and utilize waste-steam as an energy source. The output ethanol (approximately 97 percent alcohol by volume) would then be pumped into storage tanks from which it may be pumped into tankers for shipping and sales. The liquid waste from the ethanol production process (relatively small volume) would be piped into the water treatment and handling facilities already in place in the plant. Using energy and waste management synergies wherever possible, the net marginal energy requirement of the ethanol production process would be relatively minor compared to the energy usage of the sugar refining process.

The construction of ethanol production facilities, even under the proposed sugar factory-integrated design, represents a substantial investment of capital. Construction costs are estimated, based on industry accepted standards for integrated facilities, at roughly \$1.65 per gallon of annual capacity.

Price Discovery in Ethanol

The price of ethanol is determined by the price of gasoline and other factors rather than the cost of producing ethanol from corn. The uncertainty associated with crude oil and gasoline prices are a major factor affecting decisions with respect to investment in sugar beet ethanol production facilities.

Futures Market

Ethanol future contracts have been traded on the Chicago Board of Trade since March 23, 2005. Many useful insights can be obtained from examination of current data.² Ethanol-blended

gasoline is generally priced at a \$0.02 to \$0.03 per gallon premium to unblended fuel. Gasoline distributors desire that higher octane fuel be priced higher than lower octane fuel. In addition, there is a small reduction in mileage from using ethanol-blended fuel. This is offset by the increased air quality.³

The relationship between crude oil and ethanol is not highly correlated but the two price series do follow a similar trend. The price of ethanol, while ultimately linked to the cost of its production, appears to be most strongly correlated with the price of gasoline. The price of corn and ethanol tend to follow the same trend, which would be expected since corn is the primary ingredient in ethanol.

Cash Prices for Corn in July 2008

More than any other single market force, the massive expansion in corn consumption by ethanol plants has changed the dynamics of grain markets. While the 2008 crop is estimated to be the one of the largest in history (USDA WASDE) at 13.3 billion bushels, demand appears to be outpacing supply. New ethanol plants are forced to compete for corn with the sweetener industry, livestock feeding industries and existing ethanol plants to purchase the number of bushels needed to operate their facilities. The effect has been an unprecedented runup in cash and futures prices for corn. On May 1, 2008, Chicago Board of Trade corn futures closed at \$6.15 per bushel on the July 2008 market. Corn futures prices had not exceeded \$3.00 per bushel since 1996. This change had caused many of Jim's members to consider putting more corn in their crop rotations.

Forces affecting ethanol production profits

Currently no plants manufacture ethanol from sugar beet pulp or from sugar beet sugar in the United States. Thus, there are no historical data to measure past market performance. Jim knows that ethanol margins have been high over the past three years. However, these high historical margins are not necessarily indicative of the future. As Jim considers the tasks and processes that will be ahead should ACSC decide to enter the ethanol market, the current state of the industry is the best way to measure potential profitability.

Rivalry Among Competitors

Competition between firms in ethanol is focused on price. The raw material purchase costs are well known and the technology process is licensed from several providers. Thus, price is a function of volume of ethanol produced. Consequently, price competition and more specifically, low-average cost production is the basis for competition. Firms with the lowest cost can reduce price and capture market share. The cost of storing ethanol is high such that inventory costs can be substantial and firms have an incentive to market ethanol quickly. Finally, because ethanol is not differentiated, buyers can switch relatively easily. The market for ethanol is growing due to government mandates. This fact mitigates the impact of intense rivalry. However, it is likely that the supply of ethanol will surpass the mandates, making rivalry more intense for new entrants.

Threat of Entry

The primary barrier to domestic entry into ethanol production is the stiff competition the proposed ethanol facilities are likely to face from existing ethanol production facilities and the large volume of production capacity expected to come online in the next two years. These Midwestern U.S. facilities are overwhelmingly dominated by processes based on corn. While

corn has traditionally been a marginally cost-efficient input for ethanol production, recent market events appear to have shifted the equation. It should be noted that the first cellulosic ethanol plant is being constructed at a cost of \$200 million and is expected to be online by 2010. Start-up costs are beginning to increase due to greater energy and labor costs. Furthermore, the technology to build a plant is owned by several technology providers who do not have the expertise to build such a plant to use sugar beets. Corn is a storable commodity while sugar beets are perishable and inventory is a large barrier to entry for a sugar-beet-based ethanol plant.

Bargaining Power Among Sellers

Jim first gathered information that would indicate whether existing producers are able to exercise market power when selling their output. In 2005, about 75 companies operated more than 90 ethanol production facilities in the United States, producing about 4.1 billion gallons annually (Federal Trade Commission). These producers either market their own output or rely on a handful of large marketers, or several relatively smaller ones, to arrange sale agreements. The duration of these arrangements commonly varies from shorter and longer term (a few years) agreements. None of the marketers control the quantity supplied by the firms they represent (Federal Trade Commission). Jim also knows that cooperatives, small private companies and multi-national corporations have invested billions of dollars over the course of the last 10 years to construct ethanol production facilities wherever sufficient corn is grown to support the plants. This potential overcapacity will create a fiercely competitive ethanol sales market and effectively cap ethanol prices at roughly the total cost of production at average cost facilities as long as oil prices remain at less than \$60 per barrel. Furthermore, suppliers do not have sophisticated logistics services and must depend on rail providers and trucking companies to move their ethanol to end users. Ethanol cannot be transported via existing pipelines, which further complicates matters.

The principal input in ethanol is corn and energy (e.g., natural gas). The dramatic increase in the cost of corn has the potential to have strong detrimental effects on the profitability of existing ethanol facilities. The ethanol industry is currently in a state of rapid change and does not appear to have reached equilibrium. Despite its current variability, it appears that corn prices are likely to be substantially higher in the foreseeable future than they have been in the last ten years. This high input price limits the ability of large Midwestern ethanol production facilities to undercut the prices that might be offered by the proposed sugar beet ethanol facility.

Bargaining Power Among Buyers

Jim also wondered whether ethanol buyers, such as oil companies, were able to exercise market power when purchasing ethanol. Demand for ethanol has increased over the past few years for several reasons (Federal Trade Commission). Using ethanol in gasoline blends can extend existing gasoline volumes. This is reflected in the aforementioned relationship between gasoline and ethanol prices. Second, ethanol has become accepted as an alternative oxygenate to methyl tertiary butyl ether (MTBE), especially as states prohibit the use of MTBE in gasoline due to environmental liability concerns. Third, state and federal policies require the use of renewable fuels in blends with gasoline. Each of these factors ensures that new ethanol demanders will enter the market over time. Ethanol is shipped in large volume lots to end users and broken up and blended into mixtures in demand locations. These buyers are large and can buy ethanol from anyone. These buyers have access to logistics services, which adds to their bargaining power.

Ethanol is not unique and is homogeneous, which means buyers can acquire ethanol from anyone.

Substitutes for Ethanol

The level of profits for ACSC will also be affected by price of products that are closely related to ethanol. One possible substitute for ethanol produced by ACSC is ethanol made in other countries. The international market for ethanol, like the international market for sugar, trades at a notably lower price than the domestic market due to tariffs. Although ethanol is a commodity product, it is expensive to transport. As a result of the high transport costs and high domestic price relative to world prices, none of the ethanol produced in the proposed ethanol facilities is expected to compete effectively in export markets. Ethanol is also closely related to several other products. Although gasoline is the most obvious alternative product for fuel, biodiesel is another alternative fuel that could influence the marketability of ethanol. In addition, new electric and hybrid engine technologies can extend current gasoline volumes. Thus, there is little reason for buyers to have loyalty to any brand of ethanol and switching costs are very low.

This information suggests to Jim that both suppliers and demanders of ethanol will likely behave competitively. But things can change. Jim wonders if future policies or future mergers among other producers will increase the potential for strategic pricing behavior.

Real Options in Ethanol Production

There is sufficient time between developing a feasibility study for an ethanol plant that used sugar beet pulp, preparing a business plan for such a plant and constructing a plant that Jim knows that retaining the option to commence ethanol production may have value. The profits associated with the ethanol investment decision are uncertain, being affected by corn and ethanol prices, as well as the competitive environment in which ethanol would be produced. The technology, while known in a laboratory setting, needs to be proven in a different setting.

Jim would like to provide his members with a sense of how to consider the uncertainty of corn and ethanol prices, as well as the competitive environment, when making a decision to commit the cooperative's resources to ethanol production. Since ACSC is controlled by its sugar beet producing members, he hopes some of their prior experience with ethanol production ventures may inform them about what variables affect the profits from ethanol production. Furthermore, it is likely that other sugar beet processors would desire similar information. The sugar beet processors collaborated on joint research projects funded by the Beet Sugar Foundation and USDA. It was likely that the entire industry might fund a study looking at the technology aspects.

Although the opportunity to invest in ethanol production exists now, the ACSC members might benefit from deferring. When considered in a real options framework, the opportunity to invest in ethanol production now, without being obliged to, is a call option that can be exercised in the future. If the option is exercised, then an irreversible investment in ethanol production will be made. The value of this option is affected by the variance in ethanol, corn and gasoline prices; by the variance in costs of ethanol production; by the scale of investment required; and the length of time the option to defer will last, which can be influenced by market and political changes. Uncertainty with respect to construction costs, the price of corn and gasoline, the increasing costs

of constructing production facilities, the political climate and changing interest and inflation rates make the deferral option more valuable. New information about some or all of these variables is very likely to be discovered in the future. As information is revealed, ACSC members will have to decide if the option to build in the future is “in-the-money,” meaning that in the future there will be value to constructing ethanol production facilities, or that the option has little or no value, “out of the money.” Thus, a first step would be to learn more about the technology to manufacture ethanol from pulp before formulating a feasibility study and business plan to present to the board.

Members of ACSC had prior experience with investing in businesses such as ethanol. Some had invested in Spring Wheat Bakers (Boland and Oelke; McKee), Dakota Growers Pasta (Boland, Freberg, and Barton) and other cooperatives. The technology employed by Spring Wheat Bakers was unproven and ultimately the cooperative went out of business. ACSC had invested in a corn sweetener venture called Pro-Gold Cooperative that was owned by Golden Growers Cooperative and ACSC (majority owner). This plant had been built in the mid-1990s for \$260 million and lost over \$35 million in equity shortly after construction was completed due to a price-costs squeeze due to high corn prices and price competition in the sweetener industry (Boland and Barton). Cargill now managed the plant. A group of Minnesota producers had invested in a similar venture in the early 1990s called Minnesota Corn Processors. It too lost money in the same time period. ADM bought a portion of the equity and ultimately acquired all of the equity (Boland et al.). Thus, Jim knew that a new venture such as this using unproven technology should be carefully considered.

With added information, Jim and the members of ACSC could decide to proceed over several phases and not necessarily commit to the entire project but instead learn more about the uncertainty of the cellulosic ethanol process. As their uncertainty about the market for ethanol production evolves, they may choose to react with a full commitment or abandon the idea. If ACSC does not enter the ethanol production market, however, its profits will still be affected by other uncertainties. These include still having to deal with the problem of imports, the need to lobby to change domestic policy and the probability that all sugar processors will lobby similarly.

Summary

Jim wanted to focus his discussion to the membership around these main questions.

1. What are the cost factors that affect the profitability of using sugar beets for ethanol production?
2. How would existing and future sugar policy affect the profitability of using sugar beets for ethanol production?
3. What market forces external to ACSC should Jim consider that will affect the profitability of ethanol production? Do these offset the cost factors on profitability?
4. What action would the membership recommend to him with respect to using sugar beets for ethanol production?

His style of management meant open communication with the membership. This issue required a lot of education with the membership because the present policy meant that continuing to use sugar beets as sugar was the most profitable alternative. The introduction of genetically modified

sugar beets was occurring in 2008 and this would significantly increase yields (DeVuyst and Wachenheim). This could result in excess sugar in the United States and that could result in policy changes that would change the situation.

Footnotes

¹The history and other information about American Crystal Sugar Company can be found in Boland and Barton. Boland and Marsh and Hueth and Melkonyan present further information about their grower contracts. For those reasons, we have not included this information in this paper.

²Current prices of futures contracts are available at tradingcharts.com.

³The air quality benefit from ethanol is disputed by some authors (Pimentel, 2003).

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Table 1. Estimated ethanol feedstock and production costs, sugar beet feedstock.

	2003	2004	2005	Average
Feedstock required (tons/gal)	0.0409	0.0408	0.0392	0.0403
Feedstock market price (\$/ton)*	41.40	36.90	39.15	39.15
Production costs:				
Feedstock cost (\$/gal)	1.69	1.51	1.53	1.58
Processing costs (\$/gal)	0.69	0.71	0.75	0.72
Yeast (\$/gal)	0.01	0.01	0.01	0.01
Denaturant (\$/gal)	0.04	0.04	0.05	0.04
Total cost (\$/gal)	2.45	2.27	2.34	2.35

Source: Shapouri and Salassi 2006.

*Historical sugar beet prices available online from the USDA Sugar and Sweeteners Yearbook. See Table 12 at <http://www.ers.usda.gov/Briefing/Sugar/Data.htm>.

The price of pressed pulp is determined by its nutritional value as a substitute for corn in a feed ration. This relationship was six times the December corn futures price. Thus, a \$5.00 per bushel December 2007 corn futures price would mean that pulp would be valued at \$30 per bushel. After drying and converting to a per ton price, this would mean that the price of dry pulp would be \$120 per ton.

Table 2. Comparison of estimated ethanol production costs for corn and sugar beets (\$/gal).

Cost Item	U.S. Corn	U.S. Sugar beets
Feedstock costs	0.53	1.58
Processing costs	0.52	0.72

Source: Shapouri and Salassi 2006.