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A TECHNICAL AND ECONOMIC ANALYSIS

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Cane/Energy Systems Assessment Program

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A Technical and Economic Analysis

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EXECUTIVE SUMMARY

The principal conclusion of this study is that investment in the production of fuel ethanol in Honduras can be justified only as a form of collective stabilization mechanism for the sugar industry as a whole, a means by which the industry can reduce the large losses that it suffers when world sugar prices are below about ten cents a pound ($0.10).

Ethanol production will not be profitable on its own in Honduras unless alcohol prices rise above $1.45-1.50 per gallon, a prospect considered unlikely in the next several years. Yet the financial and economic benefits to the country of an investment in ethanol can be large. For example, in a year in which world sugar prices average six cents ($0.06) and ethanol prices are $1.25, diverting sugar to ethanol would save the industry $3,350,000—well over half the cost of the distillery involved.

Unfortunately the risks involved in such an investment are also high. The prices of both sugar and ethanol are unstable and difficult to predict. Further, there are sound reasons to expect that, over the next five years, sugar prices may rise and ethanol prices may continue to be flat.

Because of these uncertainties it is unlikely that a single sugar company will choose to invest in an ethanol distillery large enough to absorb a significant portion of the country's "world market" sugar. However, if the firms in the industry were to treat an ethanol distillery as a joint partnership or insurance venture, with the costs and benefits distributed according to an agreed-upon formula, an investment of this kind may prove attractive. The fact that sugar companies in Honduras already cooperate closely in allocating markets favors such a possibility.

It must be stressed that an alcohol investment makes sense only if no better uses for sugarcane lands can be found, in the near term, that are capable of producing a profit and that do not impose unacceptably high social and economic costs on the Honduran community. The search for such investments should remain one of the highest priorities in the Honduras development strategy.

Although the technical team did not examine the range of alternative uses, it does not appear that other diversification opportunities are available on a scale comparable to investment in at least one annexed distillery. Such an investment would be prudent and would absorb half or more of the sugar currently sold on the world market. Growth of domestic consumption will absorb a good portion of the remainder in the next ten to twenty years (depending on the rate of economic growth).

An assessment of the technical alternatives available to Honduras for investing in ethanol production suggests that the most attractive option is a conventional, standard-sized (120,000-150,000 liters/day) batch fermentation process and anhydrous distillation system annexed to an existing sugar mill. Many mills appear to be viable candidates for such an installation, but on purely technical grounds

the Villanueva factory appears most attractive for dedication to alcohol production at a slightly smaller scale (90,000 liters/day) while the Santa Matilde facility appears the most attractive site for the larger scale (150,000 liters/day).*

Ethanol distillation from sugarcane also produces a number of commercial by-products, and Honduran sugar producers are in a position to develop and take advantage of these markets. The production of yeast, bagasse-based animal feed and carbon dioxide for local markets can make investment in distillery equipment more attractive while diversifying the markets for sugarcane products. These products also substitute for current imports.

One option that has been suggested is the provision of a domestic subsidy for the blending of ethanol with gasoline for the Honduran market. Such a subsidy is currently in place in the United States, and is critical to the financial survival of the American fuel ethanol industry. The US subsidy is also available to Honduran alcohol producers through the Caribbean Basin Initiative (CBI).

This study recommends against a Honduran subsidy while the US subsidy remains in place and while the tariff exemption for imports from Caribbean basin countries obtains. The cost of such a subsidy in Honduras would be high, from $2-5 million per year depending on how it is structured. On economic grounds, it is clearly more sensible for Honduras to export ethanol than use it domestically.

If Honduran decisionmakers do adopt a subsidy, and if it is based on an excise tax exemption, it would, of course, represent a payment by Honduran taxpayers to assure the financial security of the sugar industry. As such, it might be justified on the grounds of its benefit to the millers, growers and harvesters of cane, among others. On the other hand, it would also have the effect of increasing the country's tax burden (assuming government revenues remain unchanged) while reducing the incentive for agricultural diversification. Since subsidies of this kind are often difficult to eliminate, they would tend to freeze the sugar economy in place, stifling adaptation and innovation. The decision to subsidize, in other words, should be examined with great care.

* Among the mills wholly or partially owned by the Government of Honduras, ACENSA is judged to be the most attractive site.

1. INTRODUCTION

1.1 Problem Statement

The persistence of low world prices for sugar has given the sugarcane industry in Honduras a strong incentive to reduce its production of sugar and to look seriously at alternative products. Among these, fuel alcohol, or ethanol, from sugarcane has received the greatest attention. This report examines the technical options and financial and economic costs and benefits of producing alcohol in place of sugar that would otherwise be sold on the world market.

The Honduran sugar industry annually produces 86,000 short tons of sugar in excess of the country's domestic consumption and its export quota to the United States. This excess, about 36 percent of industry output, must be sold on the world market at prices well below the marginal cost of production. At current prices, the industry stands to lose nearly $8 million in 1986 on world market sales, repeating a performance of the past several years.

A number of strategies are possible under these circumstances. The industry can continue to produce sugar (and molasses) at current or somewhat reduced levels, awaiting a return to better sugar prices on the world market. Given the historically cyclical nature of sugar prices, this approach can seem prudent to sugar company officials. It requires no new investment or new unfamiliar activity, and most companies have been able to remain solvent, despite large losses on the world market, because of proceeds from sugar sales in the protected domestic and US quota markets. The recent, slow upward creep of world prices may lend support to a wait-and-see approach.

The risks in trusting the world market for a return to better price levels are all too familiar to Honduras, however. The losses experienced by the industry since 1980-81 have had adverse effects on cane farmers, others employed in the industry, government revenues, and foreign exchange earnings, and have reduced stability in an important sector of the national economy. Prices have proved surprisingly resistant to expected increases, which have been projected by all analysts over the past 3-4 years, and are not expected to climb above 10 cents per pound until 1989 or later. To add to the difficulty, the US sugar export quota has been declining by some 10,000 tons per year for Honduras, gradually removing an important source of revenue.

Another option is for the industry to reduce the amount of land devoted to cane production and simply produce sugar for the protected markets. In this way, world market sales and losses would be eliminated. This strategy, however, imposes a severe hardship on independent cane growers, their employees, and others working in the sugar industry, who do not have ready alternatives. Sugar mills, also, would be underutilized and the adjustment to new activities would require considerable time for both sugar companies and thousands of independent cane farmers. In addition, returning to present sugar production capacity if the world price returns to profitable levels would be compromised.

Finally, sugar producers could try to diversify into new agricultural products and to a limited extent they are doing so, converting some acreage. The development of new crops such as melons, winter vegetables, legumes, cattle and aquaculture operations is being implemented on cane lands. While perhaps offering promise for long-term development, these activities do not offer sufficient hope for the sugar industry in the near term. The time and investment required to develop competitive operations and to produce a reliable income from new crops on a large scale will certainly be greater than for new products from cane. Like sugar, these crops must compete for limited and sometimes uncertain markets. Unlike sugarcane, the fifth largest agriculture industry with over 20,000 employed, new crops are less labor-intensive and do not address the serious problem of rural unemployment.

1.2 Scope of Study

Alcohol fermentation and distillation from cane involves risks and uncertainties like other diversification strategies, but it offers a number of attractions to the industry that other approaches do not. It is a well understood commercial process which would divert a portion of cane production away from sugar into a more valuable product, giving the industry an alternative to the poor world sugar market. It diversifies the industry for a lower investment than alternative crops, and does not involve a large change in the sugarcane enterprise. Alcohol production generally permits a longer operating season for the sugarcane factory, since fieldcane of different quality is suitable for alcohol production, affording higher capital utilization rates. By-products from alcohol processing, such as yeast and CO_2, offer the industry the potential for developing new markets. And lastly, alcohol maintains cane production and sugar output capacity, offering the industry the flexibility to return to sugar if market prices warrant it.

For the country as a whole the potential benefits seem significant also: alcohol diversification maintains cane farming employment, and maintains or improves export earnings. If alcohol were used domestically in a blending program with gasoline, refined petroleum product imports would be reduced. By-products such as yeast (for protein in animal feeds) and CO_2 (for beverage manufacture) stimulate new markets and substitute for current imports. Technically, the development of an ethanol and by-products industry improves overall technological capacity and stimulates the development of a more diverse labor profile, with likely economic spin-offs.

A large and expanding alcohol market exists in the US, at prices which have, in the past two years, favored alcohol over sugar. Honduras has witnessed alcohol development from cane in El Salvador, Costa Rica and Guatemala, and similar plans are underway in Panama and other countries in the region. While these programs are mostly based on export to the US, the likelihood of market saturation in the US is small. Also, a number of countries have announced domestic blending programs to develop a degree of market autonomy and displace petroleum imports.

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Alcohol production as a diversification strategy is not without costs and risks, however. These include substantial distillery investment costs, new operating practices, uncertain alcohol markets, and technical risks. Site-specific technical considerations are important in determining the potential of individual mills as sites for alcohol distilleries and by-product recovery systems. The selection of fermentation and distillation technology is also a critical area, as technical developments have spawned a number of heavily promoted new systems with promise, but which may not be sufficiently proven through commercial practice. System costs, too, can vary greatly. The trade-offs between the potential benefits and the risk of new or highly sophisticated technology must be carefully weighed.

The attractiveness of alcohol depends to a large degree on future US and world prices for sugar, alcohol and petroleum. The recent fall in oil (and alcohol) prices and sugar price increases illustrate that the market outlook is by no means certain. A careful analysis of the costs and benefits of alcohol production under various price scenarios and an understanding of critical features of these markets are critical to the decision on whether to diversify.

Alcohol prospects for Honduras also will be affected by trade policies. Several countries' sugar industries have benefitted from US tax and trade incentives which make alcohol an attractive enterprise for countries covered by the Caribbean Basin Initiative (CBI). These policies are the subject of much discussion in the US at present, and are tied to debates over the levels of subsidies and protection for agriculture industries, US budget deficits, and trade relations. While the incentives available to alcohol do not seem to be vulnerable to changes, their limited time horizon may not be sufficiently long to recoup investments in alcohol production. The risks associated with uncertain trade policies must be considered in an analysis of alcohol potential. In addition, the possibility of a domestic blending program must be examined for Honduras.

The extent of government involvement in a potential alcohol program for Honduras is a critical concern. The government has majority or full ownership in three of the seven sugar companies, and has been supporting their operations (including losses) for several years. The government is interested in promoting economically feasible alternatives for the industry, and may be a conduit or source for preferential financing of investments. Removing government involvement and returning segments of the cane industry to private sector management may be an important component of an alcohol production strategy.

State-sponsored subsidies, both direct and indirect, are large factors in the markets for both sugar and alcohol. The domestic price of sugar is guaranteed in both Honduras and the US (and in most sugar-producing countries), as is the US sugar quota price. The two leading alcohol producers in the world, Brazil and the US, both provide substantial assistance to their industries through tax exemptions, export credits, loan programs and other mechanisms. Potential producers in Honduras are optimistic about a similar sort of subsidy. Whether any subsidy makes economic sense for Honduras must be determined.

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This discussion indicates the range of issues which this study addresses in consideration of the alcohol alternative for Honduras. Before proceeding, it is helpful to understand a number of important features and background concerning the industry.

1.3 Honduras Sugar Industry: Brief Background

The Honduran sugar industry is comprised of eight factories operated by seven companies. Factories vary in grinding capacity from 1500 to 5000 tons of cane per day. Cane yields, at 30 tons/acre, are relatively high; grinding seasons range from 90 to 179 days, depending on location and cane supply; sucrose content ranges from 9.5 to 12 percent; purchased energy use in the mills (diesel and electricity) is low and declining. Approximately 40 percent of cane lands under cultivation are owned and operated by the sugar companies, and 60 percent is under contract with independent producers.

Half of industry capacity (most of which might be considered over-capacity today) came into production in the late 70's. Like many sugar industries worldwide, that of Honduras expanded largely in response to the promise of high export profits, encouraged by the high prices prevailing at the time. The industry consequently became an important source of foreign exchange earnings. Since 1980, of course, world prices have plummeted and remained, leaving the Honduras industry with a relatively high debt burden and cost structure, and greatly reduced export earnings.

The industry will produce some 231,000 short tons (210,000 MT) of sugar in 1985-86, a 4.5% decrease from the 1984-85 crop year. Similarly, harvested acreage this year of 73,500 acres (30,000 ha) represents a decrease of 3.2% from the previous year. Total sugar availability is approximately 239,000 short tons including inventory, and is allocated among three principal markets as shown in the following table:

Market	Quantity	Share	Price
Domestic Market	127,500 st	53.3%	24.5¢/lb
US Quota	25,535 st	10.7%	18.5¢/lb
World Market	85,930 st	36.0%	appr. 6¢/lb
TOTALS	238,965 st	100.0%	17.2¢/lb (avg)[1]

At an average price of over 17¢/lb, the industry as a whole should be able to obtain at least modest returns on sugar production. In fact, of the four privately owned sugar companies only one (AZUNOSA) has failed to show a profit in recent years, and this is attributable to heavy start-up costs. Profit margins have not been significant, however, and have shown declines three years in a row.[2]

[1] Honduras Sugar Producers Association data; and USDA, "Honduras Sugar & Molasses Annual," Foreign Agricultural Service, Washington, DC, May 1985.
[2] Motes and Borgatti, "The Honduran Sugar Industry," report to USAID, August 1985.

Of the three government-owned companies only one has been able to achieve a small profit in recent years. Two, ACENSA and ACANSA, have suffered losses totaling $6-to-10 million each of the past three years, primarily the result of large debts carried by the companies. The government holds most of this debt, and owns ~3% and 100%, respectively, of the shares in these companies[3]. Thus the majority of industry losses are underwritten by the government. With world prices improving only marginally this year and the US quota declining, large losses are again projected for these firms.

Despite the large variation among company performances the industry as a whole is characterized by close cooperation. This includes a market sharing agreement, the "intercambio," managed by the Honduran Sugar Producers Association, which allocates the three principal sugar markets to each company on a fixed percentage based on the company's total production. The purpose is to permit each company to share equitably in the profitable domestic and US markets. Given low world prices, a change made in 1985 also allows companies to reduce production without losing their share of the domestic and US markets. Reductions instead are removed from their "world market" total. Thus if a sugar company wishes to begin diversifying, say into new crops on a test basis, it does not risk losing its primary revenue source.

Further, as the domestic market requires white sugar ("blanca") and export markets require raw ("morena") sugar, individual companies produce a sugar "slate" which best matches their capabilities and their locations. For example, this year Cahsa, Honduras' largest sugar company, will produce 63,000 tons of raw sugar, even though its allocation for export amounts to only 36,500 tons. This is because of its proximity to Puerto Cortes. Exchanges of sugar are done on paper, and companies compensate each other for revenue differences based on their allocated market shares (saving the industry transportation costs).

1.4 Other Studies

The proposal to produce ethanol from cane in Honduras is not new. It has been analyzed in at least four studies in recent years. A 1980 study for the Ministry of the Economy concluded that both an annexed and an autonomous distillery would be attractive for Honduras, producing about 10 million gallons of fuel alcohol per year, primarily for domestic blending to displace expensive oil imports. The autonomous distillery was recommended for new lands in an undeveloped region of the country.[4]

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[3] Company data.

[4] IPS Engineers, Inc., "Estudio Preliminar Technico-Economico...," Baton Rouge, LA, June 1980.

An OAS study completed in 1984 suggested a possible strategy of increasing cane production and using existing excess grinding capacity at three mills to produce up to 17 million gallons of alcohol per year, both for domestic blending and export. This analysis also considered that an ethanol incentive price up to $2.10/gallon would be instituted for alcohol blended domestically.[5]

A 1985 study conducted for USAID on the status of the Honduran sugar industry estimated that the cost of producing alcohol would be slightly over $2 per gallon, and would thus require a substantial subsidy. It recommended detailed analysis of the alcohol option, as well as consideration of other options for the industry.[6]

A feasibility study completed for CAHSA in late 1985 examined a number of possible options for alcohol for export, including production from cane juice, syrup, "A" molasses and blackstrap at a range of scales. It concluded that production costs were too high (approximately $1.95/gallon) to obtain a profit, but that at prevailing prices alcohol would mean smaller losses than world market sugar sales. This study also examined the US alcohol market in detail.[7]

1.5 Execution of the Study

This study was carried out by a team of specialists sponsored jointly by the Office of Energy of AID's Bureau for Science & Technology (Washington) and USAID/Honduras' Office of Agriculture and Rural Development, through a contract with Ronco Consulting Corporation. The team traveled to Honduras January 15-February 3, 1986, and met with sugar, petroleum and agriculture industry officials, Government of Honduras, USAID and finance institution officials, and interested private company representatives to collect information necessary for the assessment. The team visited every sugar company except one (AYSA). Analysis, further research, and report writing and assembly was conducted largely in Washington during February-March.

The sections which follow address technical issues important to an alcohol initiative in Honduras (Section 2); characteristics of sugar factories as candidates for a distillery (Section 3): financial and economic analyses (Section 4); implementation issues for an alcohol program (Section 5); and an analysis of employment in the cane industry (Section 6). Recommendations concerning alcohol diversification are contained in each section, and are summarized in the Executive Summary. A series of appendices present information on potential dedication of a sugar factory to alcohol, the US alcohol market and trade issues, sugar company profiles, and economic analysis tables.

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5 "Resources and Potential of the [Sugar] Industry for the Production of Energy-Producing Products," CEPCIES/970, Organization of American States, Washington, DC, July 1984.

6 Motes (op cit.).

7 F.C. Schaffer and Assoc., Inc., "Study for Installation of Ethanol Facility," Vols. 1-3, (for CAHSA), Baton Rouge, LA, December 1985.

2. TECHNOLOGIES

2.1 Alcohol Technologies and Systems

This section reviews the technical options available for a Honduran fuel alcohol initiative. Many experimental technologies have been proposed in recent years. However, the team strongly recommends that only proven technologies be employed for the initial phase of a Honduran alcohol program. This reduces the field of candidate technologies, but still leaves several alternatives for fermentation, distillation and by-product recovery systems.

2.1.1 Turnkey Systems

A turnkey system is an installation provided entirely by a single vendor, including all engineering, equipment, shipping, site preparation, facility construction and, usually, start-up. The rapid increase in worldwide distillery capacity (more than seven-fold over the last 10 years [1]*) has motivated engineering firms in Brazil, the U.S., West Germany, Venezuela, and other countries to develop and market turnkey sugarcane-based distilleries. In the schematic of a typical annexed distillery (Figure 2.1), the turnkey system would be represented by the distillery section in black, plus all interconnections to the sugar factory (white).

There are three major advantages to a turnkey system. First, such systems avoid the need for extra engineering to couple equipment from various vendors. Second, they are generally protected by guarantees which cover installation costs, performance and construction time. The third advantage is cost. The larger manufacturers can achieve scale economies by producing several distilleries per week and some offer attractive financing packages as well. Savings are also realized on the costs of capital because of the short times needed to install turnkey distilleries. Installed costs of less than $1.00 per annual gallon are typical.

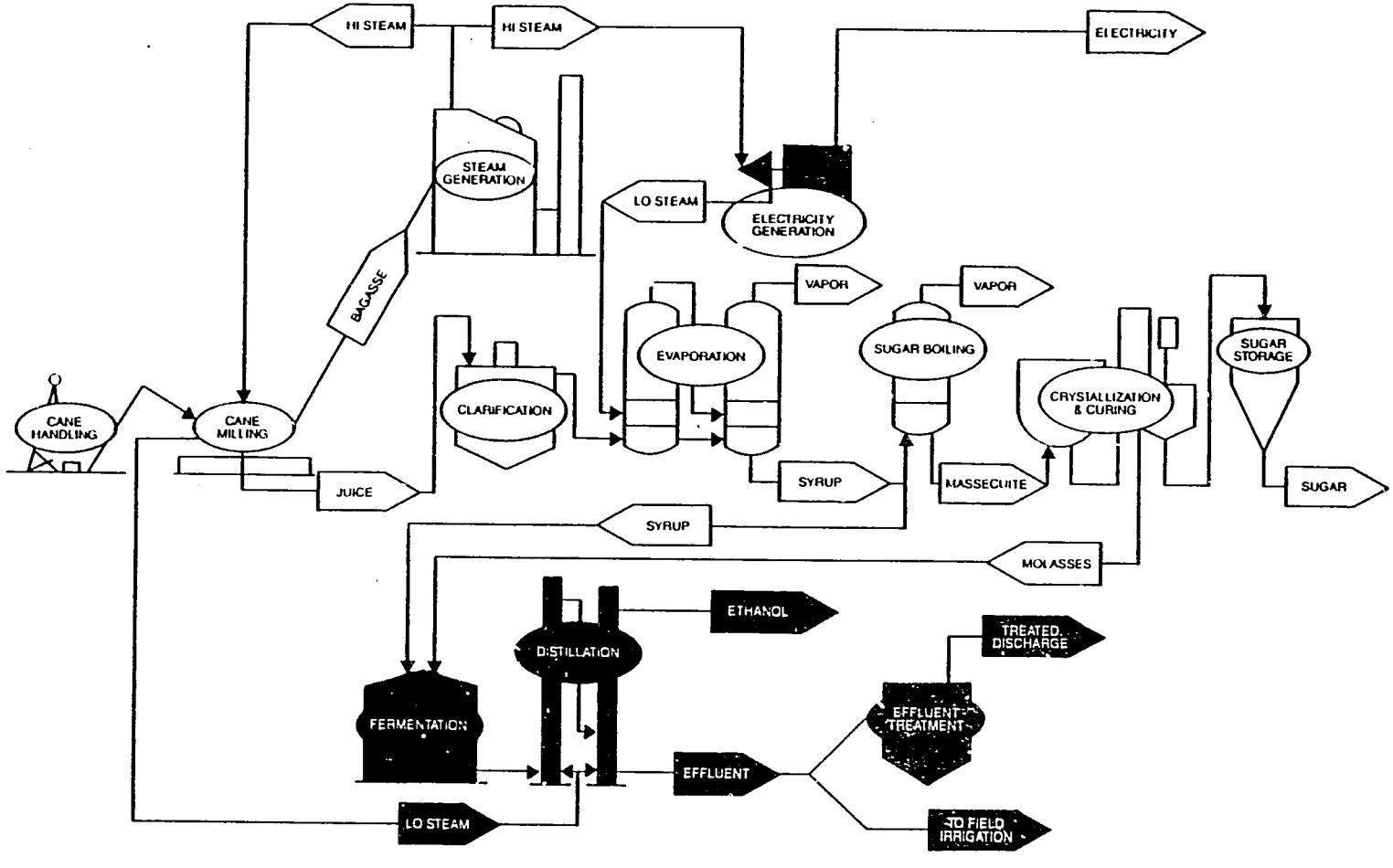
2.1.2 Innovations in Fermentation

Fermentation is the enzymatic degradation of sugars by yeast into ethanol, carbon dioxide and other compounds. In conventional batch systems fermentation tanks are arranged in parallel with each tank representing a "batch" where full fermentation of the stock occurs. Batches are staggered so that a continuous flow of dilute alcohol is supplied to the distillation section, where alcohol is separated from the fermented stock. Batch systems involve numerous fermentation tanks, but provide flexibility in having a tank ready (or almost ready) should contamination occur in one.

A great deal of research has been devoted to the development of continuous fermentation technology as an improvement over batch fermentation. In continuous fermentation, the tanks are used in series, the product flows continuously from the

* References cited in []'s are found at the end of the section.

Figure 2.1:
Schematic of Annexed Distillery



first to the last tank and each vessel is in a different stage of fermentation. Yeast is separated and recycled continuously, allowing higher alcohol concentrations in fermentation. Another refinement under investigation employs flash evaporation of the fermentation liquor with recycle to enhance ethanol removal. Continuous fermentation has reached the stage where it offers as good an alcohol yield as batch systems. Its convenenience is that it accelerates conversion and requires less tanks than batch fermentation. It also reduces the quantity of wastewater requiring disposal.

More advanced continuous fermentation concepts are under development that employ special yeasts tolerant to the high osmotic pressures found in these systems (e.g., the Biostil process [2]), immobilized cells and enzymes, fermentation under vacuum, and a host of other innovations. Researchers have also been developing alternative organisms for performing ethanol fermentations. The most promising alternative is the use of bacteria (Zymomonas mobilis) rather than yeasts to achieve faster fermentation rates and greater ethanol yields. The Sucrotech process has been successfully demonstrated in commercial-scale tests [3] and will be introduced into fuel alcohol distilleries in Zimbabwe and Malawi shortly. Also, a variant of Zymomonas has been identified that will selectively ferment the glucose component of sucrose to ethanol while preserving fructose, the component containing most of the "sweetener value" of sucrose.

The greatest inconvenience of the continuous systems is that if for any reason the process is interrupted, the whole distillery must be shut down. If contamination occurs the entire fermentation plant will be contaminated, and the losses will be substantial. By contrast, if contamination occurs in the batch system, a single fermenter is isolated and disposed of, but the distillery will continue operating. Continuous systems also require tighter process controls, rigid production schedules and more highly trained personnel.

Considering the inflexibility of continuous systems, the team does not recommend them in the first phase of a project in Honduras. A well engineered batch fermentation plant will provide as good, or better, performance than new techniques, will be easier to operate, and can be easily converted to a continuous fermentation system at a later phase of the project. Consideration should be given to future refinements when laying out the distillery so that retrofits will require a minimum of plant alterations.

2.1.3 Innovations in Distillation and Dehydration

The separation of alcohol from the fermented stock is achieved by means of distillation. Steam heat is used to separate components which vaporize at different temperatures. "Heads", or compounds with boiling points below ethanol, are vaporized first and extracted from the top of the column. Ethanol vaporizes next and is extracted. The "tails", or compounds with higher boiling points, vaporize last and flow up, leaving the vinnase or liquid stillage at the bottom of the column. Modern systems are continuous and composed of several columns.

The large demand for distillation equipment over recent years has increased research and development and achieved major energy efficiency improvements in this previously dormant industry. Modern systems exchange heat between steam and the ethanol product by means of reboilers located outside the columns (to avoid the addition of water in the system, as done previously when live steam was injected into columns). The recovery of the condensate brings a substantial energy savings. Another innovation is the tranference of product between stages in vapor form, instead of using the costly, previously common, in-process condensations. Manufacturers have also adjusted pressures in the distillation system, obtaining further savings in process energy.

Distillation concentrates the alcohol to 190-192 proof (95-96º Gay-Lussac). It is not possible to produce pure, or anhydrous, ethanol by further concentration because it forms a constant boiling mixture with water (called an azeotropic mixture). The separation of the excess water, or dehydration, is normally achieved by introducing a volatile solvent into the mixture that entrains the remaining water (azeotropical drying). Benzene has been the most common entrainer, although cyclohexane, gasoline and ether (in pressurized systems) have also been used because of benzene's carcinogenicity.

Several energy saving alternatives have been developed for alcohol drying. One approach uses molecular sieves which are zeolite beads that selectively absorb small water molecules. As wet ethanol passes through a column of these sieves, water is absorbed and a dry ethanol product is obtained. The sieves eventually become saturated with water and must be regenerated by heating the column to drive the water out. This technology is offered by Linde (Union Carbide) and is used commercially in at least one U.S. distillery. Another alternative is drying by pervaporization, which uses membranes that have selective permeability. By pumping aqueous ethanol at elevated temperature and pressure by such membranes, only the water passes through the membrane and is selectively removed. This technique has been tested at small scales (up to 2,000 gallon/day) but no commercial installations are yet operating [4]. Cost and energy requirements for these drying alternatives are compared with conventional azeotropic distillation in Table 2.1.

Despite the estimated energy and/or capital savings of new drying technologies, the team recommends against using them in an initial project. First, the distillation/drying section of the distillery should be oversized initially, in order to take advantage of fermentation improvements added later which effectively increase plant capacity. The new technologies do not have the engineering scale economies of conventional distillation and azeotropic drying systems, and would entail significant cost should the distillery retrofit new fermentation techniques such as yeast recycle. Another drawback cited is that azeotropically-dried ethanol will be contaminated with trace amounts of solvent and will, therefore, be unsuitable for potable and industrial alcohol markets. However, potable alcohol does not have to be rendered anhydrous for sale, and the industrial alcohol market in Honduras is very small. Small-scale molecular sieve and pervaporization systems can be operated without an unreasonable penalty in cost per unit of dry ethanol produced, if a distillery using azeotropic drying wants to produce ethanol for the industrial market.

Table 2.1: Comparison of Ethanol Drying Systems

SYSTEM	Initial Investment (60,000 liter/day installation, US$)	Energy Required (KCal/liter)	Cost of Operation (US$/liter)
Azeotropic			
80 to 95%	350,000	1,400	0.040
95 to 99.5%	250,000	600	0.032
Total	600,000	2,000	0.072
Molecular Sieves			
80 to 95%	350,000	1,400	0.040
95 to 99.5%	350,000	400	0.017
Total	700,000	1,800	0.057
Pervaporization			
80 to 99.5%	480,000	250	0.042

Source: Ref [5]

2.1.4 By-Product Recovery Systems

Much research has been devoted to the development of by-product applications because of the benefits that such sales offer. There are a number of options for further upgrading of by-products to obtain value-added products. Some of these upgrading technologies are currently used commercially and, therefore, represent options for possible implementation in a Honduran alcohol program.

2.1.5 Carbon Dioxide

For every gallon of alcohol a distillery also produces 4.6 lbs. of carbon dioxide. Its most common applications are for beverage carbonation and dry ice production, however, CO_2 is probably the most under-utilized distillery by-product because of its low market value and high transport cost. Synthetic applications such as urea manufacture have been declining, but new applications such as enhanced oil recovery have helped bolster demand in some locations. A number of on-site applications, such as using CO_2 as a carbon source for the production of high protein algae by photosynthesis are currently under investigation [6].

The cost for carbon dioxide recovery, cleaning and compression are significant. A system for recovering 10 st/day of carbon dioxide from a 120,000 liter/day distillery is quoted at $500,000 and total costs for CO_2 production are estimated to run 3-4¢/lb carbon dioxide [7]. This cost compares quite favorably with the cost in Honduras of CO_2 recovery from flue gas. This is approximately 7¢/lb at scales below 10^6 scf/day (10 st/day = 2×10^5 scf/day).

2.1.6 Yeast

For every gallon of ethanol, 1/3-to-2/3 lbs of yeast is produced. The exact quantity depends upon whether yeast recycle is in use and in other operating practices of the distillery. Yeast production is flexible and can be increased

easily to meet a strong demand for the product. Yeast is one of the most often utilized by-products of distillery operations because of its high protein (45-55%) and vitamin content as shown in Table 2.2. It generally has a value comparable to that of soybean meal which ranges from 15-20¢/lb dry weight in Honduras [5].

Table 2.2: Composition of Brewer's Yeast

COMPONENT	Percent of Total
Protein	54.7%
Ash	7.0%
Moisture	3.3%
Calcium	0.12%
Fat (ether)	2.1%
Phosphorous	1.5%
Total Lipids	5.6%
Sodium	0.04%
Carbohydrates (by diff.)	29.4%

Yeast is easily separated by centrifuging the fermentation broth and is usually sold by distillers in wet form to local markets where it is used in feed formulations for poultry, swine, livestock and aquaculture. The total investment for yeast recovery, spray drying, and bagging is estimated to be $618,000 for a 120,000 liter/day distillery excluding the centrifuge and $1 million including the centrifuge [8] (the suitability of idle sugar mill centrifuges for yeast recovery must be investigated). Since it is a good product its own right, there is no need for further upgrading except, perhaps, to dry it.

2.1.7 Bagasse

For every gallon of ethanol produced from sugarcane juice, 17.5 lbs. of bagasse (dry weight) is generated during cane milling. Bagasse is a lignocellulosic material similar to hard wood in compostion and can be used in many of the same applications. Sugar mills have relied upon the use of bagasse for fuel and although an energy-efficient sugar mill could generate a 15-20% bagasse surplus, most mills have sought to eliminate bagasse surpluses to avoid the problem of disposal. As energy costs have risen, however, and the value of by-products has become more apparent, efforts to conserve bagasse have increased. A modern autonomous distillery in Brazil yields a surplus of 2.2 lbs. of bagasse (dry weight) per gallon of ethanol after the energy requirements of the distillery have been met [9].

Surplus bagasse can be sold to others as fuel or it can be used within the mill to generate electric power which might then be sold to local utilities. Techniques have been developed for the preservation and densification of bagasse to make it a more attractive fuel for home cooking and other energy applications.

Bagasse is also used as a bulk fodder for cattle and other ruminants. Bagacillo, fine bagasse derived from cane pith which can be separated from the raw bagasse fiber during milling, is more digestible to ruminants than raw bagasse and is more valuable. The limited digestibility of raw bagasse has prompted investigations into

treatment methods to enhance digestibility. By breaking down the structure of the bagasse (hydrolysis), a much greater proportion of the bagasse feed will be used by the animal. There now exist low-cost methods using steam, caustic soda and hydrogen peroxide for converting raw bagasse into a highly digestible fodder [9, 10, 11]. The properties of bagasse before and after treatment are shown in Table 2.3.

Table 2.3: Comparision of Raw and Autohydrolyzed Bagasse

Determination	Raw Bagasse	Autohydrolyzed Bagasse
Dry Matter (%)	48.31	44.32
Raw protein (g/100g dry matter)	1.86	1.67
Raw fiber	45.09	34.45
Cellulose	44.69	43.99
Hemicellulose	22.91	--
Lignin	14.89	15.06
Ether Extract	2.26	4.86
Mineral Matter	2.73	4.77
Non-nitrogenated Extract	48.06	54.25
In-vitro Digestibility of Dry Matter (%)	35.31	64.82
Animal weight gain (g/day)	610	1160
Feed consumption rate (kg/day)	7.2	11.8

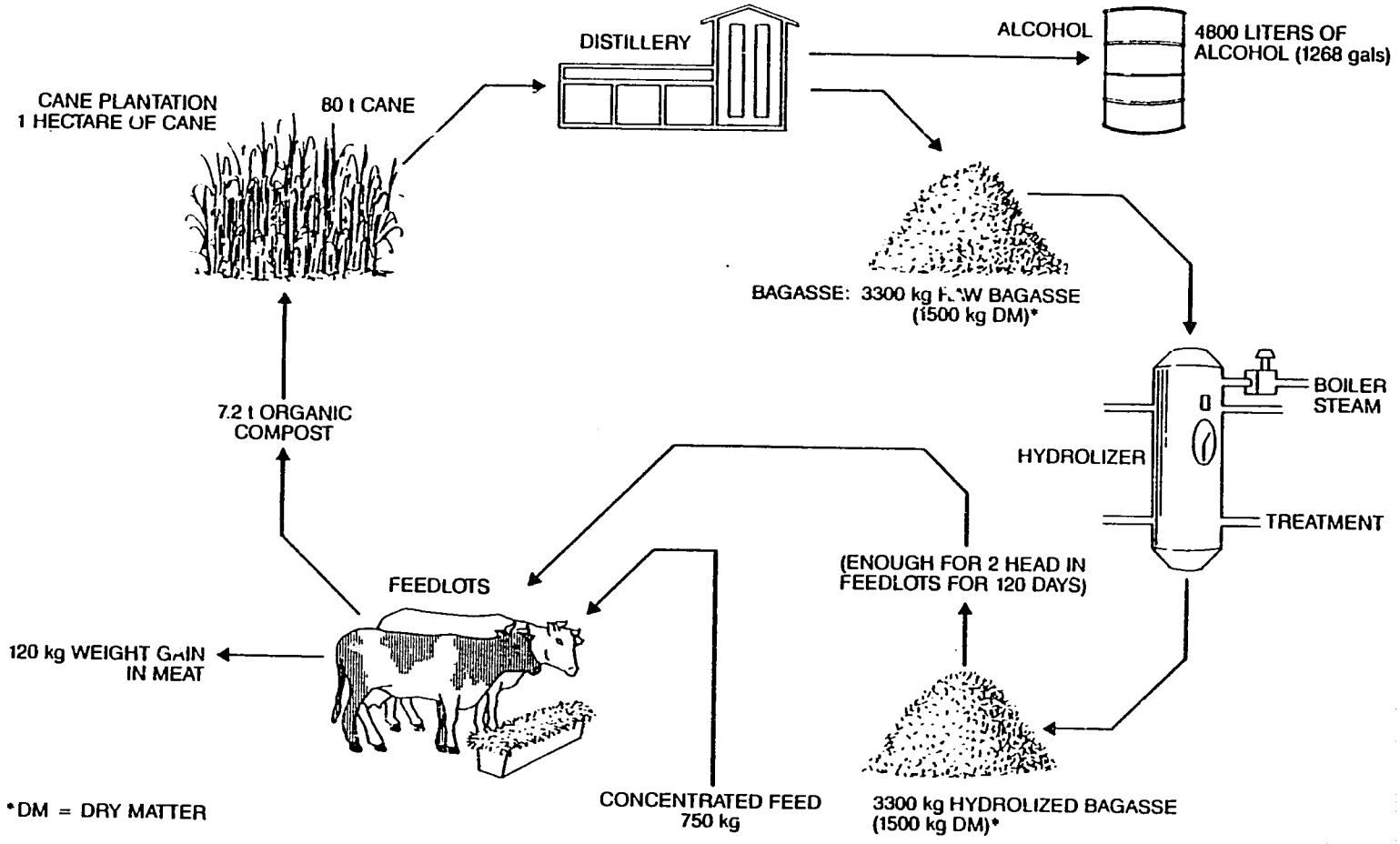
Source: Ref [9]

The steam treatment option is attractive because most sugar mills and distilleries have surplus steam available, although caustic treatment can be used when the steam plant is not in operation. Bagasse feed produced by steam autohydrolysis costs $30.80/ton (dry weight, July 1985 quote) compared to $27.90 - $30.80/ton (dry weight; January 1985 quote) for feed prepared by caustic soda. (This includes the cost of protein, urea and salt additives needed to formulate a balanced feed.) Yeast by-product also can serve as the protein complement of the feed.

Bagasse feed options allow integrating the operations of a distillery with the surrounding livestock industry and add value to the sugarcane enterprise. An efficient 120,000 liter/day distillery, for example, can produce enough bagasse feed to support 3,000 head of cattle. These mutual relationships are depicted in Figure 2.2. Sugar firms in Honduras have begun developing feeds on a limited basis, and the livestock industry is beginning to experience new investment. Opportunities to pursue joint development should be looked at closely under an alcohol project.

Other uses for bagasse include furfural production, paper and fiberboard, and as a source of fermentable sugars for the off-season. Furfural is a reasonably valuable (66¢/lb) but low volume specialty chemical and only a few furfual plants are needed to meet current demand. For the production of paper and fiberboard, larger quantities of bagasse than are potentially available in Honduras are needed. Lastly, an innovative bagasse application is the research by Dedini (Brazil) on the production of fermentable sugar for the off-season by bagasse hydrolysis, termed ACOS, for acid catalyzed organoslov process. Large sugar yields are achieved

Figure 2.2:
Integration of Livestock Production with an Alcohol Distillery



and the process is currently being scaled up to a 100 liter/day pilot facility [12]. Although additional development work is required before the process is commercial, this technology could address the problem of the seasonal operation of sugarcane-based distilleries, given sufficient bagasse availability.

2.1.8 Stillage

For every gallon of alcohol, 10-16 gallons of wastewater containing 6-7 lbs of organic wastes are produced. This wastewater, or stillage, vinasse or slops, is heavily contaminated with organic compounds and nutrients (Table 2.4). Stillage composition will vary depending upon the feedstock, with solids concentrations ranging from 1.2% for corn to 6.7%-8.7% for blackstrap molasses [13]. The disposal of stillage is one of the major problems associated with distilleries and a host of treatment options (shown in Figure 2.3) have been investigated.

Table 2.4: Composition of Stillage From a Distillery Using Cane Juice

Constituent	Percent(%)
Water	98.58
Solids	1.42
Protein	0.22
Gums	0.33
Sugars (mostly reducing)	0.17
Glycerine	0.08
Lactic Acid	0.08
Fiber	0.01
Lignin, phenols, etc.	0.19
Ash	0.22

Source: Ref [5]

Bio-oxidation of stillage using activated sludge technology can provide a clean effluent, but costs 4¢/gallon of ethanol, produces large quantities of sludge that require disposal and affords no by-product credit [14]. In the U.S., stillage is concentrated and sold as a feed supplement, affording a by-product credit of 3-5¢/gallon of ethanol; however, evaporation equipment and energy costs run as high as 17¢/gallon of ethanol. Reverse osmosis is also being explored as a more energy-efficient method of concentrating stillage; however, this requires first removing stillage solids, and operating costs are estimated to be at least 4¢/gallon ethanol [15].

As has been noted, many distilleries use stillage as an irrigation supplement for cane fields adjacent to the distillery. A holding pond may prove necessary to minimize problems caused by suspended solids and to give the stillage an opportunity to cool. Its fertilizer values (shown in Table 2.5). are generally less than a tenth of its potential feed value, but "ferti-irrigation" can cost little if an irrigation system is already in place, provided that there are no significant costs in bringing stillage to the irrigation head. Experience now spans about 10 years of practice in Mexico and Brazil. The primary risk is over-application, which can promote growth of harmful micro-organisms which can compete with cane for nitrogen, and over the long term,

Figure 2.3:
Stillage Disposal and Recovery Processes

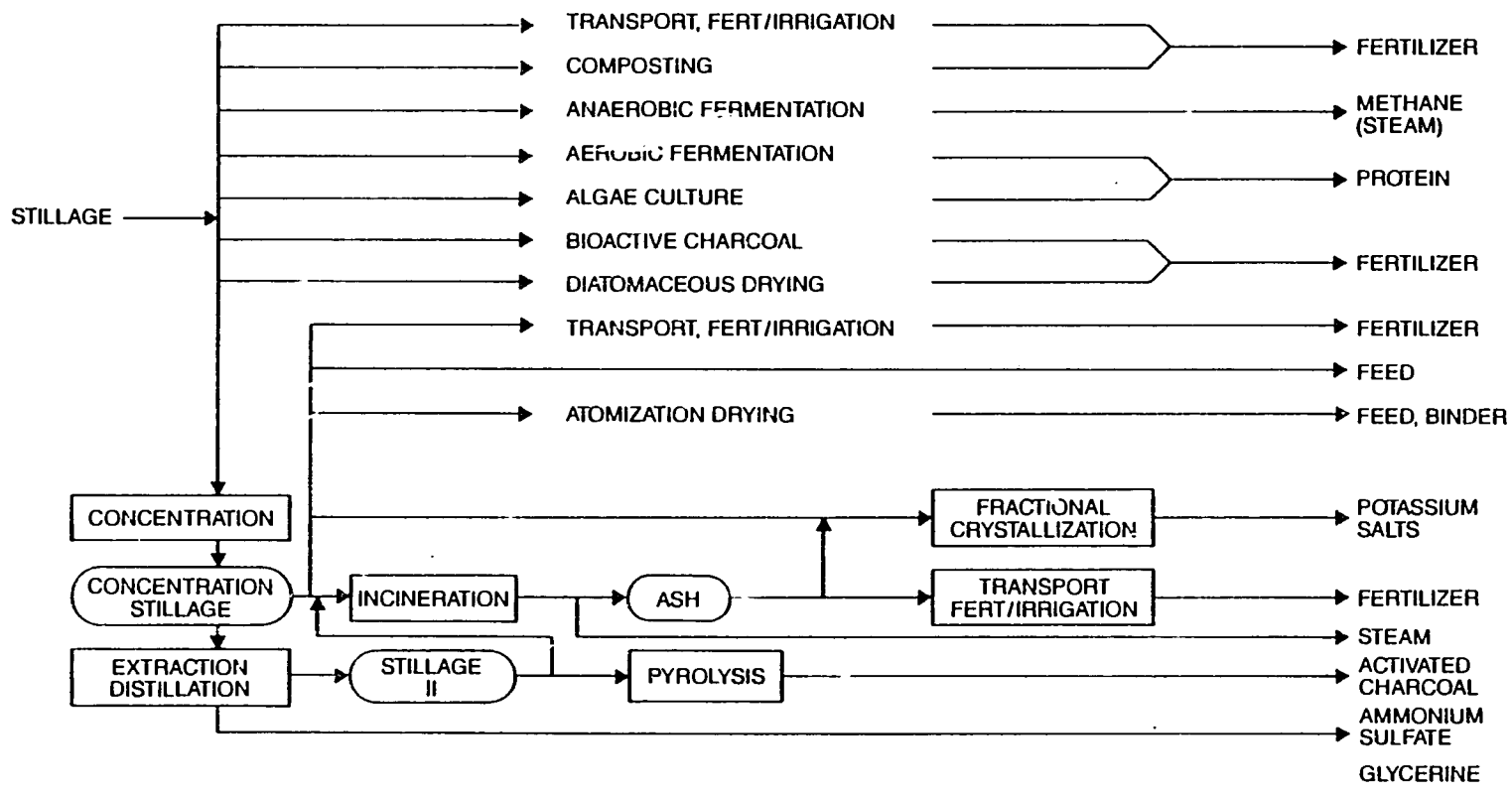


Table 2.5: Fertilizer Values of Stillage
(kg per m^3 of Stillage)

Stillage Substrate	Ammonium Sulfate	Super Triple Phosphate	Potassium Chloride
Molasses	6.0	0.4	13.0
Cane Juice	1.5	0.4	2.0
Mixed	3.5	0.4	7.7
Cassava	2.5	0.2	7.8

Source: Ref [15]

the accumulation of salts and heavy metals should be monitored. Stillage loadings range from 35-50 m^3/Ha/harvest to as high as 400-500 m^3, depending upon stillage strength [15, 16]; stillage salt concentration should be below 1,000 ppm [16]. At these levels no adverse effects should be encountered.

Another commercial practice for stillage treatment is anaerobic digestion for methane production. Bacardi, Badger, Sorigona and Dedini all offer stillage digestion systems. This approach is sometimes attractive because a useful energy product, methane, is obtained, but it involves a substantial capital investment. The reported cost for the Bacardi system is $1.50-1.75 per 10^6 Btu of methane produced, or 2.4-2.9¢/gallon of ethanol [17]. This system was developed for high strength rum distillery slops, however; if applied to the much thinner stillage from a cane juice-fed distillery, the costs would be considerably greater. Methane would have to be at least twice its current value for there to be a positive return on an anaerobic digestion system investment.

Other approaches that are beginning to be used commercially are the use of stillage in single cell protein production, hydroponic gardening, and plant and animal aquaculture. In the U.S., Archer Daniels Midland employs stillage as a source of nutrients and heat for the hydroponic gardening of vegetables and is currently expanding operations. Some applications involve organisms "feeding" on stillage to produce protein and other foods. In Australia, for example, a rum distillery has installed a unique single cell protein system that uses the fast-growing yeast, Candida ingens, to produce yeast protein from stillage while reducing the wastewater BOD (Biological Oxygen Demand) [18]. Feeding trials indicate that the yeast protein can fully replace other feed protein ingredients such as casein. The by-product credit for this protein amounts to 10¢ or more per gallon of ethanol [19].

In aquaculture, stillage is degraded by micro-organisms, releasing nutrients and carbon dioxide which are than used in algae production by photosynthesis and the algae are, in turn, eaten by fish and other animals [20]. Some species of fish (tilapia) can tolerate high stillage loadings, but most commercially important species do not tolerate direct application [21]. The filamentous algae Spirulina, however, can be grown on stillage at very high productivities and harvested easily, contains 70% protein, and is an excellent substitute for soybean meal in a range of aquaculture and animal feeds [22]. Distillery carbon dioxide, which is usually vented, can serve as an additional carbon source. It is possible to produce more than 2 lbs. of algae for every gallon of ethanol and a production cost under 15¢/lb algae appears feasible in a setting where raw materials are already provided [23].

2.2 Recommendations for a Honduran Distillation System

This section sets forth the team's recommendations concerning the configuration for a fuel alcohol distillery in Honduras. It follows the process flow path of alcohol production. The industry should, initially, take a conservative approach and use proven technologies. However, provisions should be made to allow for future improvements in fermentation technology and for the possible use of supplemental feedstocks.

2.2.1 Feedstock Preparation and Storage

Since the purpose of alcohol production in Honduras is to replace world market sugar, cane juice is the principal feedstock for the distillery. Juice must be used immediately, so the distillery is constrained to operate during the period when sugarcane can be harvested and delivered to the plant. Although rigorous standards on feedstock sucrose content are unneccessary, harvesting is still only possible during the dry season; thus, under reasonable conditions a distillery in Honduras can operate on cane juice for a period of 180 days (up to 200 days under the most favorable conditions).

Molasses could be used as a supplemental feedstock during the off-season but this is not presently recommended because:

- Molasses markets are currently strong.
- The distillery may need alternate fuels (probably fossil) to operate during the off-season.
- Storage capacity for molasses would probably have to be installed.
- Pretreatment of blackstrap molasses would probably be required to minimize contamination of the fermentation and fouling of equipment.
- Molasses may, however, provide an important feedstock to extend distillery operation when markets warrant; an example of this is discussed in Appendix B.

There is some potential for using feedstocks such as sorghum and banana wastes during the off-season although neither is recommended initially. Sorghum has the advantage of providing sufficient residues to meet fuel needs and of being suitable for sugar extraction using the cane crushing equipment. Banana wastes and other starchy feedstocks will first require saccharification. No additional equipment need be installed initially but, the distillery should be laid out to allow space for a saccharification section if one is desired in the future.

Feedstock pretreatments such as filtration or sterilization are often needed when continuous fermentation technology is employed or when dirty feedstocks like blackstrap molasses are used. Since batch fermentation and clarified cane juice are recommended, there is no need for a pretreatment station.

2.2.2 Fermentation

Batch fermentation is recommended for initial use by a Honduras distillery. The first step is preparation of the yeast, Saccharomyces cervisiae that performs the fermentation. The yeast is available commercially in the form of ampuoles which are kept refrigerated until use. It is first propagated under sterile laboratory conditions and then transferred and grown in successively larger vessels (stainless steel propagators and pre-fermenters) until there is sufficient yeast to innoculate the fermenters. Yeast propagation is carried-out under aerobic conditions; contamination should be minimized by using air filtration and by sterilizing nutrients and vessels employed.

The fermenters (probably 8) will be arranged in parallel and should be made of 304 stainless steel or better. Nozzles entering and exiting the tank should be fitted tangentially to the surface of the vessel. Conical roofs should be provided to permit the recuperation of CO_2 and the condensation and recovery of ethanol vapors. Temperature control is effected by re-circulating the fermentation broth through "paraflow" plate-type heat exchangers. A water cooling system may be required for the fermenters unless sufficient quantities of cold water are available.

The sugar rich juice from the clarifiers (at a brix no higher than 30° and a temperature no higher than 32°C) is first charged into the fermenter to about 1/3 capacity. The yeast innoculum is transferred from the pre-fermenter (constitutes about 3% of the fermenter volume) and the fermenter is then filled with juice. The sugar content of the solution is regulated to produce an 8-10% alcohol concentration in the final fermentation broth going to distillation. Fermentation is performed under anaerobic conditions and should be completed after 30 hours at 37°C. If the fermentation temperature is allowed to exceed 37°C the yeast will die and ethanol production will cease. The completed fermentation broth, containing 8-10% ethanol is then pumped to a holding tank which feeds into the distillation section. Batch fermentations are staggered to provide a continuous feed from the holding tank to distillation. The fermented batch cannot stand long or it will deteriorate and undesired by-products will form.

2.2.3 Yeast Recovery

Yeast recovery is recommended for the distillery to produce yeast for sale as a feed ingredient. Recovery is best achieved by centrifuging the fermentation broth before it is fed to the holding tank for distillation. At this point, the yeast will still be viable and the live yeast could be separated from the dead, sanitized, and re-used in subsequent fermentations. This requires some sophistication in yeast handling, and the need for feed protein ingredients in Honduras is so great that yeast is a desirable distillery co-product. One of the sugar centrifuges freed up by diverting cane juice to alcohol is a possibility, but its suitability for this purpose must be confirmed.

Yeast coming off the centrifuge will be approximately 20% solids and will decompose rapidly unless dried. Yeast drying by spray drying (or drum drying) is recommended to provide a dry yeast product (8% moisture or less) which is then bagged for distribution. If the distiller chooses to institute yeast recycle in the future, then the recovery system will already be in place and only a yeast separation and sanitization section need be added.

2.2.4 CO_2 Recovery

Although there is a modest demand for CO_2 in Honduras by bottling companies, only 20-25% of the CO_2 available from one distillery could be sold. This may not justify the installation of CO_2 recovery and compression equipment by the distiller. However, the bottler may choose to install its equipment at the distillery and pay the distiller a small price for crude CO_2. It is, therefore, recommended that the distillery not install CO_2 recovery equipment unless a larger CO_2 market develops. The distillery should, however, explore possible cooperative arrangements for CO_2 recovery with bottlers in Honduras.

2.2.5 Distillation

The most important factor in selecting distillation equipment is the desired energy efficiency of the system, which must be balanced with cost of equipment. Efficiency improvements in the last few years have resulted in the availability of numerous distillation and drying process. Another determining factor is the performance of distillation equipment when operating below its rated capacity. The distillation section should be over-sized by 20-25% so that future improvements in the productivity of the fermentation section (such as by continuous fermentation) can be exploited in increasing the overall output of the distillery. Again, equipment should be selected which allows operation below rated capacity without undue sacrifices in energy efficiency.

It is also recommended that the entire system be purchased from a single manufacturer, in order to have the fullest protection by guarantees, to avoid extra engineering work needed to couple equipment from different manufacturers, and to obtain the most energy-efficient, logical flow possible. Although more sophisticated dehydration technologies based upon molecular seives and pervaporization have been proposed for Honduras, the team recommends using conventional dehydration technology based on azeotropic distillation. Since the most commonly used azeotroping solvent, benzene, is a carcinogen, the use of cyclohexane is recommended. If this choice of solvent presents problems for obtaining turnkey packages from manufacturers, then benzene can still be used as long as adequate safety procedures are followed.

A final consideration in selecting distillation equipment is the operating steam pressures for which the equipment will function efficiently. The exhaust steam available to the distillery from the mill is low pressure and should match the requirements of the distillation equipment chosen.

2.2.6 Alcohol Storage

Only a small alcohol storage tank should be installed on the distillery site. The principal location for storage of alcohol in quantity should be at Puerto Cortes, preferably inside the Texaco refinery grounds, since this is the channel through which alcohol would either be exported or distributed domestically.

2.2.7 Stillage (Vinasse) Disposal

The team has verified that most distillery sites in Honduras are suitable for the disposal of stillage by ferti-irrigation using existing irrigation systems. Since the stillage from a distillery using cane juice will be relatively dilute, the more liberal loading standard of 500 m^3/Ha/harvest should apply and this would require 690 Ha of irrigated lands for a 120,000 liter/day distillery operating 180 days/year. A distillery capable of producing 150,000 liters a day would require 860 ha of irrigated land. Soil studies and stillage analyses should, however, be performed before committing to this disposal option. A holding pond is also recommended so that suspended solids will first have an opportunity to settle and so the stillage can cool to ambient temperatures. It would also be necessary to pump or otherwise transport the stillage to the head of the irrigation system.

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3. SITES

3.1 Introduction

This section examines site-specific attributes of the 8 sugar mills as candidates for annexed distilleries. It stresses three principal considerations:

- Size and characteristics of the mills;
- Location relative to alcohol markets;
- Availability of markets for distillery by-products.

The assessment team recommends a Honduran distillery(ies) be annexed or retrofitted to an existing sugar mill(s). Annexation takes advantage of existing utilities and cane crushing capacity, reducing total costs by more than a third compared to an autonomous distillery. It also permits a return to sugar production should world market prices recover. The principal considerations are the capacity of the mill to support commercial-scale distilleries, cane availability, season length, and the condition of the mill, particularly the condition of the utility system. These subjects are treated in the sections which follow. Information is also provided on the size (or potential size) of the markets for the commodities discussed.

3.2 Production Capacity

The sugar mills in Honduras are small-to-average by industry standards, ranging from 1,500-5,000 tons of capacity per day. The standard scale for cane-based distilleries is 120,000 liters, which requires approximately 2,000 tons of sugarcane (@ 60 liters/ton of cane).

In the case analyzed in this study, the goal is to reduce the industry's dependence on the export of "world market" sugar. This could be acomplished by the installation of two distilleries, one of 150,000 liters a day and a second of 120,000 liters/day. Accordingly, the analysis of costs and benefits in this report examines installations of both kinds.

A variety of considerations must be taken into account in choosing the proper scale of distillery. Generally speaking, the larger the distillery the lower the costs of production, a factor which favors the larger facility. On the other hand, a proper "match" between the distillery and the cane mill is also important. Where possible (as is the case with Villanueva), it is best to dedicate a mill entirely to alcohol production.

First, the dedicated mill does not have to meet the dual processing requirments of sugar and alcohol; juice goes directly to alcohol, and technical and administrative activities are reduced. Second, the energy requirements of alcohol production are less than for sugar, which could reduce fossil fuel consumption or make larger

quantities of bagasse available. Third, capital utilization rates of sugar mills can increase by lengthening the grinding season, and using cane tops and "sour" or overly mature cane not suitable for sugar production. Many mills currently have grinding seasons of less than 100 days, but could increase this by 20-25% by harvesting cane for alcohol. Fourth, molasses transportation is eliminated, since any produced could be used as alcohol feedstock. Blackstrap or high test molasses could also be stored for use in the distillery after the grinding season, and fuel requirements could be met from bagasse savings. Altogether the benefits of dedicating a mill to alcohol are subtantial; an illustrative case is developed in Appendix B.

3.3 Facility Characteristics

Major savings can be realized if an annexed distillery does not require the installation of new utilities. This appears to be the case in Honduras since nearly all the mills currently have surpluses of low pressure steam required for distillation. There may also be significant energy savings with alcohol processing. For example, the steam requirement (low pressure) for a 150,000 liter/day distillery is 51,320 lbs/hr, while the decrease in steam required for the sugar factory is 76,661 lb/hr, for a net reduction of 25,361 lb/hr of steam [1].* Such a steam reduction could reduce bagasse consumption by 106 st/day (wet weight) or 2.67 lb (dry weight) of bagasse saved per gallon of ethanol.

The potential for conserving energy depends largely on whether there will be economies in the high pressure steam requirements to run the mill's turbines and turbogenerators with the distillery option. In nearly all cases this will impose a major constraint to potential bagasse savings and would require major modifications in mill utilities if a surplus of bagasse is to be achieved. There also seem to be utility system efficiency improvements aside from the distillery option that could reduce fossil fuel and electric power purchases or that could make more bagasse available for other uses; these options should be evaluated separately.

Technical and managerial expertise available at sugar factories appears sufficient to undertake and operate a distillery. Additional training will be needed, and the trained work force will require expansion if alcohol and sugar are produced together at a given site. A company's technical expertise will, however, influence its ability to subsequently introduce improvements in fermentation, distillation and by-product technology and this might affect a company's long-range potential for fully exploiting the alcohol option.

Lastly, the exact nature of a mill must be analyzed in the course of a full distillery feasibility study. This includes factors such as the mill layout, land for the distillery, availability of water supplies, utilities, structures, and other mill equipment that can be employed in the service of a distillery.

* References cited in [ ]'s are found at the end of the section.

3.4 Grinding Seasons and Off-Season Feedstocks

A disadvantage in using sugarcane juice as a feedstock for alcohol production is its seasonal availability. The grinding season in Honduras ranges from 90-180 days depending on cane availability and mill location, so a juice-based distillery could operate only half the year, at best. If sugarcane is used exclusively for alcohol production, the harvesting period can be extended to 200-220 days because the need for maximum sucrose (versus invert sugar) content is reduced. Both kinds of sugar can be fermented to alcohol with equal yields. It is also possible to recover cane tops and culls normally high in invert sugar and this can enhance acreage yields by as much as 20% [2]. If the mill is also producing crystalline sugar, however, these options cannot be exercised.

In Brazil, several distilleries have been modified to utilize cassava as an alternative feedstock during cane's off-season. Cassava is a tuber widely grown in the tropics, whose starch must be saccharified to glucose before fermentation. The addition of a saccharification section to the distillery is required, and this section would be idle during the cane grinding period. The penalty in idling a saccharification section half the year, however, is much less that for idling the distillery.

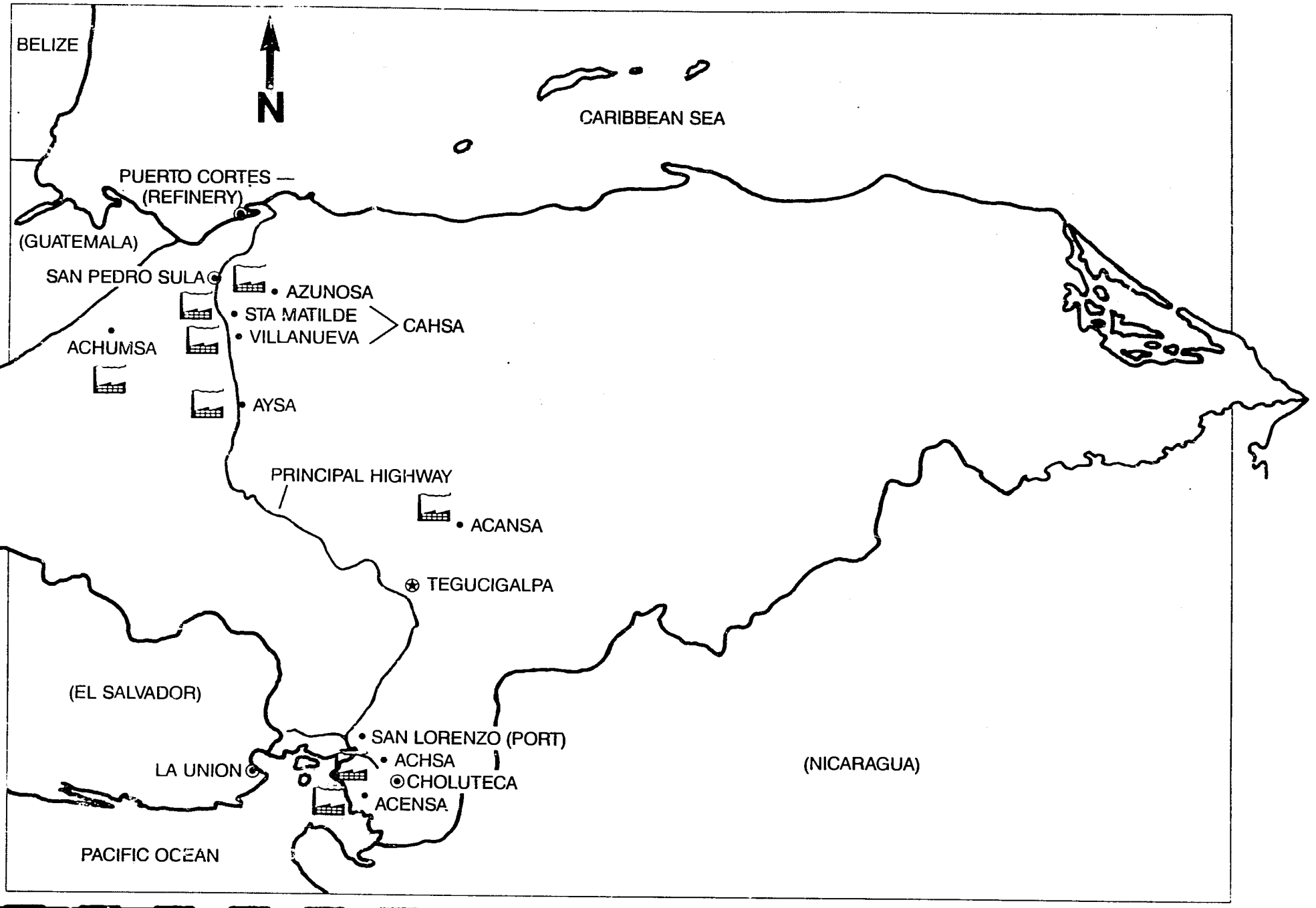
Cassava is not an important crop in Honduras, but large quantities of bananas are produced for export (1.98 billion lb. projected for 1986) [3]. Bananas are harvested year round and 26% of the bananas delivered to processing facilities are rejected [4]. Half the rejects (rough estimate available in San Pedro Sula Valley area) could support a 60,000 liter/day distillery. As a starchy feedstock, bananas must first be saccharified. This is being done on a pilot commercial scale in Colombia, and the estimated cost for a saccharification unit is US$ 660,000 (installed, 60,000 l/d alcohol distillery) [5]. The added capital costs may be easily justified if feedstock costs are low as anticipated. This should be regarded as a mid- or long-range option, meriting attention perhaps in laying out the distillery so that a saccharification unit could be added in the future.

Another feedstock proposed for the off-season is sorghum [6]. Although the San Pedro Sula region has sufficient agricultural potential to supply off-season feedstock for distilleries, it is unlikely that other regions of Honduras would be able to do so without severely compromising food production.

3.5 Location Relative to Alcohol Markets

If a distillery is poorly situated in relation to alcohol and gasoline distribution systems transportation costs can be high. The locations of the seven sugar companies in Honduras are shown in the map on the following page (CAHSA has two mills, Santa Matilde and Villanueva, in close proximity). Five of the eight mills are located in the north. The population of Honduras is just over 4 million, with 37% concentrated in the two principal urban areas: San Pedro Sula in the north and Tegucigalpa in the south central region. Industrial development is concentrated around San Pedro Sula. The Choluteca region in the south is also heavily populated although there is little industrial development.

Figure 3.1:
Map of Honduras



3.5.1 Export Alcohol Market

There are two potential markets for Honduran fuel alcohol: an export market for sales to the United States, and a domestic market for blending with gasoline. The ethanol market in the U.S. is large and expanding. Demand for alcohol is expected to be nearly one billion gallons in 1986, up from over 725 million gallons in 1985. This is 200-300 million gallons/year over effective U.S. alcohol production capacity. Countries covered by the Caribbean Basin Initiative (CBI), including Honduras, have an advantage in exporting to meet this demand because they are exempt from 64¢/gallon in duties (and ad valorem taxes) that are otherwise imposed on U.S. fuel ethanol imports. In addition, ethanol tax benefits in some states (Alabama 3¢/gallon, Florida 2¢/gallon) also apply to imports.

Despite the projected demand for ethanol in the U.S., there are a number of uncertainties at this time associated with alcohol trade policies and oil prices (see Appendix C: US Alcohol Market and Trade Issues). Ethanol prices are currently soft, ranging from $1.04-1.30/gallon CIF, Gulf Coast (late April 1986). Producers in the U.S. expect increased demand to push up prices by summer, and several producers have been able to secure contracts for alcohol at $1.70/gallon in states offering added subsidies. Assuming that prices do firm up (to $1.35-1.50), but that CBI producers have to discount by 10¢/gal to win sales, then export alcohol may be able to obtain $1.25-1.40/gallon on the Gulf Coast or $1.18-1.33/gallon at Puerto Cortes. The financial and economic analyses use a $1.25 price.

The export of alcohol requires transportation to a deepwater port for shipping. Puerto Cortes, on the Caribbean coast in the northwest of the country, is Honduras' principal port and also the location of its single refinery (Texaco) and the gasoline distribution system. Gasoline is shipped by trucks to service stations throughout the country from Puerto Cortes, returning empty. Distilleries located in the north along the main route connecting Puerto Cortes, San Pedro Sula and Tegucigalpa could transport alcohol to the port using the returning trucks. At an estimated usual cost of 4¢/gallon/100 kilometers, savings could be significant. Only a nominal investment is needed to install tankage facilities.

Savings in shipping costs can also be realized because tankers now delivering gasoline and other refined products to Honduras (via Puerto Cortes) return empty to the U.S. Thus, a major portion of the 7¢/gallon cost of shipping alcohol from Puerto Cortes to the U.S. Gulf Coast could be saved. In the south, the deepwater port at San Lorenzo is suitable and is currently used for molasses exports from ACENSA and ACHSA. By using both Caribbean and Pacific Ocean ports, Honduras could take advantage of any favorable differences in the purchase price of alcohol between the U.S Gulf and West coasts. Although incoming fuel shipments to San Lorenzo in the south are limited, extensive traffic through the nearby port at La Union could present a similar savings (see map).

Table 3.1 indicates that transportation costs can differ by as much as 10¢/gal for different potential distillery locations. For distribution to Puerto Cortes, the three sites near San Pedro Sula (CAHSA, AZUNOSA, AYSA) have the lowest transportation costs. On-site storage requirements might also be greatly reduced.

Table 3.1
Transportation Costs for Distillery Sites

Factor	CAHSA	AZUNOSA	AYSA	ACHUMSA	ACANSA	ACENSA	ACHSA
Domestic Market							
Destination	P. Cortes	P. Cortes	P. Cortes	P. Cortes	P.Cortes	Tegucigalpa	Tegucigalpa
Distance (km)	60	85	147	180	303	142	140
Transportation Cost (¢/gal)	2.8[1]	3.4[1]	5.9[1]	7.2	12.1	5.7 (15.5)[6]	5.6 (15.4)[6]
Facility Needs	BF, SS[2]	BF, SS	BF, SS	BF, SS	BF, SS	BF, BFS	BF, BFS
Export Market							
Destination	P. Cortes	P. Cortes	P. Cortes	P. Cortes	San Lorenzo	San Lorenzo	San Lorenzo
Distance (km)	60	55	147	180	138	34	32
Transportation Cost (¢/gal)	2.8[1]	3.4[1]	5.9[1]	7.2	5.5	1.4	1.3
Facility needs	SS	SS	SS	SS	SS, PSL[5]	SS, PSL	SS, PSL

1 can potentially use-empty Texaco tankers returning to the refinery
2 BF - blending facility
3 SS - site storage
4 BFS - blending facility storage
5 psl - port storage and loading facility
6 Cost if alcohol has to be transported to San Pefro Sula

3.5.2 Domestic Alcohol Market

Alcohol-gasoline blends are not currently sold in Honduras, but could be with little technical difficulty. Alcohol can be blended with gasoline up to 20% (by volume) with no need for engine modifications. Given gasoline demand of 35 million gallons per year, up to 7 million gallons of alcohol could be consumed domestically. Since the conversion of all Honduran "world market" sugar to alcohol would yield over 13 mm gal/yr, a demand for up to 55% of this ethanol could be created by implementation of a domestic alcohol fuels program if domestic blending were economically attractive (this question is examined in Section 5.4).

Alcohol can be blended in two ways. It can be transported to Puerto Cortes and blended with gasoline refined or imported there, or it can be transported to the major gasoline markets and blended there. Texaco is receptive to the use of ethanol in blends, although a modest investment would be required for tankage and a blending facility at Puerto Cortes. Since there are no oil refineries or distribution centers in the south, alcohol produced there would have to be trucked at expense to centers of use (primarily Tegucigalpa) and blending and tankage facilities would have to be constructed. If ethanol production in the south exceeded the market available in Tegucigalpa, trucking to San Pedro Sula would be required. As in the export case, therefore, the northern sites are more suitable for distribution to a domestic market.

3.6 Markets for Distillery By-Products

Honduras presents clear opportunities for marketing distillery by-products, especially yeast, carbon dioxide and bagasse. The ability to dispose of stillage by "ferti-irrigation" is important, eliminating or reducing disposal costs. For those sites where stillage cannot be disposed of, a penalty of 4¢/gal of ethanol should be assessed (cost of aerobic wastewater treatment system).

3.6.1 Yeast

The potential market for yeast in Honduras is as a protein ingredient in concentrated animal feeds. The largest feed consumer in the country is the poultry industry, mostly located near population centers. Hogs (0.5-1 million) and cattle (2.5-3 million) are also raised but, with the exception of some dairy cattle are generally ranged-fed. Efforts are underway to intensify feeding regimes and concentrated feed demand is expected to grow steadily. The consumption of concentrated animal feeds in Honduras is shown in Table 3.2.

Table 3.2: Consumption of Concentrated Feeds

Animal	Consumption(st)	% of Market
Poultry	111,540	76.7
Cattle	21,450	14.7
Hogs	10,010	7.9
Shrimp	2,500	1.7
Totals	145,510	100.0

Source: Ref [7]

The largest feed mill is the Alcon plant in San Pedro Sula which produces 84,000 st feed/yr or 58% of the feed market. Another major feed mill exists in Tegucigalpa, and a number of smaller mills are distributed throughout the country (Copan, La Paz, Comayagua). There are no feed mills in the south although aquaculture, poultry and cattle operations are to be found there.

The most popular source of protein in feed is imported soybean meal which has a 48% protein content and constitutes 20-26% of the feed. Projected imports for 1986 are 20,280 st, with Alcon requiring 14,400 ton. Yeast at 48-52% protein is equivalent to soybean meal. A market analysis completed earlier projects a substantial demand for yeast as shown in Table 3.3. Feed prices range from $260-320/ton for poultry and shrimp and $160-$240/ton for cattle. The average price of imported soybean meal is 15¢/lb, or approximately $6 million/year in foreign exchange expenditures [8].

Table 3.3: Projected Demand for Yeast in Concentrated Feeds

Year	Concentrated Feed Consumption (MT/yr)	Yeast Demand Potential (MT/yr)	Effective Yeast Demand (MT/yr)
1986	141,941	11,355	568
1987	151,209	12,096	847
1988	160,477	12,838	1,283
1889	169,745	13,579	1,765
1990	179,013	14,321	2,148
1995	242,451	15,289	3,879

Source: Ref [6]

A 120,000 liter/day distillery would generate 1712 metric tons/year of yeast by-product (operating 180 days/year). By the earliest date of operation (mid-1987), there would be sufficient demand to consume at least half the yeast produced, and further market prospects are positive. A distillery in the South might even contemplate a feed mill operation of its own. Yeast is currently sold wet to local pig producers by the Cerveceria Hondurena in San Pedro Sula and Tegucigalpa (45 55-gal drums/week) and the brewery's spent grain sales total 4,170 MT/year. In dilute form, the yeast commands a price of $3-3.50/drum (340 lb).

Yeast is expensive to recover (capital cost estimate: $680,000), but the net return is still attractive. A sugar factory with an annexed distillery could curtail or eliminate sugar production, possibly freeing centrifuges for use in yeast recovery. Yeast recovery and spray drying would cost approximately 5¢/lb, plus the cost of transport to the feed mill. A net yeast by-product credit of 6.6¢/gallon ethanol is estimated for this analysis.

3.6.2 Carbon Dioxide

There is a demand for carbon dioxide in Honduras. Beverage bottling plants currently burn diesel and scrub the flue gas for carbon dioxide, producing the quantities shown in Table 3.4.

Table 3.4: Carbon Dioxide Demand (Beverage)

Location	Quantity (lb/yr)
San Pedro Sula	1,126,400
Tegucigalpa	803,000
La Ceiba	437,800
Total	2,367,200

The cost of CO_2 produced from diesel is high (7¢/lb) and the largest beverage company has indicated a interest in purchasing CO_2 from a distillery, if available. Carbon dioxide is also the basis of dry ice production. There is potential for introducing a dry ice industry in Honduras because of its exports of frozen beef (9 million lb/yr) and shrimp (13.2 million lb/yr). An optimistic estimate of the total market might be 4 million lb/yr, divided roughly equally between San Pedro Sula and Tegucigalpa.

The standard distillery can produce 16mm lb/yr of CO_2 (at 60% recovery), about four times the estimated demand. It is feasible for distilleries to sell CO_2 to customers within a reasonable distance; carbon dioxide recovery should cost 4¢/lb (lower if existing scrubbing equipment can be used). However, unless a greater market is identifed, there is not now sufficient justification to install a carbon dioxide recovery system in an annexed distillery in Honduras.

3.6.3 Bagasse

Bagasse and bagacillo can be used as ruminant feeds. A subsidiary of CAHSA already offers a bagasse-based feed with the ingredients shown below. About 12-16 tons/day of feed is produced at the Santa Matilde plant and sold for $70/ton.

Nutrimiel:			
Bagacillo	50%	Mineral Salts	5%
Molasses	25%	Phosphorus	5%
Protein	10%	Urea	5%

Honduras has about 4 million head of livestock, of which only a small percentage eat concentrated feeds. Natural forage is typically inadequate, however, and the six-month dry season in the south (from January to June) causes severe problems. This is the same period when sugar mills are grinding, during which bagasse can be made available as a substitute for natural forage.

Bagasse availability in Honduras is limited, but efficient sugarcane operations can generate large surpluses. Most mills have worked to eliminate bagasse surpluses by burning it in boilers for steam and electric power, albeit inefficiently. Ethanol production generally results in considerable steam savings compared to sugar, but this may not result in additional bagasse. A detailed energy audit would be required to accurately determine the results at a given mill. The analysis in this study assumes that additional bagasse available through alcohol production will be one-third of the amount theoretically available, based upon the estimated reduction in steam requirements (2.67 lb/gallon x .33 = 0.88 lb/gallon; note: 2.2 lb/gal is obtained in modern distilleries). Also, it assumes a credit for bagasse only for those mills currently producing a surplus.

3.6.4 Stillage

Cane fields adjoin every sugar mill in Honduras, and some portions are under irrigation. The amount of irrigated land per mill ranges from 900 to 3400 hectares. The standard distillery produces almost 350,000 m^3 of thin stillage per year, which at the commonly recommended loading of 500 m^3/ha/harvest requires only 690 ha of irrigated land (more conservative loading can of course, be done) for disposal. All candidate sites could, therefore, use irrigation as a stillage disposal strategy although several (AZUNOSA, ACANSA) should exercise caution because of the limited area available.

3.6.5 By-Product Summary

Even under favorable circumstances, by-product credits will only afford a modest reduction in alcohol production costs in Honduras. The maximum credit of 12.4¢/gallon is important, but well below U.S. figures for corn by-products. Table 3.5 summarizes quantities, values and costs of distillery by-products. The credits available to individual mills are summarized in Table 3.6. Results favor the location of a distillery in the north of Honduras. When combined with differences in transportation costs, site selection alone can affect alcohol costs by up to 14¢/gallon.

Table 3.5: Distillery By-Product Values and Costs

By-Product	Quantity Produced (lb/gal)	By-Product Value (¢/lb)	Cost of recovery (¢/lb)	Net Credit (¢/gal ethanol)	Transport Cost (¢/lb)
Yeast	0.33-0.66	15	5	3.3-6.6	.06/100 km
Carbon Dioxide	4.6	7[1]	3-4	8.4-11.2[2]	.6/100 km
Bagasse	0-2.2	0.04	0	0-0.088	2.1/100 km
Stillage	10-16 gal, w/ 6 lb organics	—	—	—	Impractical

1 Based on current cost from scrubbing diesel flue gas in Honduras.
2 Based on the recovery of 2.8 lb CO_2/gallon ethanol.

3.7 Site Recommendations

Table 3.7 summarizes the key attributes of each mill. The sites in the north of the country offer the highest by-product credits, the lowest alcohol transport costs, and the greatest potential for the use of alternative feedstocks. As noted earlier, Honduran "world market" sugar exports would be absorbed by the installation of annexed distilleries at two mills, one distillery of 150,000 liters/day capacity, and another of 120,000 liters/day.

Table 3.6
Estimated By-Product Credits at Potential Distillery Sites
(Basis: 120,000 l/day facility, 180 day operation)

Item	CAHSA	AZUNOSA	AYSA	ACHUMSA	ACANSA	ACENSA	ACHSA
Carbon Dioxide Market (10^6lb/yr)	4	4	4	2	2	2	2
Transportation Cost (¢/lb)	.74	.91	.87	1.1	0.20	0.85	0.85
Net Ethanol Credit (¢/gal)	2.3	2.2	2.2	1.0	1.3	1.1	1.1
Yeast							
Market Location	San Pedro	San Pedro	San Pedro	San Pedro	Tegucigalpa	Tegucigalpa	Tegucigalpa
Transportation Cost (¢/lb)	0	0.17	0.54	.072	0.18	0.85	0.85
Net Ethanol Credit (¢/gal)	3.3	3.2	3.1	3.1	3.2	3.0	3.0
Bagasse							
Availability (lb/gal)	0.89	0.88	0	0.88	trace	0	0
Net Ethanol Credit (¢/gal)	3.5	3.5	0	3.6	trace	0	0
Stillage disposal capability	yes	yes	yes	yes	yes	yes	yes
Total By-Product Credits (¢/gal)	9.1	8.9	5.3	7.6	4.5	4.1	4.1
Transportation costs[2] (¢/gal)	2.8	3.4	5.9	7.2	12.1	5.7	5.6
Net Effect of Location Factors on Alcohol Cost (¢/gal)	6.3	5.5	(0.6)	0.5	(7.6)	(1.6)	(1.5)

[2] Domestic Market

Table 3.7
Summary of Mill Characteristics

	CAHSA STA MATILDE	CAHSA VILLANUEVA	AZUNOSA	AYSA	ACHUMSA	ACANSA	ACENSA	ACHSA
Item Capacity (st/day)								
Absolute	5,000	1,500	6,000	2,200	3,100	2,200	4,200	1,800
Current	4,400	Total	3,000	2,200	2,500	2,000	3,424	1,670
Days of Operation (1985)	141	179	90	117	95	89	115	155
Area under irrigation (Ha)	3,400	Total	900	na	1,290	na	1,210	
Area under Cultivation (Ha)								
Administration	4,860	Total	1,470	na	1,510	168	1,930	1,430
Independent	7,290	Total	2,870	na	410	2,247	4,000	2,140
Interest in Fuel Alcohol	yes	yes	yes	no	no	yes	yes	no
Availability of Alternate Feedstocks	yes	yes	yes	limited	limited	no	limited	limited
Transportation Costs (¢/gal)								
Domestic Market	2.8[1]	2.8[1]	3.4	5.9[1]	7.2	5.5	5.7	5.6
Export Market	2.8[1]	2.8[1]	3.4[1]	5.9[1]	7.2	12.1	1.4	1.3
By-Product Credits (¢/gal)	12.4	12.4	12.1	8.4	10.9	7.7	7.1	7.1
Production Costs	Low	Low	Medium	Medium	Low	High	High	Low

[1]Can potentially use empty Texaco tankers returning to the refinery

SITES

For reasons explored more carefully in the section on costs and benefits, the study team believes it would be prudent to begin with one facility rather than two. The first facility would provide confirmation of financial costs and benefits, and even the smaller of these distilleries would produce enough alcohol to saturate the domestic "back-up" market at a 20% blend.

Many of the Honduran mills would be appropriate for the installation of annexed distilleries. Of the five mills in the north of the country, three (Villanueva, AYSA, ACHUMSA) are of the appropriate size for dedication to alcohol production.[1] Of the candidate mills, Villanueva exhibits the most favorable attributes in terms of operating period, flexibility in cane supply and availability of land for stillage disposal. It also has the advantage that a distillery scaled at 90,000 liters/day would absorb all of its capacity, allowing it to abandon sugar production entirely when it turns to ethanol.

The three largest mills (Sta. Matilde, ACENSA and AZUNOSA) have demonstrated interest in alcohol production and are candidates for distilleries of either 120,000 liters/day or 150,000 liters/day[2]. As in the case of Villanueva, all of these mills are technically acceptable for alcohol production, although Sta. Matilde appears to be the most appropriate in terms of location, cane supply and irrigation infrastructure.[3] Should they opt for the larger scale ethanol facility, their costs of production would be somewhat lower.

1 ACHSA, in the south, is also in this category, but mill owners have indicated that they have no interest in alcohol production. In contrast, ACANSA, in the central region, has expressed interest, but is probably the least desirable site in the country on technical grounds.

2 AZUNOSA, of the three, would have to increase its cane supply to sustain a 150,000 liter/day facility.

3 Although none of them present the same stillage disposal opportunties as does Villanueva.

References

[1] F.C. Schaffer & Assoc., Inc., "Study for Installation of Ethanol Facility," for CAHSA, Vol. 2, Baton Rouge, LA, December 1985.

[2] Klausmeier, W.H., "Evaluation of the Technology Development Component of the First Brazilian Alcohol Program", Sylvatex report to the World Bank, Elmhurst, IL, April, 1984.

[3] "Honduras Merchandise Export Trends - Volume, Price and Revenue", Office of Economic and Program Analysis, USAID, Tegucigalpa, Honduras, January 30, 1986.

[4] Communication with A. Scott, General Manager, Azucarera del Norte, El Progreso, Honduras, January 27, 1986.

[5] Quote provided by St. Lawrence Reactors, Ltd., Mississauga, Ontario, Canada, letter April 24, 1986.

[6] "Diversificacion Agro-Industrial en base de la Produccion de Alcohol y Subproductos de la Destileria Sula, S.A.", El Consult, Tegucigalpa, Honduras, December 1985.

[7] Diagnostico Agroindustrial, CONSUPLANE/Fundacion Friedrich Ebert, 1983.

[8] Communications with J. Lopez, Alcon Feed Co.; and A. Elvir, Fondo Ganadero, San Pedro Sula, Honduras, January 27, 1986.

4. COSTS AND BENEFITS

4.1 Assumptions

The goal of an ethanol program would be to improve the economic prospects of the Honduran sugar industry by diverting sugar currently sold on the world market to the production of a more profitable product. The type and scale of the facility recommended to accomplish this purpose, described in the preceding section, sets the basic terms for the analysis of the program's financial and economic attractiveness to prospective investors and to the Honduran nation as a whole. Thus the analysis focuses on annexed distilleries designed to produce anhydrous alcohol for sale in the United States market and co-products (yeast, animal feed, and carbon dioxide) for sale in the domestic market. It assumes that distilleries operate 180 days per year at rated capacity. To reflect the options recommended, the team analyzed the predicted costs and benefits associated with distilleries of two sizes (150,000 liters per day and 120,000 liters/day), and the results of this work are reported in detail in Appendix A. Because the larger distillery had somewhat lower per unit costs, it forms the basis for the discussion of costs and benefits in the pages that follow.

The analysis of distillery investments has several parts. The first is a series of financial analyses designed to illustrate the likely internal rates of return (IRR) of an alcohol investment under a variety of market price conditions. The primary IRR analysis treats the entire alcohol plant cost as an equity investment, or negative cash flow, in year 1 of the analysis period; this disregards the source of the funding and the specific terms for the repayment of any loans contracted to finance the investment. Sensitivity tests are then performed to determine the consequences for IRR of changes in the prices of sugar or alcohol. A second IRR analysis treats the case in which investors make a partial equity investment (15% and 20% of plant cost) in year 1, with the remainder financed at vendor-offered financing terms; the costs and benefits are then examined under a limited set of sugar price scenarios.

Two additional financial analyses explore the implications of different investment terms, the one assuming that the distillery will be financed by a loan with repayment over a five year period ending in 1992 (when the U.S. ethanol subsidy may terminate), and the second amortizing the loan over a fifteen year period.

The financial analyses are then complemented by an economic analysis designed to analyze the costs and benefits of the investment in terms of its impact on foreign exchange. It calculates the costs of foreign exchange components of the investment as well as the benefits of increased foreign exchange earnings by using a foreign exchange conversion factor (or "shadow price") of 1.25. Section 6 of this report contains a detailed investigation of the implications of ethanol projects for cane growers and others employed in the industry.

The analysis is incremental or marginal in character throughout. This means that current investment in land and mills is treated as sunk cost. The analysis focuses on the additional costs required for investment in and production of alcohol, and on the contribution that the investment will make to the financial returns of firms in the industry. It does not ask whether it would be worthwhile building a new cane mill to produce alcohol; the mills already exist. Although the land used to grow sugar cane does have an opportunity cost—the acreage can be used to grow other products—those costs are not reflected in this analysis. In this respect, the analysis assumes implicitly that alternative land uses either have greater investment and economic costs, or have been explored and rejected.

Assumptions about the prices of sugar and alcohol are of critical importance to the financial and economic analyses. To illustrate this importance, the investigation begins with a "base case" that assumes a price for alcohol of $1.25 per gallon and a sugar price that begins at US $0.07/lb. in 1988 (the first year of the project) and rises to $0.12 by 1992, after which it levels off. It is important to stress that this does not represent a forecast of sugar and alcohol prices. The study assumes that world market sugar prices are likely to continue to behave as they have in the past, cycling up and down—although there are reasons to believe that they may settle to a higher average price in the next decade compared to the past five years. The team's working estimate, embodied in the base case, is based on the assumption that prices will tend to rise gradually in the next five years.

The analysis also assumes that alcohol prices will be variable, reflecting decisions in the United States concerning subsidies for ethanol use and import, as well as fluctuations in the price of world oil. It now appears that the U.S. federal tax subsidy of $0.60/gallon will remain in force until 1992. The same is true for the duty-free access of alcohol produced in Honduras, a result of the legislation creating the Caribbean Basin Initiative (CBI), which will not expire until 1996. However, because of low world oil prices and pressures on the budget, it is only prudent to assume that this subsidy will end in 1992 and that domestic pressures will force an end to the duty-free access in 1996. Accordingly, we assume a firm demand for alcohol only until 1992 (see Appendix C).[1]

The uncertainties surrounding the markets for sugar and ethanol cannot be over-emphasized. These uncertainties form the basis for the conclusion of this study that, despite the low current price of sugar, investment in 1986 by a single company in an alcohol distillery would represent an unacceptable degree of risk. As all concerned with the sugar industry are aware, prices of sugar reached record lows in the last eighteen months. Indeed, had alcohol plants been built two years ago, they would have paid for themselves already.

[1] There are good reasons to expect a return of world oil prices to the $20-$30/barrel level by the early 1990s. The assumptions of this study are therefore almost certainly conservative.

These uncertainties, which include the possibility of early rewards to an ethanol investment, are also the basis for the study's recommendation, outlined in Section 5: Implementation, that the best approach for Honduras may well be an industry-wide cooperative scheme in which the mills share the benefits, costs and risks. This would lessen company exposure and afford them protection for the times when world market sugar rises above the threshold range of US 9-10¢/lb. To accommodate these uncertainties, the analysis relies heavily on sensitivity tests to illustrate the implications of changes in markets.

The cost of building and equipping a distillery and related structures is based on direct quotations from equipment manufacturers, estimates prepared for Honduras from engineering firms[2], and information developed by the technical staff of the assessment team. To simplify matters, the financial and economic analyses assume that the mill to be used will be located in the San Pedro Sula area, taking advqntage of by-product markets, and that the entire product will be exported through the facilities at Puerto Cortes. The analysis also assumes that cane tops will be used. (A separate analysis presented in Appendix B assumes that a small mill will be dedicated entirely to the production of ethanol from cane juice, at the scale of 90,000 liters/day).

The estimated cost of the larger (150,000 liter/day) distillery is US$ 4.33 million installed, plus an additional $0.75 million needed for equipment to recover the by-products, for a total of $5.1 million. Of this amount, about one-fourth represents domestic costs and the remainder represents foreign exchange costs. The 120,000 liter/day distillery, installed, will cost $0.5 million less.

Although an ad valorem import duty of five percent is indicated, the Central American Agreement on Fiscal Incentives provides for the total exemption from duties on the import of machinery and equipment employed in new manufactures. The industry would also be entitled to exemption from duties on the import of raw materials, semi-finished products (except fuel for transportation), and packaging materials. There is also an investment tax credit for profits invested in equipment and machinery that increases productive capacity, a credit available during the year such investments are made. Finally, there is also a draw-back system which provides total exemption of import taxes on materials and goods incorporated into final products which are exported outside of Central America. With the exception of the exemption from import duties, these incentives have not been taken into account in the analysis.

4.2 Results

In interpreting the results in the tables presented in this section and in Appendix A, it is important to understand that what is measured is not profits that result from investment in alcohol. Rather the focus is the extent to which the sugarcane industry is better or worse financially producing alcohol than producing sugar for the world market. As table 4.1 indicates, the team estimates that the cost of production of alcohol in Honduras ranges from $1.40 per gallon to $1.52/gallon

[2] F.C. Schaffer & Assoc., "Study for Installation of Ethanol Facility," for CAHSA, December 1985, Baton Rouge, LA.

depending on distillery scale and investment amortization periods. Alcohol that is sold at a price below this will not be profitable, per se, but may cover substantially greater costs than sugar sold on the world market. The marginal cost of producing sugar in Honduras is approximately US$0.12/lb. (not including capital, financing and some administrative costs, 1983-84 data); similarly sugar sold below this on the world market loses money.

Indeed it appears unlikely that an investment in ethanol in the near future in Honduras will attain profitability unless alcohol prices in the US market return to the $1.55-1.70/gallon range. It may still be an attractive proposition, however, if the sale of the alcohol involves smaller losses than would the sale of the same sucrose converted to sugar.

Table 4.1: Estimated Alcohol Production Costs ($/gal)

	150,000 l/d	120,000 l/d
Cost per ton of cane ($)[1]	13.25	13.25
Cane cost per gal. alcohol (@ 15.8 gal/ton)	0.8386	0.8386
Cost of processing cane to sugar[2]	0.3800	0.3800
Administrative costs (sugar)[2]	0.2018	0.2018
Cost of processing juice to alcohol[3]		
Wages and salaries	0.0144	0.0180
Fringe benefits	0.0043	0.0054
Utilities and miscellaneous	0.0645	0.0673
Operating supplies	0.0900	0.0900
Shipping to port	0.0300	0.0300
Savings in processing sugar and molasses[4]	-0.0252	-0.0252
Savings in shipping sugar and molasses[4]	-0.0855	-0.0855
Reduction in administrative costs[4]	-0.0633	-0.0633
Sales of by-products[5]	-0.1010	-0.1010
Reduction in cane cost (from cane tops)[6]	-0.0396	-0.0396
Subtotals	1.3090	1.3164
Capital costs, distillery[7]		
15 years[8]	0.0910	0.1032
TOTALS	1.4000	1.4196
5 years[6]	0.1791	0.2032
TOTALS	1.4881	1.5196

[1] Expected industry average for 1985/86.
[2] Based on 1983-84 industry operating cost data, Honduras Sugar Producers Assoc.
[3] From spreadsheets, Appendix A. Some costs based on detailed estimates made by F.C. Schaffer and Associates for CAHSA (Dec. 1985).
[4] Based on F.C. Schaffer and Associates estimates.
[5] From Table 3.6.
[6] From spreadsheets, Appendix A.
[7] Capital costs do not include existing mills, which are treated as sunk costs.
[8] 15-year capital costs calculated at 9.5% interest.

4.2.1 Financial Analysis Results: IRR

For the case where alcohol plant costs are treated as a 100% equity investment at the start of the project (no finance or amortization costs), Table 4.2 shows the changing relationship between sugar and alcohol prices, and the effect that price changes have on the annual benefits (or losses) from investment in a 150,000 l/d alcohol plant. For example, at the ethanol price of $1.25/gallon, the "break point" occurs between $0.10/lb sugar, which shows a $657,700 benefit over sugar sales, and $0.11/lb. sugar, which shows a loss of $177,700. Similarly, if sugar prices averaged $0.06/lb and alcohol $1.25/gal in a given year, the net benefit of producing alcohol would be $3.99 million.

Table 4.2: Annual Net Financial Benefits, IRR Analysis: Sensitivity to World Prices of Sugar and Alcohol (US$ 000's)

Price of Alcohol	Price of Sugar .06	.07	.08	.09	.10	.11	.12
0.70	75.9	-759.5	-1594.9	-2430.2	-3265.6	-4101.0	-4936.4
0.75	432.6	-402.8	-1238.2	-2073.6	-2909.0	-3744.4	-4579.8
0.80	789.3	-46.1	-881.5	-1716.9	-2552.3	-3387.7	-4223.1
0.85	1145.9	310.5	-524.8	-1360.2	-2195.6	-3031.0	-3866.4
0.90	1502.6	667.2	-168.2	-1003.6	-1839.0	-2674.4	-3509.7
0.95	1859.3	1023.9	188.5	-646.9	-1482.3	-2317.7	-3153.1
1.00	2216.0	1380.6	545.2	-290.2	-1125.6	-1961.0	-2796.4
1.05	2572.6	1737.2	901.8	66.4	-769.0	-1604.3	-2439.7
1.10	2929.3	2093.9	1258.5	423.1	-412.3	-1247.7	-2083.1
1.15	3286.0	2450.6	1615.2	779.8	-55.6	-891.0	-1726.4
1.20	3642.6	2807.2	1971.8	1136.5	301.1	-534.3	-1369.7
1.25	3999.3	3163.9	2328.5	1493.1	657.7	-177.7	-1013.1
1.30	4356.0	3520.6	2685.2	1849.8	1014.4	179.0	-656.4
1.35	4712.6	3877.2	3041.9	2206.5	1371.1	535.7	-299.7
1.40	5069.3	4233.9	3398.5	2563.1	1727.7	892.3	57.0
1.45	5426.0	4590.6	3755.2	2919.8	2084.4	1249.0	413.6
1.50	5782.7	4947.3	4111.9	3276.5	2441.1	1605.7	770.3
1.55	6139.3	5303.9	4468.5	3633.1	2797.7	1962.4	1127.0
1.60	6496.0	5660.6	4825.2	3989.8	3154.4	2319.0	1483.6

Using this information, internal rates of return for an alcohol project under varying price assumptions can be calculated. Table 4.3 shows that under "base case" price conditions ($1.25/gallon ethanol; sugar prices rising to $0.12/lb) the project has a negative IRR of 7 percent. If sugar prices should stabilize at $0.09/lb in 1989, however, the IRR would be a robust 21%; in other words, the investment would make good sense to a sugar producer faced with the alternative of greater losses selling sugar on the world market at $0.09/lb. At a price of alcohol of $1.25 and sugar of $0.06, the benefits would be large enough that the entire investment would be paid back in less that two years, showing an IRR of 74 percent. Table 4.4 shows the sensitivity of the IRR to prices of both sugar and alcohol.

Table 4.3: Sensitivity of Financial IRR to Sugar Price Scenarios
(Assume Price of Alcohol = $1.25)

YEAR:	1987	1988	1989	1990	1991	1992
Price of Sugar	0.07	0.08	0.09	0.10	0.11	0.12
Net Benefits	-5082.00	2328.52	1493.12	657.73	0.00	0.00
Internal Rate of Return =		-0.07				
Price of Sugar	0.07	0.08	0.09	0.09	0.09	0.09
Net Benefits	-5082.00	2328.52	1493.12	1493.12	1493.12	1493.12
IRR		0.21				
Price of Sugar	0.07	0.08	0.09	0.10	0.10	0.10
Net Benefits	-5082.00	2328.52	1493.12	657.73	657.73	657.73
IRR		0.06				
Price of Sugar	0.06	0.06	0.06	0.06	0.06	0.06
IRR		0.74				
Price of Sugar	0.07	0.08	0.08	0.08	0.08	0.08
IRR		0.36				

Table 4.4: Sensitivity of Financial IRR to Sugar & Alcohol Prices
(US$ 000's)

Price of Alcohol	Price of Sugar .06	.07	.08	.09	.10	.11	.12
0.70	0.01	-0.15	-0.31	-0.48	-0.64	-0.81	-0.97
0.75	0.09	-0.08	-0.24	-0.41	-0.57	-0.74	-0.90
0.80	0.16	-0.01	-0.17	-0.34	-0.50	-0.67	-0.83
0.85	0.23	0.06	-0.10	-0.27	-0.43	-0.60	-0.76
0.90	0.30	0.13	-0.03	-0.20	-0.36	-0.53	-0.69
0.95	0.37	0.20	0.04	-0.13	-0.29	-0.46	-0.62
1.00	0.44	0.27	0.11	-0.06	-0.22	-0.39	-0.55
1.05	0.51	0.34	0.18	0.01	-0.15	-0.32	-0.48
1.10	0.58	0.41	0.25	0.08	-0.08	-0.25	-0.41
1.15	0.65	0.48	0.32	0.15	-0.01	-0.18	-0.34
1.20	0.72	0.55	0.39	0.22	0.06	-0.11	-0.27
1.25	0.79	0.62	0.46	0.29	0.13	-0.03	-0.20
1.30	0.86	0.69	0.53	0.36	0.20	0.04	-0.13
1.35	0.93	0.76	0.60	0.43	0.27	0.11	-0.06
1.40	1.00	0.83	0.67	0.50	0.34	0.18	0.01
1.45	1.07	0.90	0.74	0.57	0.41	0.25	0.08
1.50	1.14	0.97	0.81	0.64	0.48	0.32	0.15
1.55	1.21	1.04	0.88	0.71	0.55	0.39	0.22
1.60	1.28	1.11	0.95	0.79	0.62	0.46	0.29

NOTE: Calculated as though the benefit starts in year 2 (1988) and would be received to infinity, according to the formula IRR = net annual benefit/capital cost.

Investors in an alcohol project may be more likely to provide partial equity financing, say 15 or 20 percent of the project costs, with the remainder financed at the best possible terms (vendors are offering 85% finnacing at 7.5%, 8-year term at the time of this study). Table 4.5 shows a series of IRR analyses at both 15 and 20 percent equity, and under three sugar price scenarios through 1992 — stabilizing at $0.09/lb, $0.10/lb, and cycling between $0.08 and 0.10/lb. Net benefits for each year from Table 4.2 are adjusted by financing costs ("Yearly payment").

When sugar prices stabilize at $0.09/lb, the IRR improves to 83% and 113% for the two partial equity cases, compared to 21% for the 100% equity case in Table 4.3. With cycling sugar prices, the IRR is still a robust 28% and 33% (20% and 15% equity, respectively). When sugar prices stabilize at $0.10/lb for three years of the six-year period, however, the IRR results are negative 168% and 172%. It is important to note, however, that this analysis assumes the project period ends in 1992 and the plant has no salvage value. Incorporating a salvage value of $500,000 in 1992 (10% of investment costs), the IRR's in this sugar price scenario are positive 38% (20% equity case) and 26% (15% equity case). In summary, a partial equity investment seems to show better returns on the alcohol project.

Table 4.5: IRR's Based on Partial Equity Investment
Sensitivity to Sugar Price Scenarios
(Distillery Cost of $5082K, Alcohol @ $1.25/Gal)

YEAR:	1987	1988	1989	1990	1991	1992
20% Equity ($1016K), $4066K debt at 7.5%, 5 yrs. (Yearly Pmt: $1004.97)						
Price of Sugar	.07	.08	.09	.09	.09	.09
Net Benefits	-1016.00	1323.55	488.15	488.15	488.15	488.15
IRR	0.83					
Price of Sugar	.07	.08	.09	.10	.10	.10
Net Benefits	-1016.00	1323.55	488.15	-347.241	-347.24	-347.24
IRR	-1.68		IRR w/ Salvage		0.38	
Price of Sugar	.09	.10	.08	.09	.10	.08
Net Benefits	-1016.00	-347.24	1323.55	488.15	-347.24	1323.55
IRR	0.28					
15% Equity ($762K), $4320K debt at 7.5%, 5 Yrs. (Yearly Pmt: $ 1067.75)						
Price of Sugar	.07	.08	.09	.09	.09	.09
Net Benefits	-762.00	1260.77	425.37	425.37	425.37	425.37
IRR	1.13					
Price of Sugar	.07	.08	.09	.10	.10	.10
Net Benefits	-762.00	1260.77	425.37	-410.02	-410.02	-410.02
IRR	-1.72		IRR W/Salvage		0.26	
Price of Sugar	.09	.10	.08	.09	.10	.08
Net Benefits	-762.00	-410.02	1260.77	425.37	-410.02	1260.77
IRR	0.33					

4.2.2 Financial Analysis Results: Non-IRR

Tables 4.6 and 4.7 illustrate the annual benefits from an alcohol project, this time assuming, respectively, five-year and fifteen-year amortization periods. As Table 4.5 reveals, the break point in the five-year amortization comes between $0.09/lb and $0.10/lb sugar. The fifteen-year amortization reveals a break point similar to that of the IRR analysis, between $0.10 and $0.11/lb for sugar.

A different way of putting this is that a mill (or group of mills) in possession of a distillery, and therefore able to divert world market sugar to alcohol sales, would be in a position to reduce losses from world market sugar sales as soon as sugar prices drop below the break point. As the price of sugar dropped, the savings would increase quite dramatically. In the case of $0.06/lb sugar and alcohol stable at $1.25/gallon, for example, the mill or group of mills would save fully $2,722,000 in a year—well over half the cost of the distillery involved.

A corollary to this point is that two distilleries, which would be needed to absorb all current world market sugar, would simply double the results. In the case of $0.06/lb sugar and $1.25/gallon alcohol, the annual savings from producing alcohol would be $5.4 million. Investment in two distilleries, however, would entail higher risk since the cost of two facilities still has to be carried (amortized) when the sugar price is above the break point and the plants are not operating. Given uncertainties in sugar and alcohol markets the team feels that two distilleries would not be prudent at this time.

4.2.3 Economic Analysis Results

Among the economic benefits considered in this analysis are foreign exchange earnings, income to cane growers/harvesters, additional government revenues, and forward and backward linkages (including the effects on consumers). These benefits are in addition to the financial benefits calculated above; they accrue to persons and institutions outside the industry, to society in general. They are based on opportunity costs or prices, often referred to as shadow prices or accounting prices.

It should be borne in mind that when substantial benefits are conferred by a project to society, they may suggest the appropriateness of subsidies to encourage the project's implementation. A subsidy is not "free", however; it would come from some Honduran source, e.g., the government budget or consumers' incomes through higher prices.[3] The domestic subsidy issue is treated in Section 5.4.

[3] No account has been taken in this analysis of the cost of the U.S. gasohol subsidy to the American taxpayer. If one were to subtract the $0.60 per gallon subsidy from the prices posed, the rate of return at any reasonable forecast price of alcohol for the period under consideration would be negative. The perspective incorporated in this analysis has been from the Honduran viewpoint.

Table 4.6: Net Annual Financial Benefits:
Sensitivity to World Prices of Sugar and Alcohol
- Five Year Amortization -
(US$ 000's)

Price of Alcohol	Price of Sugar .06	.07	.08	.09	.10	.11	.12
0.90	225.08	-610.31	-1445.70	-2281.10	-3116.49	-3951.88	-4787.28
0.95	581.75	-253.64	-1089.03	-1924.43	-2724.43	-3595.21	-4430.61
1.00	938.42	103.03	-732.36	-1567.76	-2403.15	-3238.54	-4073.94
1.05	1295.09	459.70	-375.69	-1211.09	-2046.48	-2881.87	-3717.27
1.10	1651.76	816.37	19.02	-854.42	-1689.81	-2525.20	-3360.60
1.15	2008.43	1173.04	337.65	-497.75	-1333.14	-2168.53	-3003.93
1.20	2365.10	1529.71	694.32	-141.08	-976.47	-1811.86	-2647.26
1.25	2721.77	1886.38	1050.99	215.59	-619.80	-1455.19	-2290.59
1.30	3078.44	2243.05	1407.66	572.26	-263.13	-1098.52	-1933.92
1.35	3435.11	2599.72	1764.33	928.93	93.54	-741.85	-1577.25
1.40	3791.78	2956.39	2121.00	1285.60	450.21	-385.18	-1220.58
1.45	4148.45	3313.06	2477.67	1642.27	806.88	-28.51	-863.91
1.50	4505.12	3669.73	2834.34	1998.94	1163.55	328.16	-507.24
1.55	4861.79	4026.40	3191.01	2355.61	1520.22	684.83	-150.57
1.60	5218.46	4383.07	3547.68	2712.28	1876.89	1041.50	206.10
1.65	5575.13	4739.74	3904.35	3068.95	2233.56	1398.17	562.77
1.70	5931.80	5096.41	4261.02	3425.62	2590.23	1754.84	919.44

Table 4.7: Net Annual Financial Benefits:
Sensitivity to World Prices of Sugar and Alcohol
- Fifteen Year Amortization -

Price of Alcohol	Price of Sugar .06	.07	.08	.09	.10	.11	.12
0.90	853.4	18.0	-817.4	-1652.8	-2488.2	-3323.5	-4158.9
0.95	1210.1	374.7	-460.7	-1296.1	-2131.5	-2966.9	-3602.3
1.00	1566.8	731.4	-104.0	-939.4	-1774.8	-2610.2	-3445.6
1.15	1923.4	1088.0	252.6	-582.8	-1418.1	-2253.5	-3088.9
1.10	2280.1	1444.7	609.3	-226.1	-1061.5	-1896.9	-2732.3
1.15	2636.8	1801.4	966.0	130.6	-704.8	-1540.2	-2375.6
1.20	2993.4	2158.0	1322.7	487.3	-348.1	-1183.5	-2018.9
1.25	3350.1	2514.7	1679.3	843.9	8.5	-826.9	-1662.2
1.30	3706.8	2871.4	2036.0	1200.6	365.2	-470.2	-1305.6
1.35	4063.4	3228.1	2392.7	1557.3	721.9	-113.5	-948.9
1.40	4420.1	3584.7	2749.3	1913.9	1078.5	243.2	-592.2
1.45	4776.8	3941.4	3106.0	2270.6	1435.2	599.8	-235.6
1.50	5133.5	4298.1	3462.7	2627.3	1791.9	956.5	121.1
1.55	5490.1	4654.7	3819.3	2983.9	2148.6	1313.2	477.8
1.60	5846.8	5011.4	4176.0	3340.6	2505.2	1669.8	834.4
1.65	6203.5	5368.1	4532.7	3697.3	2861.9	2026.5	1191.1

Foreign Exchange Earnings

In the tables of Appendix A concerning the economic analysis, the foreign exchange receipts and expenses are indicated separately from receipts and expenditures in domestic currency. This has been done to facilitate the calculation of foreign exchange costs and benefits. A portion of the benefits shown Tables 4.8 and 4.9 are the domestic benefits from the sale of by-products such as yeast and bagasse, and the use of stillage as fertilizer. Since these will substitute for products currently being imported, they are equivalent to foreign exchange earnings even though they are sold or used domestically. (Although they are still shown as domestic receipts in the Appendix, they have been increased by the foreign exchange factor.)

As noted earlier, the benefits from net foreign exchange earnings and savings have been calculated on the basis of a foreign exchange premium of 25 percent. That is, an additional dollar of foreign exchange is estimated to have a marginal value to the Honduran economy of $1.25 (or Lps 2.5). All foreign exchange earnings and costs were multiplied by the factor 1.25, and the new values shown in the designated column.

At a world sugar price of $0.06/lb. and an alcohol price of $1.25/gallon, the net economic benefits due to the foreign exchange premium are $567,000 or 21% greater than the net financial benefits shown in Table 4.6. These benefits would tend to disappear with higher world prices for sugar and/or lower world prices for fuel alcohol. At $0.07 for sugar, the increased benefits attributable to foreign exchange earnings or savings are $358,000, and when the price of sugar rises to eight cents $150,000. Foreign exchange benefits disappear at a sugar price over $0.09 per pound. Similarly, a fall in the price of alcohol would reduce the foreign exchange benefits.

The small foreign exchange benefit in face of the substantial shadow price is due to the fact that one foreign exchange earner, alcohol, is substituting for another foreign exchange earner, sugar. Considering the foreign exchange costs associated with the financing of the distillery, the foreign exchange benefits must be considered marginal at best. Of course, if the alternative were to produce no sugar for the world market, the production of alcohol would be a foreign exchange earning proposition and would have to be compared with the foreign exchange earning prospects of alternative uses of the land currently devoted to sugar cane.

4.3 Conclusion

In examining the prospect, as well as the risks, posed by possible fluctuations in the prices of sugar and alcohol, the study team has concluded that it is highly unlikely that an individual mill owner or private investor would be willing to risk $4-$5 million to invest in alcohol production. There is simply too great a chance that sugar prices will rise in the near future, and that ethanol prices will be flat following the decline in world petroleum prices. On the other hand, the benefits of such an investment can be significant and would accrue to the industry and the entire country. Therefore, a joint investment, a kind of industry stabilization scheme against the large losses suffered when sugar prices drop to their lower levels, might well be attractive. This approach is discussed in Section 5.

Table 4.8: Net Annual Economic Benefits:
Sensitivity to World Prices of Sugar and Alcohol
- Five Year Amortization -
(US$ 000's)

Price of Alcohol	Price of Sugar .06	.07	.08	.09	.10	.11	.12
0.90	168.3	-875.9	-1920.2	-2964.4	-4008.6	-5052.9	-6097.1
0.95	614.2	-430.1	-1474.3	-2518.6	-3562.8	-4607.0	-5651.3
1.00	1060.0	15.8	-1028.5	-2072.7	-3117.0	-4161.2	-5205.4
1.05	1505.8	461.6	-582.6	-1626.9	-2671.1	-3715.4	-4759.6
1.10	1951.7	907.4	-136.8	-1181.0	-2225.3	-3269.5	-4313.8
1.15	2397.5	1353.3	309.0	-735.3	-1779.5	-2823.7	-3867.9
1.20	2843.4	1799.1	754.9	-289.4	-1333.6	-2377.9	-3422.1
1.25	3289.2	2244.9	1200.7	156.5	-887.8	-1932.0	-2976.3
1.30	3735.0	2690.8	1646.5	602.3	-441.9	-1486.2	-2530.4
1.35	4180.9	3136.6	2092.4	1048.1	3.9	-1040.3	-2084.6
1.40	4626.7	3582.5	2538.2	1494.0	449.7	-594.5	-1638.7
1.45	5072.5	4028.3	2984.1	1939.8	895.6	-148.7	-1192.9
1.50	5518.4	4474.1	3429.9	2385.7	1341.4	297.2	-747.1
1.55	5964.2	4920.0	3875.7	2831.5	1787.2	743.0	-301.2
1.60	6410.1	5365.8	4321.6	3277.3	2233.1	1188.8	144.6
1.65	6855.9	5811.6	4767.4	3723.2	2678.9	1634.7	590.4
1.70	7301.7	6257.5	5213.2	4169.0	3124.8	2080.5	1036.3

Table 4.9: Difference Between Annual Net Economic and Net
Financial Benefits at Different Alcohol & Sugar Prices
(US$ 000's)

Price of Alcohol	Price of Sugar .06	.07	.08	.09	.10	.11	.12
0.90	-56.8	-265.6	-474.5	-683.3	-892.1	-1101.0	-1309.8
0.95	32.4	-176.4	-385.3	-594.1	-803.0	-1011.8	-1220.7
1.00	121.6	-87.3	-296.1	-505.0	-713.8	-922.7	-1131.5
1.05	210.7	1.9	-206.9	-415.8	-624.6	-833.5	-1042.3
1.10	299.9	91.1	-117.8	-326.6	-535.5	-744.3	-953.2
1.15	389.1	180.2	-28.6	-237.5	-446.3	-655.2	-864.0
1.20	478.2	269.4	60.6	-148.3	-357.1	-566.0	-774.8
1.25	567.4	358.6	149.7	-59.1	-266.0	-476.8	-685.7
1.30	656.6	447.7	238.9	30.0	-178.8	-387.7	-596.5
1.35	745.8	536.9	328.1	119.2	-89.6	-298.5	-507.3
1.40	834.9	626.1	417.2	208.4	-0.5	-209.3	-418.2
1.45	924.1	715.2	506.4	297.5	88.7	-120.2	-329.0
1.50	1013.3	804.4	595.6	386.7	177.9	-31.0	-239.8
1.55	1102.4	893.6	684.7	475.9	267.0	58.2	-150.7
1.60	1191.6	982.7	773.9	565.0	356.2	147.3	-61.5
1.65	1280.8	1071.9	863.1	654.2	445.4	236.5	27.7

5. IMPLEMENTATION

5.1 Risk/Benefit Sharing

The technical and site analyses have shown that a number of sugar factories are good candidates for alcohol distilleries from the standpoint of production potential and efficiencies, transportation requirements, and potential to take advantage of markets for by-products. As the financial/economic analysis has shown, the industry as a whole is likely to benefit from a decision to invest in alcohol facilities and divert world market sugar into alcohol at times of low sugar prices. As a business proposition, however, alcohol production in Honduras could not be considered a good venture for a sugar company at expected price levels over the next 5-6 years. Given this situation, how does the industry decide to undertake diversification into alcohol production, and what organizational relationships might govern diversion of cane into alcohol?

Investment in alcohol can be thought of as an industry revenue stabilization program, since the entire industry will benefit from reduced world market sales when the price is low. This suggests a joint participation arrangement to share the investment costs and benefits. The investment and operating costs to have an alcohol production capacity would be offset by increased industry revenues from alcohol sales compared to world market sugar sales. If alcohol by itself is a break-even or marginal proposition, the investment is insurance against losses; if alcohol proves to be a moderately losing venture, the investment is insurance against larger losses, and so on. As the financial analyses show, the cost of a distillery would be recouped in approximately two years from avoided losses on the world sugar market if the alcohol price were $1.25/gallon and the sugar price were 6¢/lb.

A feature which distinguishes the alcohol option from insurance is the fact that after the investment is written off in five years the Honduran sugar industry still has an alcohol option. Production costs, however, are reduced substantially by eliminating the depreciation expense (approx. 20¢/gallon), making Honduran alcohol more competitive with lower cost producers. This cost reduction would occur at a propitious time if the US ethanol subsidy expires after 1992 as scheduled.

The way in which individual firms in the industry approach a collective alcohol option bears consideration. The industry has in place a market sharing agreement, already noted, whereby the profitable domestic and US sugar markets, as well as the unprofitable world market, are allocated to sugar companies. Essentially this agreement provides an industry-wide system for the sharing of costs, benefits and risks inherent in the sugar business, and could provide a mechanism for estimating and allocating alcohol costs and benefits.

Starting with an initial investment of approximately US$ 4.612 million for a 120,000 l/d annexed alcohol distillery with yeast recovery, each company might be responsible for a share of the investment cost according to their domestic sugar market allocations, as follows:

Company	Share	Amount ($000)
ACANSA	6.2%	285
ACENSA	20.0%	922
ACHSA	10.1%	466
ACHUMSA	6.2%	285
AYSA	12.5%	577
AZUNOSA	11.0%	507
CAHSA	34.0%	1,568
Totals	100.0%	4,612

These investment amounts represent the firms' equity contributions, proportional to each company's share of the expected benefits and costs from having and operating the distillery. Companies could treat the initial cost as a business expense, or as an investment depreciated over some agreed amortization schedule. The benefit to each company of reducing its share of world market production can be easily estimated by subtracting the world price for sugar from marginal sugar production costs (using either individual company data or an industry average), and multiplying this by the amount of sugar which a company diverts to alcohol. This would give a company a ready indicator of its potential gains (or losses) from participating in the industry scheme.

One alternative would be the formation of a separate enterprise, such as a corporation or partnership, in which all sugar companies are equity partners. Equity contributions and the distribution of income and expenses might be based on market share allocations in the "intercambio" agreement. Sugar companies would be paid by the enterprise a reasonable price for the cane which they devote to alcohol, say the industry average of Lps 26-28/ton; or they could be paid for sugar at its marginal production cost, about 12¢/lb. The price paid would be determined according to some formula which reflects the value of producing ethanol from cane, but would necessarily be higher than the world sugar price. Indeed the distillery would only operate when alcohol is a better market than the world price for sugar.

Of necessity, key management decisions of the alcohol enterprise would be made by a group of directors comprised of officials from the sugar industry. Similarly, a scheme whereby all firms participate in one or two ethanol distilleries suggests extending the market allocation agreement already in effect. In essence, a fourth market, alcohol, would be added to the three sugar markets presently allocated. In actuality, alcohol production replaces world market sugar, so these two markets represent the same sugar. Alcohol would necessitate a fourth market allocation, however, because it has a different price and value from world market sugar, and because all world market sugar may not be diverted to alcohol. Paper transactions involving the "transfer" of cane from one factory to the company where the distillery is located are performed in the same way as sugar transfers in the current agreement.

5.2 Private Vs. Public Sector

As an economic policy objective, it may be desirable for alcohol development to be a private sector initiative to the maximum extent practical, given the financial problems and performance of the state-controlled segments of the sugar industry. Alcohol in Honduras is not likely to happen as a purely private sector endeavor, however. Most of the industry faces financial difficulties, and is one-third owned and controlled by the government. The expected returns are not sufficiently attractive, and a single company or two companies will not be willing to undertake sizable investments given the risks of future price movements, even assuming that they maintain their entitlements to the domestic and US quota sugar markets. Industry attitudes generally favor some sort of government involvement given the perceived risk, but are negative toward government control of alcohol. The main apprehension is of being locked into an alcohol production schedule, perhaps for domestic blending, when sugar prices become more profitable.

The Honduran government debt exposure in the sugar industry, combining loans and loan guarantees, is estimated at over $82 million, held by the development agencies CONADI and BANADESA. The government also holds approximately $30 million in share capital in the companies of ACENSA (83 percent government ownership), ACANSA (100%) and AYSA (50%).[1] It might be argued that GOH exposure in the sugarcane industry is already too high, and that government involvement in alcohol facilities will only increase the public burden. It also would continue a trend of public sector participation in an industry which should be more controlled by market factors.

On the other hand, at this level of exposure, and particularly considering recent losses at ACENSA and ACANSA, government interest in pursuing loss-avoidance and diversification strategies for the industry is high. The government must support policies which help make the industry more sound financially and which preserve the real value of the industry to the Honduran economy. As this study concludes, the alcohol option is the best alternative for stabilizing the sugar industry over the next 5-6 years, and should act to stem the losses suffered primarily by the government firms. Reducing and/or eliminating losses is perhaps the most important step toward making the government-owned sugar companies attractive to private sector interests. Without such a diversification, the large operating losses from sugar production continue (at projected price levels), and unpaid interest on government guaranteed loans acts to build debt further at these companies.

Government involvement in alcohol development is probably necessary, and may be able to provide direction for eventual adjustment by the sugar industry. At a minimum, legislative changes are needed in order to distinguish fuel alcohol uses from potable, to establish technical standards for the product, and to set any trade policies that may be needed for new articles of commerce. Some of these efforts are reportedly underway for alcohol in Honduras.

1 Motes and Borgatti, "The Honduran Sugar Industry," report to USAID, August 1985, p. 30, and Company data.

IMPLEMENTATION

It is important that regulatory changes in the treatment of alcohol reflect the options and the flexibility that may be required in the sugarcane industry as the technology for new chemical and fiber products from cane becomes economic. Extending this outlook, the government could support applied and pilot research in the industry for new sugarcane diversification approaches; this is an appropriate role which should not entail a large administrative function.

Government financial support for initial investment in alcohol facilities may also be an appropriate action given the variation in credit-worthiness among companies in the industry. This could take the form of direct loans or loan guarantees, both of which have substantial precedents in the sugar industry. Obviously it is preferable not to increase an already high public debt in the industry, or to increase liability for debt, if avoidable. The GOH might therefore provide access to, or assistance in arranging, low-cost outside financing; this is discussed below.

In other respects, an alcohol endeavor in Honduras should be largely directed by the sugar companies themselves. A joint industry initiative could take the form of a corporate partnership, mentioned above, assigning responsibilities and distributing incomes and losses among the equity partners as in a normal partnership. It would be responsible for any debts incurred, whether government or private. The enterprise would need to have freedom in pursuing the best markets for alcohol, and in switching production back to sugar when comparative prices warrant, suggesting flexibility in dealing with a domestic blending program. Even though alcohol would be a joint industry venture, it is the firms who are at risk and who would enjoy the benefits, at times of low world sugar prices, of diverting cane into alcohol.

It has been suggested that individual companies might have sufficient incentive to invest in alcohol production alone, both to avoid the losses they suffer from world market sugar sales and to capture the profits enjoyed now by a number of alcohol producers. Under the existing industry agreement companies can maintain their domestic and US quota market allocations while reducing their world market production, allowing them to pursue new strategies. Indeed individual companies have examined or are examining the alcohol option. But while alcohol and sugar markets six months ago, if extrapolated over the next five years, may have warranted such consideration, current price levels have introduced a tremendous uncertainty into the future market picture. In addition, few companies have the scale to support an economic alcohol operation using just their world market production, and may be forced to increase cane cultivation and/or buy sugarcane or molasses from other companies at uncertain prices to meet the needs of both sugar and alcohol production. Increased cane cultivation exacerbates the industry over-capacity problem. The prospect of more distillery capacity than would absorb the industry's overall world market production is also a possibility from individual company decisions on alcohol. Some degree of collective decision-making is imperative for the alcohol option.

5.3 Financing

Financing for the alcohol enterprise could come from a number of sources, including the companies themselves, commercial banks, equipment suppliers, development banks or the government. Although individual company debt and ability to raise capital varies greatly, the sugar industry as a whole is perhaps already carrying an excessive debt load; therefore, it is probably not realistic to expect full equity financing contributions from all the firms. Furthermore, the financially marginal returns expected from the project create a strong incentive for the industry to seek the lowest-cost financing. Among potential sources, some equipment suppliers are offering below-market interest rates (7-8 percent), and export financing agencies in some countries are doing the same; these may be appropriate. World Bank and related development organization financing (e.g., Inter-American Development Bank) can be obtained at approximately 9.5 percent for approved projects.

A potentially important source of financing is the government. The GOH has disposition over preferential loan funds which may be appropriate for an alcohol investment. For example, the revolving fund established under the San Jose Accord ("Tratado de San Jose," 1981), setting aside 20 percent of the value of oil imports from Venezuela and Mexico, stipulates a rate of interest of 8 percent and a 20 year term for loans applied to energy related investments of national interest.[2] This source of financing may be particularly appropriate and should be investigated for an alcohol project. Other government-backed loan, guarantee and investment programs should be considered as well.

It is important to note that an intense competition has developed among distillery vendors over the past year, resulting in the lowest prices to date for distillery systems. Financing or sale price discounts should be investigated thoroughly in quest of bringing down the cost of an investment in alcohol. Given the expected marginal returns from a project, discounts of several hundred thousand dollars may be sufficient to meet the investment requirements of financing institutions.

5.4 Domestic Subsidy

A Honduran blending program using a 10%/90% alcohol/gasoline ratio would absorb 3.5 million gallons of alcohol per year, a 20%/80% ratio 7 million gallons. Since total world market sugar represents approximately 13.4 million gallons, domestic blending could create a local market for up to half of potential ethanol production and provide a degree of protection from the uncertainties of the US market. A domestic program, however, would require a substantial subsidy.

2 Before 1984, this fund, the Fondo de Inversiones de Venezuela, stipulated 30% of the value of oil invoices and interest at 6%. It has been used mainly for financing the El Cajon hydroelectric project. Loans can be made for private sector investments with the approval of the Ministerio de Hacienda, the Banco Central and the Consejo Superior de Planificacion Economica.

A domestic subsidy makes sense if its cost is more than offset by the economic benefits to the country of using alcohol domestically. The cost of a subsidy program depends on how it is designed and must be looked at closely. For example, in order to make domestic alcohol prices as attractive to sugar companies as export, US subsidies extended to CBI alcohol producers would have to be equalled by a Honduran subsidy, at least through 1992 when the US program is scheduled to end. At approximately 55¢/gal (US subsidy minus shipping costs) the cost of a domestic subsidy would be $1.92 million per year with 10% alcohol blending, and $3.85 million with 20% blending. An important consideration in this type of program, however, is that alcohol supplies for domestic blending would be interrupted when the world sugar price is more favorable than the US alcohol price, and factories switch back to sugar production.

If instead the subsidy were based on a guaranteed price for alcohol in order to assure supplies for domestic blending, the subsidy would be the difference between imported gasoline wholesale prices and the guaranteed price for alcohol, since alcohol substitutes directly for gasoline. Using alcohol's average production cost of $1.40/gallon (Table 4.1) as the guaranteed price and a gasoline price of 60¢/gallon, the subsidy would be 80¢/gallon, or $2.7 million and $5.4 million per year at 10 and 20 percent blending, respectively. Such a subsidy would assure that sugar/alcohol producers are meeting their costs, but would fluctuate inversely with gasoline prices. Thus the subsidy would be large during times of low world oil prices and would diminish as oil prices rose. Gasoline prices would have to more than triple, however, for the subsidy to decrease to zero.

There is an added cost incurred in <u>not</u> exporting alcohol if foreign exchange is valued more highly by the Honduran economy than at the official exchange rate. Using the conversion factor of 1.25 (from economic analysis, Section 4.2) and an alcohol export price of $1.25/gallon, the added economic cost of domestic alcohol consumption is $1.1 million and $2.2 million per year at 10 and 20 percent blending, respectively.

The economic benefits of domestic alcohol use derive from displacing crude oil and refined product imports, which may be valued at the same shadow price for foreign exchange. Unless oil import costs exceed alcohol production costs on a per gallon basis, however, the only benefits from domestic blending are the same as the foreign exchange costs calculated above. In other words, the foreign exchange costs of not exporting alcohol cancel out the foreign exchange benefits of displacing oil imports with domestic alcohol, leaving a net cost to the economy. In order for there to be benefits to domestic blending, gasoline wholesale prices would have to rise to average alcohol production costs, which would eliminate the need for a subsidy anyway.

As long as the US alcohol subsidy exists and Honduran alcohol producers have access to it in the US market, a domestic subsidy is unnecessary and would be ill-advised. A corollary to this is that as long as alcohol prices are higher than gasoline prices, either because of high production costs or because of US subsidy effects, domestic blending does not make sense for Honduras.

There may be an argument for a domestic subsidy after 1992 (or earlier if the US subsidy is terminated) if the creation and maintenance of an alcohol industry is otherwise considered vital to the Honduran economy. The reasons for this could be several:

- temporary assistance to the sugar industry to preserve employment and help it adjust to new opportunities;
- severe oil shortages and a need to develop indigenous oil substitutes for national security reasons;
- improved prospects for large-scale industrial development in products based on alcohol fermentation (e.g., sucro-chemistry).

Such questions, however, should engage economic policy deliberations at a high level. Costs and benefits of a subsidy program would need to be analyzed closely using the best available market information at that time, and subsidy levels should be set accordingly. In all cases a subsidy should be treated as only a temporary stimulus to achieve clear economic objectives.

6. EMPLOYMENT & INDEPENDENT GROWERS

This section addresses employment in the sugarcane industry and the implications of an ethanol program for the rural economy. It examines independent grower and cooperative land holdings, organizations in the industry, farmer income, relations between the sugar companies and grower organizations, and seasonal employment.

Among the benefits associated with a Honduran alcohol program are the maintenance of an important segment of the agricultural economy and the preservation of employment in the sugar industry. Most of the sugarcane in Honduras is produced by independent growers ("independentientes"), and it is they who are affected first by any downturn in the industry. With reductions in cane production for the 1985-86 season, for example, approximately 700 jobs were lost; reductions in area being planted in cane for the 1986-87 season will result in an estimated loss of another 600-1200 jobs. These numbers represent direct employment only and do not indicate the full scope of employment effects.

6.1 Land Holdings

For the 1985-86 crop year sugarcane area planted (as opposed to harvested) is estimated at 32,059 hectares (79,000 acres); this represents a reduction of 1425 hectare from the previous season. In the agriculture sector sugarcane ranks sixth in total cropland (including livestock pasture), as shown in Table 6.1 below. Approximately two-thirds of this area is in the north of Honduras (CAHSA, AZUNOSA, AYSA and ACHUMSA), one quarter is in the southern region (ACENSA and ACHSA), and the remaining cane lands are located in the Cantarrannas valley in central Honduras (ACANSA).

Table 6.1: Agricultural Land Use
(1980, ha 000's)*

1. Pasture	722.6	8. Rice	20.3
2. Corn	351.3	9. African Palm	18.3
3. Coffee	152.3	10. Cotton	12.7
4. Beans	57.9	11. Plantain	7.1
5. Sorghum	51.6	12. Tobacco	5.8
6. Sugar Cane	32.1	13. Citrus	4.0
7. Banana	20.9	14. Pineapple	2.9

*Source: Encuesta Nacional Agricola, Direccion General de Estadisticas y Censos, Tegucigalpa, 1980; last year for countrywide data (note sugarcane figure is 1985-86 season).

Almost two-thirds (63.8%) of all land devoted to cane is cultivated by independent growers, who number over 2900. Of the 1425 hectare reduction from the '84-'85 crop, independent producers sustained a reduction of 1027 hectare. Cane land distribution between independents and the sugar companies ("Administration cane," or "Admin.") is shown for the two crop years in Table 6.2.

Table 6.2: Sugarcane Area Planted by Company & by Independents, '84-'85 and '85-'86 (ha)

	'84-'85 Season			'85-'86 Season		
Company	Independ.	Admin.	Total	Independ.	Admin.	Total
ACANSA	2790	169	2959	2247	168	2415
ACENSA	4228	2181	6409	3920	1690	5710
ACHSA		1631	1497	3128	1463	1505
2968						
CAHSA		6769	4657	11426	6769	4657
11426						
AZUNOSA	2740	1371	4111	2732	1470	4202
AYSA	2919	635	3554	2919	635	3554
ACHUMSA	404	1480	1884	404	1480	1884
Totals	21481	11990	33471	20454	11605	32059

Sources: Sugar company data for 1985-86; Honduras Sugar Producers Association for 1984-85.

Farm sizes for independent growers vary from 0.175 hectare (0.5 acre) to 323 ha (800 acres) with an average farm size of 21 hectare (52 acres). Small farms (less than 5 ha) are numerous and 72 percent are smaller than 20 ha. Only five percent of independent cane farm holdings are larger than 100 ha; nonetheless, these represent 22 percent of all land cultivated in cane in Honduras (Table 6.3). Table 6.4 shows the number of independent growers supplying cane to each sugar company and the average farm size for independents at each mill. (See also Appendix D for individual company profiles and specific data on independent grower holdings serving each company.)

Table 6.3: Farm Size Distribution

Range in Ha	% of Farms in Each Category
0-5	25.4
6-20	47.0
21-50	15.0
51-100	7.4
101-500	5.2
	100%

Table 6.4: Independent Growers & Average Farm Size, by Company

Company	Area in ha	# of Indep.*	Avg. Size (ha)
ACANSA	2247	202	30.0
ACENSA	3920	1094	11.3
ACHSA	1463	172	14.6
CAHSA	6769	642	29.4
AZUNOSA	2732	551	42.7
AYSA	2919	222	24.0
CHUMBAGUA	404	30	13.4
Totals	20454	2912 (mean)	21.2

* Includes members of coops.

Under the Honduran Agrarian Reform law, the Instituto Nacional Agrario (INA) is required to form and promote Empresas Asociativas de Campesinos (cooperatives) with a minimum of five members and mainly using family labor. The law made provision for the appropriation of land holdings in excess of 100 ha (if irrigated), but exempted the production of sugarcane provided efficient cultivation is maintained (Decree 8, 1983, and Decree 170, 1974). A subsequent decree stipulates that sugar companies should not undertake substantial new sugarcane area development and that land acquired since 1964 in excess of 40 percent should be sold. In other words, sugar companies are required by law to limit their own land to 40 percent of the acreage supplying their factory. This mandate is not retroactive, so that mills above the 40 percent standard at the time of the law were "grandfathered" (e.g., ACHUMSA, which owns 73% of the land in its operation).

There are 74 such "co-ops" organized under agrarian reform with a total membership of 1951; together they represent 22 percent of all land planted in cane. Coop information is presented in Table 6.5 below, and in Appendix D.

Table 6.5: Coops, by Company

Company	# of Coops	# of Members	Area (ha)
ACANSA	4	129	136
ACENSA	24	750	2100*
ACHSA	3	72	109
CAHSA	26	412	2587
AZUNOSA	19	487	1834
AYSA	8	101	294
Totals	74	1951	7060 ha

* Includes 200 adjudicatarios (individuals granted land under Agrarian Reform), who own 1260 ha.
Source: Company data and Coops.

6.2 Employment and Income

The sugar industry in Honduras is the fifth largest employer in the agricultural sector, with an estimated 19,762 people employed directly in farm, factory and administrative operations (1985). Thirty-one percent of the employees are contracted on a permanent basis while the remainder (69%) are temporary employees hired mainly during the harvesting season. This does not include an unknown number of truckers, equipment supplier/agents, and family labor. The industry association estimates 15 man-hours of work per ton of cane from planting through processing and transport, or a total of 23,500 man-years per year (@ 2.35 million tons of cane and 1500 hrs/man-year). Only cattle raising, corn, coffee and bananas rank above the sugar industry in employment.

Table 6.6: Permanent & Temporary Employment, and Wages Paid, by Company, 1985

	Permanent	Temporary	Total Employed	Wages (000's Lps)
ACANSA	450	53	503	1,400.0
I.P.*	389	1,005	1,394	1,133.0
ACENSA	450	1,400	1,850	7,043.4
I.P.	679	1,267	1,946	2,099.3
ACHSA	123	1,228	1,351	4,986.3
I.P.	253	458	711	818.6
CAHSA	879	1,253	2,132	10,551.4
I.P.	1,172	1,800	2,972	2,914.3
ACHUMSA	291	1,181	1,472	3,837.6
I.P.	87	150	237	176.1
AZUNOSA	183	912	1,095	3,465.0
I.P	473	1,030	1,503	1,159.9
AYSA	186	689	875	3,075.2
I.P.	545	1,176	1,721	1,541.4
Totals	6,160	13,602	19,762	44,201.5 Lps.

* I.P.= Independent Producers Source: Company data.

Sixty percent of total jobs in the sugar industry are located in the northern region, where the majority of the mills are located. During the harvesting season, migration occurs from the south, where work opportunities are most limited, to the central and northern cane growing areas.

One of the factors contributing to under-employment in rural areas is the seasonal nature of agriculture, in Honduras as elsewhere. Agriculture provides most of the employment during the rainy season (mid-May to mid-October), after which the rural worker has few earning opportunities. Sugarcane labor requirements, by contrast, are highest in the dry season beginning in mid-November and lasting until mid-May. In this way it complements other agricultural activities.

EMPLOYMENT

Over time the sugar companies have sought to reduce to a minimum personnel employed on a permanent basis and to hire most employees on a temporary basis of not more than two months. To harvest the cane crop, mills will contract the services of a "Contratista" who provides all harvesting services and coordinates cane transport to the mills. Salaries paid to farm workers equal 5 Lempiras (Lps) per day. Cane cutters are paid based on cane tonnage harvested per day or the number of linear meters of cane rows harvested, which for practical purposes is the same. On average a cutter harvests 2.5 tons per day at a rate of 5 Lps/ton, earning 12.50 Lps. Workers who belong to a union will earn approximately 30% more. In 1985, more than 44 million Lps ($22 million) were paid in salaries and social benefits by the sugar industry.

Sugarcane has traditionally been a good crop for the cane grower in Honduras, largely due to high domestic sugar prices. The government has helped the grower to obtain stable, relatively high prices for cane; each time it has approved a domestic sugar price increase it has made provisions for those benefits to be passed on to the grower. According to the Banco Nacional de Desarrollo Agricola (BANADESA), which has financed much of the cane crop over the last decade through arrangements with sugar factories, experience with sugarcane has been considerably better than other crops, and numerous former growers of rice, corn and cotton have shifted to cane.

Other benefits have also been associated with cane growing. For the large farmer it has permitted extensive farming at low financial risks while at the same time protecting his land from any expropriations under the agrarian reform. Small farmers have benefitted from the relative ease of cane farming, allowing time to concentrate on other income activities or staple crops during the rainy season. For the rural worker who owns no land it has provided a source of employment every year.

Average Price Received by Grower, Last Six Harvests
(Lps/st)

1985/86	1984/85	1983/84	1982/83	1981/82	1980/81
24.65	29.00	31.50	30.00	31.00	32.00

The prices received for cane in the past are shown above. The new prices have caused some friction between sugar companies and independent producers. Concern over the possibility that cane prices will continue to decline has stimulated a small search for alternative crops, but at present no clear alternatives have emerged. Farmers however, are spending as little as possible in maintenance of their cane crop, and normal agricultural practices such as land renovation and subsoiling appear to be on the decline.

6.3 Cane Farming Economics

The following is an example of the returns a cane grower might expect for a typical operation assuming he decides to replant his cane fields according to good cultivation practice. The data for these estimates are from BANADESA and some adjustments were made (e.g., harvest costs). Yields were estimated at 93 tons per hectare, which is about 15 percent higher than the national average of 80 tons/ha, because of the use of fertilizers and irrigation. Financial costs were based on the interest rates that BANADESA has for mid-term cane investments and 15 percent for operationing capital (crop and farm maintenance). Current prices for a ton of cane are used in the calculations. No financial costs were estimated for harvest operations since it is assumed that mills finance it at no cost to the farmer (compensating for the interest not received by the farmer for the 1-3 month waiting period for final payment after harvest. It is also assumed that the hypothetical farmer is located 24 kilometers away from the mill.

1. Operating Costs:

	Lps/ha		Lps/ton
Labor	422		4.53
Mechanized Operations	152		1.64
Ag. Chemicals	323		3.47
Total Operating Costs	897		9.64
Financial Cost	135		1.45
Subtotal Lps	1032/ha	Lps	11.09/ton

2. Harvest, Load, Transport & Admin. Costs:

Harvest	—		4.00
Load	—		1.80
Cane Transport (24 km)	—		4.90
Administrative	—		0.20
		Lps	10.90/ton

3. Returns Per Hectare and Per Ton at Various Cane Prices:

Cane Price (Lp/ton)	24.18	24.75	25.00	26.50	27.60	28.00
Expenses (cost/ton)	21.99	21.99	21.99	21.99	21.99	21.99
Gross Margin (Lp/ton)	2.19	2.76	3.01	4.51	5.61	6.01
Depreciation (Lp/ton)	2.06	2.06	2.06	2.06	2.06	2.06
Net Income (Lp/ton)	0.13	0.70	0.95	2.45	3.55	3.95
Net income (Lp/ha)	12.09	65.10	88.35	227.85	330.15	367.35
IRR (after deprec.)	0.6	3.2	4.3	11.1	16.1	17.9
IRR (no deprec.)	9.9	12.5	13.7	20.5	25.5	27.3

(IRR: Internal rate of return)

At prevailing cane prices over the past several years, a grower could expect net income per hectare in excess of 400 Lps. This income is net of all costs, including depreciation and finance. By comparison, a number of alternative crops might be expected to generate income on a per hectare basis as follows (BANADESA data):

Melons	Lps 1144
Soybeans	" 523
Sesame	" 206
Corn	" 84

These returns are an indicator, but are not directly comparable since they do not include finance or depreciation costs as in the cane case. It is also important to note that new crops often involve uncertain markets, significant start-up costs, and considerable time to attain efficient production in practice.

6.4 Independent Grower Organizations

There are three organizations of cane growers: Empresa Cooperativa Agroindustrial de Canicultores (ECARAC), the Honduran Cane Growers Association (AHCI), and the Union de Productores de Cana del Sur (UPROCASUR). Each of these organizations is interested in diversification options for growers, and there is a strong feeling that the alcohol option requires immediate evaluation and decisions on the part of the government and the industry.

The Honduran Association of Independent Cane Growers (AHCI) is based in San Pedro Sula and was formed in 1967. It has a total membership of 253 growers who supply CAHSA and AYSA, comprising 95% of all independent grower cane going to these mills. AHCI is by far the best organized and most aggressive of the independent growers groups. The directors of AHCI recognize the market problems faced by the sugar industry and acknowledge that some areas will be eliminated unless an alternative is found for world market sugar. ACHI generally supports the ethanol production option, since it allows growers to continue in cane. AHCI is also looking strongly into the possibility of taking more advantage of the high-priced domestic sugar market by cutting down 30 to 40 percent of cane land in order to eliminate the sugar CAHSA and AYSA sell in the world market. This would require the cooperation of those mills in cutting down in their acreage in the same proportion and at the same time establishing a new price per ton of cane based on the average of the domestic and U.S. quota markets. (According to estimates made by AHCI, the price per ton could be around 36 Lps if this formula is used.)

ECARAC is formed by 29 cane growing cooperatives, and they are associated to the Honduran Federation of Agrarian Reform Cooperatives (FECORAH). A total area of 3150 hectares are being cultivated in sugar cane by ECARAC, and they produce approximately 240,000 tons of cane per year. The total number of members

in ECARAC is 851, and 5,208 persons are directly employed by ECARAC members. ECARAC supplies the mills which belong to CAHSA, AZUNOSA and AYSA. On behalf of ECARAC the Fondo Hondureno de Preinversion (based in Tegucigalpa) has initiated a study of the installation of an independent ethanol distillery; this is supported by the Inter-American Development Bank (Washington, DC).

The Union de Productores de Cana Del Sur (UPROCASUR) consists of 24 co-ops and 276 independent growers supplying cane to ACENSA and ACHSA. It is the least organized of the three cane growers associations, comprised mainly of small growers and Agrarian Reform coops. This group has had bad experience with basic grain crops and regards cane as an excellent crop assuming prices at the levels of recent years. UPROCASUR considers the main option to be double purpose cattle (milk and beef), but is aware of the local dry season forage problems for livestock. They would be interested in alcohol production in the south that maintains cane production and provides potential animal feed supplements.

6.5 Conclusions

During the last two sugarcane seasons cultivation area has declined. At least 1126 hectares are being eliminated for 1986-87, and it is expected that most of the area reductions are going to take place on independent grower lands. If sugar production in Honduras were reduced to the level needed to satisfy the domestic and US quota markets, direct employment losses would amount to approximately 8000 jobs; an additional unknown number of jobs would be lost in the sugarcane "service" economy.

Some independent growers and mills are trying to diversify into new crops. In the northern region, soybeans, pineapple for export, plaintain for export and local markets, and cattle are being considered. In the south, ACENSA has begun a diversification program of melons, sesame, soybeans and cattle. At present none of these options provide as stable an income source as cane, and all generally involve lower labor requirements. While these and other options should continue to receive priority attention, they do not address the pressing problem of reduced rural employment and income in the sugarcane sector.

Diversification into alcohol production would capture the interest of all groups currently concerned with cane. Growers associations, coops and their financiers should be participants in discussions relating to alcohol development, particularly as it is apparent that a number of independent investigations are starting. Given the limited scope of the sugarcane industry's world market sugar resources, continued cooperation across groups in the industry will be necessary to fashion an effective diversification program.

APPENDIX A

COST-BENEFIT TABLES

Table A

CALCULATION OF THE STANDARD FOREIGN EXCHANGE CONVERSION FACTOR

(Millions of US Dollars)

	1982	1983	1984	1985	1987 est.
Total Imports (M)	738.70	827.25	918.15	1027.50	
Total Exports (X)	676.50	698.70	745.70	827.10	
Import Taxes & Surcharges (Tm)	89.10	100.70	129.40	156.90	
Export Taxes & Surcharges (Tx)	-46.60	-38.90	-43.60	-47.00	
(M+Tm) + (X-Tx)	1457.70	1587.75	1749.65	1964.50	
M + X	1415.20	1525.95	1663.85	1854.60	
(M+Tm) + (X-Tx)/(M+X)	1.03	1.04	1.05	1.06	1.08
Average 1982 - 1985		1.045			

Due to exchange controls, a parallel market exists in which at the time of this report Lempiras are being exchanged for US dollars at the rate of Lps2.80=US$1.00. The foreign exchange premium in the parallel market is taken to be 1.42.

Marginal value of foreign exchange, parallel market	1.42
Estimated foreign exchange premium (1.08+1.42)/2	1.25

Table A1 3-31-86

Financial Analysis of Annexed Distillery 150,000 l/day
Incremental Method
(units U.S.$ 000's).
(Amortization of facilities in five years.)

YEAR	1987	1988	1989
COSTS			
DISTILLERY			
Domestic			
Construction	-1289.0		
Import Duties (5%AV)	0.0		
Foreign			
Equipment and Materials(Azeo,150k ltrs)	-2245.0		
By-product Capital Costs	-748.0		
Freight and Insurance	-500.0		
Engineering	-300.0		
LOANS AND AMORTIZATION			
Foreign			
Equipment Supplier (7.5%,5yrs.)	3793.0	-937.5	-937.5
Foreign banks (10%, 5yrs.)	1289.0	-340.0	-340.0
COSTS OF PROCESSING JUICE TO ALCOHOL			
Wages and Salaries, Domestic		-102.7	-102.7
Fringe Benefits, Domestic		-30.8	-30.8
Utilities and Misc., Domestic		-460.2	-460.2
Operating Supplies, Foreign		-642.0	-642.0
SHIPPING TO PORT (at $0.03/gal)			
Domestic (1/3)		-71.3	-71.3
Foreign (2/3)		-142.7	-142.7
TOTAL COSTS			
Domestic	0.0	-665.0	-665.0
Foreign	.0	-2062.2	-2062.2
Total	.0	-2727.2	-2727.2
BENEFITS			
REVENUES FROM ALCOHOL SALES			
Foreign			
At $1.25/gal. FOB, POE		8916.8	8916.8
At $1.00		7133.4	
At $1.05		7490.1	
At $1.10		7846.7	
At $1.15		8203.4	
At $1.20		8560.1	
Less foregone revenues from sugar			
At $0.06/lb		-5012.4	-5012.4
At $0.07		-5847.8	
At $0.08		-6683.1	
At $0.09		-7518.5	
At $0.10		-8353.9	
At $0.11		-9189.3	
At $0.12		-10024.7	
Less foregone revenues from molasses			
Foreign at $50/ton		-699.9	-699.9

SALES OF BY-PRODUCTS			
Domestic			
Yeast at $0.066 per gal. alcohol		470.8	470.8
Carbon dioxide		0.0	0.0
Other		249.7	249.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES			
Domestic		179.9	179.9
Foreign			
SAVINGS IN SHIPPING SUGAR			
Domestic		172.6	172.6
Foreign		345.3	345.3
SAVINGS IN SHIPPING MOLASSES			
Domestic		30.8	30.8
Foreign		61.6	61.6
REDUCTION IN ADMINISTRATIVE COSTS			
Domestic at $1.00 per ton cane		451.6	451.6
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)			
Domestic at $0.625/ton cane		282.2	282.2
TOTAL BENEFITS			
Domestic	0.0	1837.6	1837.6
Foreign	0.0	3611.4	3611.4
Total	0.0	5449.0	5449.0
NET BENEFITS			
Domestic	0.0	1172.6	1172.6
Foreign	.0	1549.2	1549.2
Total	.0	2721.8	2721.8

NOTES:

Daily capacity, gallons	39.6
Assumption: 150 days per year	
Assumed annual capacity @180 days/year	7133.4
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	451.6
Sugar displaced at 185 lbs/ton cane,lbs	83539.3
Molasses displaced at 5.2763 gal. per ton can at density of 11.75 lbs./gal	14.0
Savings in transport costs sugar to port	517.9
Savings in transport costs molasses to port	92.4
Savings in Processing Costs of sugar	179.9

Sensitivity to Changes in World Sugar Price	Net Benefits
When world sugar price is $0.06	2721.8
When world sugar price is $0.07	1886.4
When world sugar price is $0.08	1051.0
When world sugar price is $0.09	215.6
When world sugar price is $0.10	-619.8
When world sugar price is $0.11	-1455.2
When world sugar price is $0.12	-2290.6

Table A2
SENSITIVITY OF NET ANNUAL FINANCIAL BENEFITS
TO WORLD PRICES OF SUGAR AND ALCOHOL
Five Year Amortization
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.90	225.1	-610.3	-1445.7	-2281.1	-3116.5	-3951.9	-4787.3
0.95	581.8	-253.6	-1089.0	-1924.4	-2759.8	-3595.2	-4430.6
1.00	938.4	103.0	-732.4	-1567.8	-2403.2	-3238.5	-4073.9
1.05	1295.1	459.7	-375.7	-1211.1	-2046.5	-2881.9	-3717.3
1.10	1651.8	816.4	-19.0	-854.4	-1689.8	-2525.2	-3360.6
1.15	2008.4	1173.0	337.6	-497.7	-1333.1	-2168.5	-3003.9
1.20	2365.1	1529.7	694.3	-141.1	-976.5	-1811.9	-2647.3
1.25	2721.8	1886.4	1051.0	215.6	-619.8	-1455.2	-2290.6
1.30	3078.4	2243.0	1407.7	572.3	-263.1	-1098.5	-1933.9
1.35	3435.1	2599.7	1764.3	928.9	93.5	-741.9	-1577.2
1.40	3791.8	2956.4	2121.0	1285.6	450.2	-385.2	-1220.6
1.45	4148.5	3313.1	2477.7	1642.3	806.9	-28.5	-863.9
1.50	4505.1	3669.7	2834.3	1998.9	1163.5	328.2	-507.2
1.55	4861.8	4026.4	3191.0	2355.6	1520.2	684.8	-150.6
1.60	5218.5	4383.1	3547.7	2712.3	1876.9	1041.5	206.1
1.65	5575.1	4739.7	3904.3	3069.0	2233.6	1398.2	562.8
1.70	5931.8	5096.4	4261.0	3425.6	2590.2	1754.8	919.4

Table A3 3-31-86

Financial Analysis of Annexed Distillery 150,000 l/day

Incremental Method

(units U.S.$ 000's).

(Amortization of facilities in fifteen years.)

YEAR	1987	1988	1989
COSTS			
DISTILLERY			
Domestic			
Construction	-1289.0		
Import Duties (5%AV)	0.0		
Foreign			
Equipment and Materials(Azeo,150k ltrs)	-2245.0		
By-product Capital Costs	-748.0		
Freight and Insurance	-500.0		
Engineering	-300.0		
LOANS AND AMORTIZATION			
Foreign			
Equipment Supplier (9.5%,15yrs.)	3793.0	-484.5	-484.5
Foreign banks (10%, 5yrs.)	1289.C	-164.7	-164.7
COSTS OF PROCESSING JUICE TO ALCOHOL			
Wages and Salaries, Domestic		-102.7	-102.7
Fringe Benefits, Domestic		-30.8	-30.8
Utilities and Misc., Domestic		-460.2	-460.2
Operating Supplies, Foreign		-642.0	-642.0
SHIPPING TO PORT (at $0.03/gal)			
Domestic (1/3)		-71.3	-71.3
Foreign (2/3)		-142.7	-142.7
TOTAL COSTS			
Domestic	0.0	-665.0	-665.0
Foreign	.0	-1433.9	-1433.9
Total	.0	-2098.9	-2098.9
BENEFITS			
REVENUES FROM ALCOHOL SALES			
Foreign			
At $1.25/gal. FOB, POE		8916.8	8916.8
At $1.00		7133.4	
At $1.05		7490.1	
At $1.10		7846.7	
At $1.15		8203.4	
At $1.20		8560.1	
Less foregone revenues from sugar			
At $0.06/lb		-5012.4	-5012.4
At $0.07		-5847.8	
At $0.08		-6683.1	
At $0.09		-7518.5	
At $0.10		-8353.9	
At $0.11		-9189.3	
At $0.12		-10024.7	
Less foregone revenues from molasses			
Foreign at $50/ton		-699.9	-699.9

SALES OF BY-PRODUCTS			
Domestic			
Yeast at $0.066 per gal. alcohol		470.8	470.8
Carbon dioxide		0.0	0.0
Other		249.7	249.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES			
Domestic		179.9	179.9
Foreign			
SAVINGS IN SHIPPING SUGAR			
Domestic		172.6	172.6
Foreign		345.3	345.3
SAVINGS IN SHIPPING MOLASSES			
Domestic		30.8	30.8
Foreign		61.6	61.6
REDUCTION IN ADMINISTRATIVE COSTS			
Domestic at $1.00 per ton cane		451.6	451.6
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)			
Domestic at $0.625/ton cane		282.2	282.2
TOTAL BENEFITS			
Domestic	0.0	1837.6	1837.6
Foreign	0.0	3611.4	3611.4
Total	0.0	5449.0	5449.0
NET BENEFITS			
Domestic	0.0	1172.6	1172.6
Foreign	.0	2177.5	2177.5
Total	.0	3350.1	3350.1
		3350.1	
		1105.6	
		2244.5	

NOTES:

Daily capacity, gallons	39.6
Assumption: 150 days per year	
Assumed annual capacity @180 days/year	7133.4
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	451.6
Sugar displaced at 185 lbs/ton cane,lbs	83539.3
Molasses displaced at 5.2763 gal. per ton ca at density of 11.75 lbs./gal	14.0
Savings in transport costs sugar to port	517.9
Savings in transport costs molasses to port	92.4
Savings in Processing Costs of sugar	179.9

Sensitivity to Changes in World Sugar Price	Net Benefits
When world sugar price is $0.06	3350.1
When world sugar price is $0.07	2514.7
When world sugar price is $0.08	1679.3
When world sugar price is $0.09	843.9
When world sugar price is $0.10	8.5
When world sugar price is $0.11	-826.9
When world sugar price is $0.12	-1662.2

Table A4
SENSITIVITY OF NET ANNUAL FINANCIAL BENEFITS
TO WORLD PRICES OF SUGAR AND ALCOHOL
Fifteen Year Amortization
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.90	853.4	18.0	-817.4	-1652.8	-2488.2	-3323.5	-4158.9
0.95	1210.1	374.7	-460.7	-1296.1	-2131.5	-2966.9	-3802.3
1.00	1566.8	731.4	-104.0	-939.4	-1774.8	-2610.2	-3445.6
1.05	1923.4	1088.0	252.6	-582.8	-1418.1	-2253.5	-3088.9
1.10	2280.1	1444.7	609.3	-226.1	-1061.5	-1896.9	-2732.3
1.15	2636.8	1801.4	966.0	130.6	-704.8	-1540.2	-2375.6
1.20	2993.4	2158.0	1322.7	497.3	-348.1	-1183.5	-2018.9
1.25	3350.1	2514.7	1679.3	843.9	8.5	-826.9	-1662.2
1.30	3706.8	2871.4	2036.0	1200.6	365.2	-470.2	-1305.6
1.35	4063.4	3228.1	2392.7	1557.3	721.9	-113.5	-948.9
1.40	4420.1	3584.7	2749.3	1913.9	1078.5	243.2	-592.2
1.45	4776.8	3941.4	3106.0	2270.6	1435.2	599.8	-235.6
1.50	5133.5	4298.1	3462.7	2627.3	1791.9	956.5	121.1
1.55	5490.1	4654.7	3819.3	2983.9	2148.6	1313.2	477.8
1.60	5846.8	5011.4	4176.0	3340.6	2505.2	1669.8	834.4
1.65	6203.5	5368.1	4532.7	3697.3	2861.9	2026.5	1191.1

Table A5 3-31-86

Economic Analysis of Annexed Distillery 150,000 l/day

Incremental Method

(units U.S.$ 000's).

(Amortization of facilities in five years.)

YEAR	1987 Financial	1987 Economic	1988 Financial	1988 Economic
COSTS				
DISTILLERY				
Domestic				
Construction	-1289.0	-1289.0		
Import Duties (5%AV)	0.0	0.0		
Foreign				
Equipment and Materials(Azeo,150k ltr	-2245.0	-2806.3		
By-product Capital Costs	-748.0	-935.0		
Freight and Insurance	-500.0	-625.0		
Engineering	-300.0	-375.0		
LOANS AND AMORTIZATION				
Foreign				
Equipment Supplier (7.5%,5yrs.)	3793.0	4741.3	-937.5	-1171.9
Foreign banks (10%, 5yrs.)	1289.0	1611.3	-340.0	-425.0
COSTS OF PROCESSING JUICE TO ALCOHOL				
Wages and Salaries, Domestic			-102.7	-102.7
Fringe Benefits, Domestic			-30.8	-30.8
Utilities and Misc., Domestic			-460.2	-460.2
Operating Supplies, Foreign			-642.0	-802.5
SHIPPING TO PORT (at $0.03/gal)				
Domestic (1/3)			-71.3	-71.3
Foreign (2/3)			-142.7	-178.3
TOTAL COSTS				
Domestic	0.0	0.0	-665.0	-665.0
Foreign	.0	322.2	-2062.2	-2577.7
Total	.0	322.2	-2727.2	-3242.8
BENEFITS				
REVENUES FROM ALCOHOL SALES				
Foreign				
At $1.25/gal. FOB, POE			8916.8	11145.9
At $1.00			7133.4	8916.8
At $1.05			7490.1	9362.6
At $1.10			7846.7	9808.4
At $1.15			8203.4	10254.3
At $1.20			8560.1	10700.1
Less foregone revenues from sugar				
At $0.06/lb			-5012.4	-6265.4
At $0.07			-5847.8	-7309.7
At $0.08			-6683.1	-8353.9
At $0.09			-7518.5	-9398.2
At $0.10			-8353.9	-10442.4
At $0.11			-9189.3	-11486.7
At $0.12			-10024.7	-12530.9
Less foregone revenues from molasses				
Foreign at $50/ton			-699.9	-874.9

Domestic				
Yeast at $0.066 per gal. alcohol			470.8	588.5
Carbon dioxide			0.0	0.0
Other			249.7	312.1
SAVINGS IN PROCESSING SUGAR AND MOLASSES				
Domestic			179.9	179.9
Foreign				
SAVINGS IN SHIPPING SUGAR				
Domestic			172.6	172.6
Foreign			345.3	431.6
SAVINGS IN SHIPPING MOLASSES				
Domestic			30.8	30.8
Foreign			61.6	77.0
REDUCTION IN ADMINISTRATIVE COSTS				
Domestic at $1.00 per ton cane			451.6	451.6
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)				
Domestic at $0.625/ton cane			282.2	282.2
TOTAL BENEFITS				
Domestic	0.0	0.0	1837.6	2017.7
Foreign	0.0	0.0	3611.4	4514.2
Total	0.0	0.0	5449.0	6532.0
NET BENEFITS				
Domestic	0.0	0.0	1172.6	1352.7
Foreign	.0	322.2	1549.2	1936.5
Total	.0	322.2	2721.8	3289.2
			2721.8	3289.2
			477.3	762.8
			2244.5	2526.3

NOTES:

Daily capacity, gallons	39.6
Assumption: 150 days per year	
Assumed annual capacity @180 days/year	7133.4
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	451.6
Sugar displaced at 185 lbs/ton cane,lbs	83539.3
Molasses displaced at 5.2763 gal. per ton cane at density of 11.75 lbs./gal	14.0
Savings in transport costs sugar to port	517.9
Savings in transport costs molasses to port	92.4
Savings in Processing Costs of sugar	179.9

Sensitivity to Changes in World Sugar Price	Net Benefits	Net Benefits	Differ-ence
When world sugar price is $0.06	2721.8	3289.2	567.4
When world sugar price is $0.07	1886.4	2244.9	358.6
When world sugar price is $0.08	1051.0	1200.7	149.7
When world sugar price is $0.09	215.6	156.5	-59.1
When world sugar price is $0.10	-619.8	-887.8	-268.0
When world sugar price is $0.11	-1455.2	-1932.0	-476.8
When world sugar price is $0.12	-2290.6	-2976.3	-685.7

Table A6
SENSITIVITY OF NET ANNUAL ECONOMIC BENEFITS
TO WORLD PRICES OF SUGAR AND ALCOHOL
Five Year Amortization
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.90	168.3	-875.9	-1920.2	-2964.4	-4008.6	-5052.9	-6097.1
0.95	614.2	-430.1	-1474.3	-2518.6	-3562.8	-4607.0	-5651.3
1.00	1060.0	15.8	-1028.5	-2072.7	-3117.0	-4161.2	-5205.4
1.05	1505.8	461.6	-582.6	-1626.9	-2671.1	-3715.4	-4759.6
1.10	1951.7	907.4	-136.8	-1181.0	-2225.3	-3269.5	-4313.8
1.15	2397.5	1353.3	309.0	-735.2	-1779.5	-2823.7	-3867.9
1.20	2843.4	1799.1	754.9	-289.4	-1333.6	-2377.9	-3422.1
1.25	3289.2	2244.9	1200.7	156.5	-887.8	-1932.0	-2976.3
1.30	3735.0	2690.8	1646.5	602.3	-441.9	-1486.2	-2530.4
1.35	4180.9	3136.6	2092.4	1048.1	3.9	-1040.3	-2084.6
1.40	4626.7	3582.5	2538.2	1494.0	449.7	-594.5	-1638.7
1.45	5072.5	4028.3	2984.1	1939.8	895.6	-148.7	-1192.9
1.50	5518.4	4474.1	3429.9	2385.7	1341.4	297.2	-747.1
1.55	5964.2	4920.0	3875.7	2831.5	1787.2	743.0	-301.2
1.60	6410.1	5365.8	4321.6	3277.3	2233.1	1188.8	144.6
1.65	6855.9	5811.6	4767.4	3723.2	2678.9	1634.7	590.4
1.70	7301.7	6257.5	5213.2	4169.0	3124.8	2080.5	1036.3

Table A7
DIFFERENCE BETWEEN ANNUAL NET ECONOMIC AND
NET FINANCIAL BENEFITS TO VARIOUS PRICES OF SUGAR AND ALCOHOL
(US $ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.90	-56.8	-265.6	-474.5	-683.3	-892.1	-1101.0	-1309.8
0.95	32.4	-176.4	-385.3	-594.1	-803.0	-1011.8	-1220.7
1.00	121.6	-87.3	-296.1	-505.0	-713.8	-922.7	-1131.5
1.05	210.7	1.9	-206.9	-415.8	-624.6	-833.5	-1042.3
1.10	299.9	91.1	-117.8	-326.6	-535.5	-744.3	-953.2
1.15	389.1	180.2	-28.6	-237.5	-446.3	-655.2	-864.0
1.20	478.2	269.4	60.6	-148.3	-357.1	-566.0	-774.8
1.25	567.4	358.6	149.7	-59.1	-268.0	-476.8	-685.7
1.30	656.6	447.7	238.9	30.0	-178.8	-387.7	-596.5
1.35	745.8	536.9	328.1	119.2	-89.6	-298.5	-507.3
1.40	834.9	626.1	417.2	208.4	-0.5	-209.3	-418.2
1.45	924.1	715.2	506.4	297.5	88.7	-120.2	-329.0
1.50	1013.3	804.4	595.6	386.7	177.9	-31.0	-239.8
1.55	1102.4	893.6	684.7	475.9	267.0	58.2	-150.7
1.60	1191.6	982.7	773.9	565.0	356.2	147.3	-61.5
1.65	1280.8	1071.9	863.1	654.2	445.4	236.5	27.7
1.70	1369.9	1161.1	952.2	743.4	534.5	325.7	116.8

Table A8 4-1-86

Financial Analysis of Annexed Distillery 150,000 l/day

Global Method

(units U.S.$ 000's).

Excludes Capital Flows

YEAR	1987	1988	1989
COSTS			
DISTILLERY			
Domestic			
Construction	-1289.0		
Import Duties (5%AV)	0.0		
Foreign			
Equipment and Materials(Azeo,150k ltrs)	-2245.0		
By-product Capital Costs	-748.0		
Freight and Insurance	-500.0		
Engineering	-300.0		
LOANS AND AMORTIZATION			
Foreign			
Equipment Supplier (7.5%,5yrs.)			
Foreign banks (10%, 5yrs.)			
COSTS OF PROCESSING JUICE TO ALCOHOL			
Wages and Salaries, Domestic		-102.7	-102.7
Fringe Benefits, Domestic		-30.8	-30.8
Utilities and Misc., Domestic		-460.2	-460.2
Operating Supplies, Foreign		-642.0	-642.0
SHIPPING TO PORT (at $0.03/gal)			
Domestic (1/3)		-71.3	-71.3
Foreign (2/3)		-142.7	-142.7
TOTAL COSTS			
Domestic	0.0	-665.0	-665.0
Foreign	-5082.0	-784.7	-784.7
Total	-5082.0	-1449.7	-1449.7
BENEFITS			
REVENUES FROM ALCOHOL SALES			
Foreign			
At $1.25/gal. FOB, POE		8916.8	8916.8
At $1.00		7133.4	
At $1.05		7490.1	
At $1.10		7846.7	
At $1.15		8203.4	
At $1.20		8560.1	
Less foregone revenues from sugar			
At $0.06/lb		-5012.4	-5012.4
At $0.07		-5847.8	
At $0.08		-6683.1	
At $0.09		-7518.5	
At $0.10		-8353.9	
At $0.11		-9189.3	
At $0.12		-10024.7	
Less foregone revenues from molasses			
Foreign at $50/ton		-699.9	-699.9
SALES OF BY-PRODUCTS			

Domestic			
Yeast at $0.066 per gal. alcohol		470.8	470.8
Carbon dioxide		0.0	0.0
Other		249.7	249.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES			
Domestic		179.9	179.9
Foreign			
SAVINGS IN SHIPPING SUGAR			
Domestic		172.6	172.6
Foreign		345.3	345.3
SAVINGS IN SHIPPING MOLASSES			
Domestic		30.8	30.8
Foreign		61.6	61.6
REDUCTION IN ADMINISTRATIVE COSTS			
Domestic at $1.00 per ton cane		451.6	451.6
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)			
Domestic at $0.625/ton cane		282.2	282.2
TOTAL BENEFITS			
Domestic	0.0	1837.6	1837.6
Foreign	0.0	3611.4	3611.4
Total	0.0	5449.0	5449.0
NET BENEFITS			
Domestic	0.0	1172.6	1172.6
Foreign	-5082.0	2826.7	2826.7
Total	-5082.0	3999.3	3999.3
		3999.3	
		1754.8	
		2244.5	

NOTES:

Daily capacity, gallons	39.6
Assumed annual capacity @180 days/year	7133.4
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	451.6
Sugar displaced at 185 lbs/ton cane,lbs	83539.3
Molasses displaced at 5.2763 gal. per ton cane at density of 11.75 lbs./gal	14.0
Savings in transport costs sugar to port	517.9
Savings in transport costs molasses to port	92.4
Savings in Processing Costs of sugar	179.9

Sensitivity to Changes in World Sugar Price

	Net Benefits
When world sugar price is $0.06	3999.3
When world sugar price is $0.07	3163.9
When world sugar price is $0.08	2328.5
When world sugar price is $0.09	1493.1
When world sugar price is $0.10	657.7
When world sugar price is $0.11	-177.7
When world sugar price is $0.12	-1013.1

Table A9
SENSITIVITY OF NET ANNUAL FINANCIAL
BENEFITS TO WORLD PRICES OF SUGAR AND ALCOHOL
Capital Flows Excluded
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11
0.60	-637.4	-1472.8	-2308.2	-3143.6	-3979.0	-4814.4
0.65	-280.7	-1116.1	-1951.5	-2786.9	-3622.3	-4457.7
0.70	75.9	-759.5	-1594.9	-2430.2	-3265.6	-4101.0
0.75	432.6	-402.8	-1238.2	-2073.6	-2909.0	-3744.4
0.80	789.3	-46.1	-881.5	-1716.9	-2552.3	-3387.7
0.85	1145.9	310.5	-524.8	-1360.2	-2195.6	-3031.0
0.90	1502.6	667.2	-168.2	-1003.6	-1839.0	-2674.4
0.95	1859.3	1023.9	188.5	-646.9	-1482.3	-2317.7
1.00	2216.0	1380.6	545.2	-290.2	-1125.6	-1961.0
1.05	2572.6	1737.2	901.8	66.4	-769.0	-1604.3
1.10	2929.3	2093.9	1258.5	423.1	-412.3	-1247.7
1.15	3286.0	2450.6	1615.2	779.8	-55.6	-891.0
1.20	3642.6	2807.2	1971.8	1136.5	301.1	-534.3
1.25	3999.3	3163.9	2328.5	1493.1	657.7	-177.7
1.30	4356.0	3520.6	2685.2	1849.8	1014.4	179.0
1.35	4712.6	3877.2	3041.9	2206.5	1371.1	535.7
1.40	5069.3	4233.9	3398.5	2563.1	1727.7	892.3
1.45	5426.0	4590.6	3755.2	2919.8	2084.4	1249.0
1.50	5782.7	4947.3	4111.9	3276.5	2441.1	1605.7
1.55	6139.3	5303.9	4468.5	3633.1	2797.7	1962.4
1.60	6496.0	5660.6	4825.2	3989.8	3154.4	2319.0
1.65	6852.7	6017.3	5181.9	4346.5	3511.1	2675.7

Table A10

SENSITIVITY OF INTERNAL RATE OF RETURN TO SUGAR PRICES

Price of alcohol = $1.25

Year	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00
Price of Sugar	0.07	0.08	0.09	0.10	0.11	0.12
Net Benefits	-5082.00	2328.52	1493.12	657.73	0.00	0.00
Internal Rate of Return =		-0.07				

Year	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00
Price of Sugar	0.06	0.06	0.06	0.06	0.06	0.06
Net Benefits	-5082.00	3999.30	3999.30	3999.30	3999.30	3999.30
Internal Rate of Return =		0.74				

Year	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00
Price of Sugar	0.07	0.08	0.08	0.08	0.08	0.08
Net Benefits	-5082.00	2328.52	2328.52	2328.52	2328.52	2328.52
Internal Rate of Return =		0.36				

Year	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00
Price of Sugar	0.07	0.08	0.09	0.09	0.09	0.09
Net Benefits	-5082.00	2328.52	1493.12	1493.12	1493.12	1493.12
Internal Rate of Return =		0.21				

Table All 4-1-86

Economic Analysis of Annexed Distillery 150,000 l/day

Global Method

(units U.S.$ 000's).

Excludes Capital Flows

YEAR	1987 Financial	1987 Economic	1988 Financial
COSTS			
DISTILLERY			
Domestic			
Construction	-1289.0	-1289.0	
Import Duties (5%AV)	0.0	0.0	
Foreign			
Equipment and Materials(Azeo,150k ltrs	-2245.0	-2806.3	
By-product Capital Costs	-748.0	-935.0	
Freight and Insurance	-500.0	-625.0	
Engineering	-300.0	-375.0	
LOANS AND AMORTIZATION			
Foreign			
Equipment Supplier (7.5%,5yrs.)			
Foreign banks (10%, 5yrs.)			
COSTS OF PROCESSING JUICE TO ALCOHOL			
Wages and Salaries, Domestic			-102.7
Fringe Benefits, Domestic			-30.8
Utilities and Misc., Domestic			-460.2
Operating Supplies, Foreign			-642.0
SHIPPING TO PORT (at $0.03/gal)			
Domestic (1/3)			-71.3
Foreign (2/3)			-142.7
TOTAL COSTS			
Domestic	-1289.0	-1289.0	-665.0
Foreign	-3793.0	-4741.3	-784.7
Total	-5082.0	-6030.3	-1449.7
BENEFITS			
REVENUES FROM ALCOHOL SALES			
Foreign			
At $1.25/gal. FOB, POE			8916.8
At $1.00			7133.4
At $1.05			7490.1
At $1.10			7846.7
At $1.15			8203.4
At $1.20			8560.1
Less foregone revenues from sugar			
At $0.06/lb			-5012.4
At $0.07			-5847.8
At $0.08			-6683.1
At $0.09			-7518.5
At $0.10			-8353.9
At $0.11			-9189.3
At $0.12			-10024.72
Less foregone revenues from molasses			
Foreign at $50/ton			-699.9
SALES OF BY-PRODUCTS			

Domestic			
Yeast at $0.066 per gal. alcohol			470.8
Carbon dioxide			0.0
Other			249.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES			
Domestic			179.9
Foreign			
SAVINGS IN SHIPPING SUGAR			
Domestic			172.6
Foreign			345.3
SAVINGS IN SHIPPING MOLASSES			
Domestic			30.8
Foreign			61.6
REDUCTION IN ADMINISTRATIVE COSTS			
Domestic at $1.00 per ton cane			451.6
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)			
Domestic at $0.625/ton cane			282.2
TOTAL BENEFITS			
Domestic	0.0	0.0	1837.6
Foreign	0.0	0.0	3611.4
Total	0.0	0.0	5449.0
NET BENEFITS			
Domestic	-1289.0	-1289.0	1172.6
Foreign	-3793.0	-4741.3	2826.7
Total	-5082.0	-6030.3	3999.3
			3999.3
			1754.8
			2244.5

NOTES:

Daily capacity, gallons.	39.6
Assumed annual capacity @180 days/year	7133.4
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	451.6
Sugar displaced at 185 lbs/ton cane,lbs	83539.3
Molasses displaced at 5.2763 gal. per ton cane at density of 11.75 lbs./gal	14.0
Savings in transport costs sugar to port	517.9
Savings in transport costs molasses to port	92.4
Savings in Processing Costs of sugar	179.9

Sensitivity of Economic Net Benefits
To World Sugar Price

	Financial Net Benefits	Economic Net Benefits	Difference
When world sugar price is $0.06	3999.3	4886.1	886.8
When world sugar price is $0.07	3163.9	3841.9	678.0
When world sugar price is $0.08	2328.5	2797.6	469.1
When world sugar price is $0.09	1493.1	1753.4	260.3
When world sugar price is $0.10	657.7	709.1	51.4
When world sugar price is $0.11	-177.7	-335.1	-157.4
When world sugar price is $0.12	-1013.1	-1379.3	-366.3

NOTE: Assumes Price of Alcohol = $1.25.

Table A12
SENSITIVITY OF NET ANNUAL ECONOMIC
BENEFITS TO WORLD PRICES OF SUGAR AND ALCOHOL
Capital Flows Excluded
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.60	-909.8	-1954.0	-2998.3	-4042.5	-5086.8	-6131.0	-7175.2
0.65	-463.9	-1508.2	-2552.4	-3596.7	-4640.9	-5685.2	-6729.4
0.70	-18.1	-1062.4	-2106.6	-3150.8	-4195.1	-5239.3	-6283.6
0.75	427.7	-616.5	-1660.8	-2705.0	-3749.2	-4793.5	-5837.7
0.80	873.6	-170.7	-1214.9	-2259.2	-3303.4	-4347.6	-5391.9
0.85	1319.4	275.2	-769.1	-1813.3	-2857.6	-3901.8	-4946.0
0.90	1765.2	721.0	-323.2	-1367.5	-2411.7	-3456.0	-4500.2
0.95	2211.1	1166.8	122.6	-921.6	-1965.9	-3010.1	-4054.4
1.00	2656.9	1612.7	568.4	-475.8	-1520.1	-2564.3	-3608.5
1.05	3102.8	2058.5	1014.3	-30.0	-1074.2	-2118.5	-3162.7
1.10	3548.6	2504.3	1460.1	415.9	-628.4	-1672.6	-2716.9
1.15	3994.4	2950.2	1905.9	861.7	-182.5	-1226.8	-2271.0
1.20	4440.3	3396.0	2351.8	1307.5	263.3	-780.9	-1825.2
1.25	4886.1	3841.9	2797.6	1753.4	709.1	-335.1	-1379.3
1.30	5331.9	4287.7	3243.5	2199.2	1155.0	110.7	-933.5
1.35	5777.0	4733.5	3689.3	2645.1	1600.8	556.6	-487.7
1.40	6223.6	5179.4	4135.1	3090.9	2046.6	1002.4	-41.8
1.45	6669.5	5625.2	4581.0	3536.7	2492.5	1448.2	404.0
1.50	7115.3	6071.0	5026.8	3982.6	2938.3	1894.1	849.8
1.55	7561.1	6516.9	5472.6	4428.4	3384.2	2339.9	1295.7
1.60	8007.0	6962.7	5918.5	4874.2	3830.0	2785.8	1741.5
1.65	8452.8	7408.6	6364.3	5320.1	4275.8	3231.6	2187.4

Table A13

SENSITIVITY OF INTERNAL RATE OF RETURN TO SUGAR PRICES

Price of alcohol = $1.25

Year	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00
Price of Sugar	0.07	0.08	0.09	0.10	0.11	0.12
Net Benefits	-6030.25	2797.62	1753.38	709.14	0.00	0.00

Internal Rate of Return = -0.08

Year	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00
Price of Sugar	0.06	0.06	0.06	0.06	0.06	0.06
Net Benefits	-6030.25	4886.10	4886.10	4886.10	4886.10	4886.10

Internal Rate of Return = 0.76

Year	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00
Price of Sugar	0.07	0.08	0.08	0.08	0.08	0.08
Net Benefits	-6030.25	2797.62	2797.62	2797.62	2797.62	2797.62

Internal Rate of Return = 0.37

Year	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00
Price of Sugar	0.07	0.08	0.09	0.09	0.09	0.09
Net Benefits	-6030.25	2797.62	1753.38	1753.38	1753.38	1753.38

Internal Rate of Return = 0.21

Table A14
DIFFERENCE BETWEEN NET ANNUAL ECONOMIC
AND FINANCIAL BENEFITS AT VARIOUS WORLD PRICES
OF SUGAR AND ALCOHOL
Capital Flows Excluded
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.60	-272.4	-481.2	-690.1	-898.9	-1107.8	-1316.6	-1525.5
0.65	-183.2	-392.1	-600.9	-809.8	-1018.6	-1227.5	-1436.3
0.70	-94.0	-302.9	-511.7	-720.6	-929.4	-1138.3	-1347.1
0.75	-4.9	-213.7	-422.6	-631.4	-840.3	-1049.1	-1258.0
0.80	84.3	-124.6	-333.4	-542.3	-751.1	-959.9	-1168.8
0.85	173.5	-35.4	-244.2	-453.1	-661.9	-870.8	-1079.6
0.90	262.6	53.8	-155.1	-363.9	-572.8	-781.6	-990.5
0.95	351.8	142.9	-65.9	-274.8	-483.6	-692.4	-901.3
1.00	441.0	232.1	23.3	-185.6	-394.4	-603.3	-812.1
1.05	530.1	321.3	112.4	-96.4	-305.3	-514.1	-723.0
1.10	619.3	410.4	201.6	-7.2	-216.1	-424.9	-633.8
1.15	708.5	499.6	290.8	81.9	-126.9	-335.8	-544.6
1.20	797.6	588.8	379.9	171.1	-37.8	-246.6	-455.5
1.25	886.8	678.0	469.1	260.3	51.4	-157.4	-366.3
1.30	976.0	767.1	558.3	349.4	140.6	-68.3	-277.1
1.35	1065.1	856.3	647.4	438.6	229.7	20.9	-188.0
1.40	1154.3	945.5	736.6	527.8	318.9	110.1	-98.8
1.45	1243.5	1034.6	825.8	616.9	408.1	199.2	-9.6
1.50	1332.6	1123.8	914.9	706.1	497.2	288.4	79.5
1.55	1421.8	1213.0	1004.1	795.3	586.4	377.6	168.7
1.60	1511.0	1302.1	1093.3	884.4	675.6	466.7	257.9
1.65	1600.1	1391.3	1182.4	973.6	764.7	555.9	347.0

Table A15 3-25-86

Financial Analysis of Annexed Distillery 120,000 l/day

Incremental Method

(units U.S.$ 000's).

(Amortization of facilities in five years.)

Base Case

YEAR	1987	1988	1989
COSTS			
DISTILLERY			
Domestic			
Construction	-1200.0		
Import Duties (5%AV)	0.0		
Foreign			
Equipment and Materials(Azeo,120k ltrs)	-1932.0		
By-product Capital Costs	-680.0		
Freight and Insurance	-500.0		
Engineering	-300.0		
LOANS AND AMORTIZATION			
Foreign			
Equipment Supplier (7.5%,5yrs.)	3412.0	-843.3	-843.3
Foreign banks (10%, 5yrs.)	1200.0	-316.6	-316.6
COSTS OF PROCESSING JUICE TO ALCOHOL			
Wages and Salaries, Domestic		-109.6	-109.6
Fringe Benefits, Domestic		-32.9	-32.9
Utilities and Misc., Domestic		-383.9	-383.9
Operating Supplies, Foreign		-513.6	-513.6
SHIPPING TO PORT (at $0.03/gal)			
Domestic (1/3)		-57.1	-57.1
Foreign (2/3)		-114.1	-114.1
		-0.2	per gal.
TOTAL COSTS			
Domestic	-1200.0	-583.5	-583.5
Foreign	1200.0	-1787.6	-1787.6
Total	0.0	-2371.1	-2371.1
BENEFITS			
REVENUES FROM ALCOHOL SALES			
Foreign			
At $1.25/gal. FOB, POE		7133.4	7133.4
At $1.00		5706.7	
At $1.05		5992.1	
At $1.10		6277.4	
At $1.15		6562.7	
At $1.20		6848.1	
Less foregone revenues from sugar			
At $0.06/lb		-4009.9	-4009.9
At $0.07		-4678.2	
At $0.08		-5346.5	
At $0.09		-6014.8	
At $0.10		-6683.1	
At $0.11		-7351.5	
At $0.12		-8019.8	
Less foregone revenues from molasses			
Foreign at $50/ton		-559.9	-559.9

SALES OF BY-PRODUCTS			
Domestic			
Yeast at $0.066 per gal. alcohol		376.6	376.6
Carbon dioxide		0.0	0.0
Other		199.7	199.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES			
Domestic		143.9	143.9
Foreign			
SAVINGS IN SHIPPING SUGAR			
Domestic		138.1	138.1
Foreign		276.2	276.2
SAVINGS IN SHIPPING MOLASSES			
Domestic		24.6	24.6
Foreign		49.3	49.3
REDUCTION IN ADMINISTRATIVE COSTS			
Domestic at $1.00 per ton cane		361.3	361.3
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)			
Domestic at $0.625/ton cane		225.8	225.8
TOTAL BENEFITS			
Domestic	0.0	1470.1	1470.1
Foreign	0.0	2889.1	2889.1
Total	0.0	4359.2	4359.2
NET BENEFITS			
Domestic	-1200.0	886.6	886.6
Foreign	1200.0	1101.5	1101.5
Total	0.0	1988.1	1988.1
		1988.1	
		192.5	
		1795.6	

NOTES:

Daily capacity, gallons	31.7
Assumed annual capacity @180 days/year	5706.7
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	361.3
Sugar displaced at 185 lbs/ton cane,lbs	66831.5
Molasses displaced at 5.2763 gal. per ton cane at density of 11.75 lbs./gal	11.2
Savings in transport costs sugar to port	414.4
Savings in transport costs molasses to port	73.9
Savings in Processing Costs of sugar	143.9

Sensitivity to Changes in World Sugar Price	Net Benefits
When world sugar price is $0.06	1988.1
When world sugar price is $0.07	1319.8
When world sugar price is $0.08	651.5
When world sugar price is $0.09	-16.8
When world sugar price is $0.10	-685.1
When world sugar price is $0.11	-1353.4
When world sugar price is $0.12	-2021.8

Table A16
SENSITIVITY OF NET ANNUAL FINANCIAL
BENEFITS TO WORLD PRICES OF SUGAR AND ALCOHOL
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.90	-9.2	-677.5	-1345.9	-2014.2	-2682.5	-3350.8	-4019.1
0.95	276.1	-392.2	-1060.5	-1728.8	-2397.1	-3065.5	-3733.8
1.00	561.4	-106.9	-775.2	-1443.5	-2111.8	-2780.1	-3448.4
1.05	846.8	178.5	-489.8	-1158.2	-1826.5	-2494.8	-3163.1
1.10	1132.1	463.8	-204.5	-872.8	-1541.1	-2209.5	-2877.8
1.15	1417.5	749.1	80.8	-587.5	-1255.8	-1924.1	-2592.4
1.20	1702.8	1034.5	366.2	-302.2	-970.5	-1638.8	-2307.1
1.25	1988.1	1319.8	651.5	-16.8	-685.1	-1353.4	-2021.8
1.30	2273.5	1605.1	936.8	268.5	-399.8	-1068.1	-1736.4
1.35	2558.8	1890.5	1222.2	553.9	-114.5	-782.8	-1451.1
1.40	2844.1	2175.8	1507.5	839.2	170.9	-497.4	-1165.8
1.45	3129.5	2461.2	1792.8	1124.5	456.2	-212.1	-880.4
1.50	3414.8	2746.5	2078.2	1409.9	741.5	73.2	-595.1
1.55	3700.1	3031.8	2363.5	1695.2	1026.9	358.6	-309.7
1.60	3985.5	3317.2	2648.9	1980.5	1312.2	643.9	-24.4
1.65	4270.8	3602.5	2934.2	2265.9	1597.6	929.2	260.9
1.70	4556.2	3887.8	3219.5	2551.2	1882.9	1214.6	546.3

SALES OF BY-PRODUCTS			
Domestic			
Yeast at $0.066 per gal. alcohol		376.6	376.6
Carbon dioxide		0.0	0.0
Other		199.7	199.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES			
Domestic		143.9	143.9
Foreign			
SAVINGS IN SHIPPING SUGAR			
Domestic		138.1	138.1
Foreign		276.2	276.2
SAVINGS IN SHIPPING MOLASSES			
Domestic		24.6	24.6
Foreign		49.3	49.3
REDUCTION IN ADMINISTRATIVE COSTS			
Domestic at $1.00 per ton cane		361.3	361.3
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)			
Domestic at $0.625/ton cane		225.8	225.8
TOTAL BENEFITS			
Domestic	0.0	1470.1	1470.1
Foreign	0.0	2889.1	2889.1
Total	0.0	4359.2	4359.2
NET BENEFITS			
Domestic	-1200.0	886.6	886.6
Foreign	1200.0	1672.2	1672.2
Total	0.0	2558.9	2558.9
		2558.9	
		763.3	
		1795.6	

NOTES:

Daily capacity, gallons	31.7
Assumed annual capacity @180 days/year	5706.7
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	361.3
Sugar displaced at 185 lbs/ton cane,lbs	66831.5
Molasses displaced at 5.2763 gal. per ton cane at density of 11.75 lbs./gal	11.2
Savings in transport costs sugar to port	414.4
Savings in transport costs molasses to port	73.9
Savings in Processing Costs of sugar	143.9

Sensitivity to Changes in World Sugar Price

	Net Benefits
When world sugar price is $0.06	2558.9
When world sugar price is $0.07	1890.5
When world sugar price is $0.08	1222.2
When world sugar price is $0.09	553.9
When world sugar price is $0.10	-114.4
When world sugar price is $0.11	-782.7
When world sugar price is $0.12	-1451.0

Table A17 3-31-86

Financial Analysis of Annexed Distillery 120,000 l/day

Incremental Method

(units U.S.$ 000's).

(Amortization of facilities in fifteen years.)

Base Case

YEAR	1987	1988	1989
COSTS			
DISTILLERY			
Domestic			
Construction	-1200.0		
Import Duties (5%AV)	0.0		
Foreign			
Equipment and Materials(Azeo,120k ltrs)	-1932.0		
By-product Capital Costs	-680.0		
Freight and Insurance	-500.0		
Engineering	-300.0		
LOANS AND AMORTIZATION			
Foreign			
Equipment Supplier (9.5%,15yrs.)	3412.0	-435.9	-435.9
Foreign banks (9.5%, 15yrs.)	1200.0	-153.3	-153.3
COSTS OF PROCESSING JUICE TO ALCOHOL			
Wages and Salaries, Domestic		-109.6	-109.6
Fringe Benefits, Domestic		-32.9	-32.9
Utilities and Misc., Domestic		-383.9	-383.9
Operating Supplies, Foreign		-513.6	-513.6
SHIPPING TO PORT (at $0.03/gal)			
Domestic (1/3)		-57.1	-57.1
Foreign (2/3)		-114.1	-114.1
TOTAL COSTS			
Domestic	-1200.0	-583.5	-583.5
Foreign	1200.0	-1216.9	-1216.9
Total	0.0	-1800.3	-1800.3
BENEFITS			
REVENUES FROM ALCOHOL SALES			
Foreign			
At $1.25/gal. FOB, POE		7133.4	7133.4
At $1.00		5706.7	
At $1.05		5992.1	
At $1.10		6277.4	
At $1.15		6562.7	
At $1.20		6848.1	
Less foregone revenues from sugar			
At $0.06/lb		-4009.9	-4009.9
At $0.07		-4678.2	
At $0.08		-5346.5	
At $0.09		-6014.8	
At $0.10		-6683.1	
At $0.11		-7351.5	
At $0.12		-8019.8	
Less foregone revenues from molasses			
Foreign at $50/ton		-559.9	-559.9

Table A18
SENSITIVITY OF NET ANNUAL FINANCIAL
BENEFITS TO WORLD PRICES OF SUGAR AND ALCOHOL
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.90	561.5	-106.8	-775.1	-1443.4	-2111.8	-2780.1	-3448.4
0.95	846.8	178.5	-489.8	-1158.1	-1826.4	-2494.7	-3163.0
1.00	1132.2	463.9	-204.5	-872.8	-1541.1	-2209.4	-2877.7
1.05	1417.5	749.2	80.9	-587.4	-1255.7	-1924.1	-2592.4
1.10	1702.8	1034.5	366.2	-302.1	-970.4	-1638.7	-2307.0
1.15	1988.2	1319.9	651.6	-16.8	-685.1	-1353.4	-2021.7
1.20	2273.5	1605.2	936.9	268.6	-399.7	-1068.1	-1736.4
1.25	2558.9	1890.5	1222.2	553.9	-114.4	-782.7	-1451.0
1.30	2844.2	2175.9	1507.6	839.2	170.9	-497.4	-1165.7
1.35	3129.5	2461.2	1792.9	1124.6	456.3	-212.0	-880.4
1.40	3414.9	2746.6	2078.2	1409.9	741.6	73.3	-595.0
1.45	3700.2	3031.9	2363.6	1695.3	1026.9	358.6	-309.7
1.50	3985.5	3317.2	2648.9	1980.6	1312.3	644.0	-24.4
1.55	4270.9	3602.6	2934.2	2265.9	1597.6	929.3	261.0
1.60	4556.2	3887.9	3219.6	2551.3	1883.0	1214.6	546.3
1.65	4841.5	4173.2	3504.9	2836.6	2168.3	1500.0	831.7
1.70	5126.9	4458.6	3790.3	3121.9	2453.6	1785.3	1117.0

Table A19 3-27-86

Economic Analysis of Annexed Distillery 120,000 l/day

Incremental Method

(units U.S.$ 000's).

(Amortization of facilities in five years.)

Base Case

YEAR	1987 Financial	1987 Economic	1988 Financial	1988 Economic
COSTS				
DISTILLERY				
Domestic				
Construction	-1200.0	-1200.0		
Import Duties (5%AV)	0.0			
Foreign				
Equipment and Materials(Azeo,120k ltr	-1932.0	-2415.0		
By-product Capital Costs	-680.0	-850.0		
Freight and Insurance	-500.0	-625.0		
Engineering	-300.0	-375.0		
LOANS AND AMORTIZATION				
Foreign				
Equipment Supplier (7.5%,5yrs.)	3412.0	4265.0	-843.3	-1054.2
Foreign banks (10%, 5yrs.)	1200.0	1500.0	-316.6	-395.7
COSTS OF PROCESSING JUICE TO ALCOHOL				
Wages and Salaries, Domestic			-109.6	-109.6
Fringe Benefits, Domestic			-32.9	-32.9
Utilities and Misc., Domestic			-383.9	-383.9
Operating Supplies, Foreign			-513.6	-642.0
SHIPPING TO PORT (at $0.03/gal)				
Domestic (1/3)			-57.1	-57.1
Foreign (2/3)			-114.1	-142.7
			-0.2	
TOTAL COSTS				
Domestic	-1200.0	-1200.0	-583.5	-583.5
Foreign	1200.0	1500.0	-1787.6	-2234.5
Total	0.0	300.0	-2371.1	-2818.0
BENEFITS				
REVENUES FROM ALCOHOL SALES				
Foreign				
At $1.25/gal. FOB, POE			7133.4	8916.8
At $1.00			5706.7	7133.4
At $1.05			5992.1	7490.1
At $1.10			6277.4	7846.7
At $1.15			6562.7	8203.4
At $1.20			6848.1	8560.1
Less foregone revenues from sugar				
At $0.06/lb			-4009.9	-5012.4
At $0.07			-4678.2	-5847.8
At $0.08			-5346.5	-6683.1
At $0.09			-6014.8	-7518.5
At $0.10			-6683.1	-8353.9
At $0.11			-7351.5	-9189.3
At $0.12			-8019.8	-10024.7
Less foregone revenues from molasses				
Foreign at $50/ton			-559.9	-699.9

SALES OF BY-PRODUCTS				
Domestic				
Yeast at $0.066 per gal. alcohol			376.6	470.8
Carbon dioxide			0.0	0.0
Other			199.7	249.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES				
Domestic			143.9	143.9
Foreign				
SAVINGS IN SHIPPING SUGAR				
Domestic			138.1	138.1
Foreign			276.2	345.3
SAVINGS IN SHIPPING MOLASSES				
Domestic			24.6	24.6
Foreign			49.3	61.6
REDUCTION IN ADMINISTRATIVE COSTS				
Domestic at $1.00 per ton cane			361.3	361.3
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)				
Domestic at $0.625/ton cane			225.8	225.8
TOTAL BENEFITS				
Domestic	0.0	0.0	1470.1	1614.2
Foreign	0.0	0.0	2889.1	3611.4
Total	0.0	0.0	4359.2	5225.6
NET BENEFITS				
Domestic	-1200.0	-1200.0	886.6	1030.7
Foreign	1200.0	1500.0	1101.5	1376.9
Total	0.0	300.0	1988.1	2407.6
			1988.1	2407.6
			192.5	386.5
			1795.6	2021.1

NOTES:

Daily capacity, gallons	31.7
Assumed annual capacity @180 days/year	5706.7
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	361.3
Sugar displaced at 185 lbs/ton cane,lbs	66831.5
Molasses displaced at 5.2763 gal. per ton cane at density of 11.75 lbs./gal	11.2
Savings in transport costs sugar to port	414.4
Savings in transport costs molasses to port	73.9
Savings in Processing Costs of sugar	143.9

Sensitivity to Changes in World Sugar Price	Net Benefits	
When world sugar price is $0.06	1988.1	2407.6
When world sugar price is $0.07	1319.8	1572.2
When world sugar price is $0.08	651.5	736.8
When world sugar price is $0.09	-16.8	-98.6
When world sugar price is $0.10	-685.1	-934.0
When world sugar price is $0.11	-1353.4	-1769.4
When world sugar price is $0.12	-2021.8	-2604.8

Table A20
SENSITIVITY OF NET ANNUAL ECONOMIC BENEFITS
TO WORLD PRICES OF SUGAR AND ALCOHOL
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.90	-89.1	-924.5	-1759.9	-2595.3	-3430.7	-4266.1	-5101.5
0.95	267.6	-567.8	-1403.2	-2238.6	-3074.0	-3909.4	-4744.8
1.00	624.2	-211.1	-1046.5	-1881.9	-2717.3	-3552.7	-4388.1
1.05	980.9	145.5	-689.9	-1525.3	-2360.7	-3196.0	-4031.4
1.10	1337.6	502.2	-333.2	-1168.6	-2004.0	-2839.4	-3674.8
1.15	1694.3	858.9	23.5	-811.9	-1647.3	-2482.7	-3318.1
1.20	2050.9	1215.5	380.1	-455.3	-1290.6	-2126.0	-2961.4
1.25	2407.6	1572.2	736.8	-98.6	-934.0	-1769.4	-2604.8
1.30	2764.3	1928.9	1093.5	258.1	-577.3	-1412.7	-2248.1
1.35	3120.9	2285.5	1450.2	614.8	-220.6	-1056.0	-1891.4
1.40	3477.6	2642.2	1806.8	971.4	136.0	-699.4	-1534.8
1.45	3834.3	2998.9	2163.5	1328.1	492.7	-342.7	-1178.1
1.50	4190.9	3355.6	2520.2	1684.8	849.4	14.0	-821.4
1.55	4547.6	3712.2	2876.8	2041.4	1206.0	370.7	-464.7
1.60	4904.3	4068.9	3233.5	2398.1	1562.7	727.3	-108.1
1.65	5261.0	4425.6	3590.2	2754.8	1919.4	1084.0	248.6
1.70	5617.6	4782.2	3946.8	3111.4	2276.1	1440.7	605.3

Table A21
COMPARISION OF THE SENSITIVITY OF NET ANNUAL ECONOMIC AND FINANCIAL BENEFITS TO WORLD PRICES OF SUGAR AND ALCOHOL
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.90	-79.9	-246.9	-414.0	-581.1	-748.2	-915.3	-1082.3
0.95	-8.5	-175.6	-342.7	-509.8	-676.8	-843.9	-1011.0
1.00	62.8	-104.3	-271.4	-438.4	-605.5	-772.6	-939.7
1.05	134.1	-32.9	-200.0	-367.1	-534.2	-701.3	-868.3
1.10	205.5	38.4	-128.7	-295.8	-462.8	-629.9	-797.0
1.15	276.8	109.7	-57.4	-224.4	-391.5	-558.6	-725.7
1.20	348.1	181.1	14.0	-153.1	-320.2	-487.3	-654.3
1.25	419.5	252.4	85.3	-81.8	-248.8	-415.9	-583.0
1.30	490.8	323.7	156.6	-10.4	-177.5	-344.6	-511.7
1.35	562.1	395.1	228.0	60.9	-106.2	-273.3	-440.3
1.40	633.5	466.4	299.3	132.2	-34.8	-201.9	-369.0
1.45	704.8	537.7	370.6	203.6	36.5	-130.6	-297.7
1.50	776.1	609.1	442.0	274.9	107.8	-59.3	-226.3
1.55	847.5	680.4	513.3	346.2	179.2	12.1	-155.0
1.60	918.8	751.7	584.6	417.6	250.5	83.4	-83.7
1.65	990.1	823.1	656.0	488.9	321.8	154.7	-12.3
1.70	1061.5	894.4	727.3	560.2	393.2	226.1	59.0

Table A22 3-29-86

Financial Analysis of Annexed Distillery 120,000 l/day

Global Method

(units U.S.$ 000's).

Base Case

YEAR	1987	1988	1989
COSTS			
DISTILLERY			
Domestic			
Construction	-1200.0		
Import Duties (%AV)	0.0		
Foreign			
Equipment and Materials(Azeo,120k ltrs)	-1932.0		
By-product Capital Costs	-680.0		
Freight and Insurance	-500.0		
Engineering	-300.0		
LOANS AND AMORTIZATION			
Foreign			
Equipment Supplier (7.5%,5yrs.)			
Foreign banks (10%, 5yrs.)			
COSTS OF PROCESSING JUICE TO ALCOHOL			
Wages and Salaries, Domestic		-109.6	-109.6
Fringe Benefits, Domestic		-32.9	-32.9
Utilities and Misc., Domestic		-383.9	-383.9
Operating Supplies, Foreign		-513.6	-513.6
SHIPPING TO PORT (at $0.03/gal)			
Domestic (1/3)		-57.1	-57.1
Foreign (2/3)		-114.1	-114.1
TOTAL COSTS			
Domestic	-1200.0	-583.5	-583.5
Foreign	-3412.0	-627.7	-627.7
Total	-4612.0	-1211.2	-1211.2
BENEFITS			
REVENUES FROM ALCOHOL SALES			
Foreign			
At $1.25/gal. FOB, POE		7133.4	7133.4
At $1.00		5706.7	
At $1.05		5992.1	
At $1.10		6277.4	
At $1.15		6562.7	
At $1.20		6848.1	
Less foregone revenues from sugar			
At $0.06/lb		-4009.9	-4009.9
At $0.07		-4678.2	
At $0.08		-5346.5	
At $0.09		-6014.8	
At $0.10		-6683.1	
At $0.11		-7351.5	
At $0.12		-8019.8	
Less foregone revenues from molasses			
Foreign at $50/ton		-559.9	-559.9
SALES OF BY-PRODUCTS			

Domestic				
Yeast at $0.066 per gal. alcohol			376.6	376.6
Carbon dioxide			0.0	0.0
Other			199.7	199.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES				
Domestic			143.9	143.9
Foreign				
SAVINGS IN SHIPPING SUGAR				
Domestic			138.1	138.1
Foreign			276.2	276.2
SAVINGS IN SHIPPING MOLASSES				
Domestic			24.6	24.6
Foreign			49.3	49.3
REDUCTION IN ADMINISTRATIVE COSTS				
Domestic at $1.00 per ton cane			361.3	361.3
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)				
Domestic at $0.625/ton cane			225.8	225.8
TOTAL BENEFITS				
Domestic		0.0	1470.1	1470.1
Foreign		0.0	2889.1	2889.1
	Total	0.0	4359.2	4359.2
NET BENEFITS				
Domestic		-1200.0	886.6	886.6
Foreign		-3412.0	2261.4	2261.4
	Total	-4612.0	3148.0	3148.0
			3148.0	
			1352.4	
			1795.6	

NOTES:

Daily capacity, gallons	31.7
Assumed annual capacity @130 days/year	5706.7
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	361.3
Sugar displaced at 185 lbs/ton cane,lbs	66831.5
Molasses displaced at 5.2763 gal. per ton cane at density of 11.75 lbs./gal	11.2
Savings in transport costs sugar to port	414.4
Savings in transport costs molasses to port	73.9
Savings in Processing Costs of sugar	143.9

Sensitivity to Changes in World Sugar Price	Net Benefits
When world sugar price is $0.06	3148.0
When world sugar price is $0.07	2479.7
When world sugar price is $0.08	1811.4
When world sugar price is $0.09	1143.1
When world sugar price is $0.10	474.8
When world sugar price is $0.11	-193.6
When world sugar price is $0.12	-861.9

Table A23
SENSITIVITY OF NET ANNUAL FINANCIAL BENEFITS
TO WORLD PRICES OF SUGAR AND ALCOHOL
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.65	-276.0	-944.3	-1612.6	-2281.0	-2949.3	-3617.6	-4285.9
0.70	9.3	-659.0	-1327.3	-1995.6	-2663.9	-3332.3	-4000.6
0.75	294.7	-373.7	-1042.0	-1710.3	-2378.6	-3046.9	-3715.2
0.80	580.0	-88.3	-756.6	-1425.0	-2093.3	-2761.6	-3429.9
0.85	865.3	197.0	-471.3	-1139.6	-1807.9	-2476.2	-3144.6
0.90	1150.7	482.3	-186.0	-854.3	-1522.6	-2190.9	-2859.2
0.95	1436.0	767.7	99.4	-568.9	-1237.3	-1905.6	-2573.9
1.00	1721.3	1053.0	384.7	-283.6	-951.9	-1620.2	-2288.6
1.05	2006.7	1338.4	670.0	1.7	-666.6	-1334.9	-2003.2
1.10	2292.0	1623.7	955.4	287.1	-381.3	-1049.6	-1717.9
1.15	2577.3	1909.0	1240.7	572.4	-95.9	-764.2	-1432.5
1.20	2862.7	2194.4	1526.1	857.7	189.4	-478.9	-1147.2
1.25	3148.0	2479.7	1811.4	1143.1	474.8	-193.6	-861.9
1.30	3433.4	2765.0	2096.7	1428.4	760.1	91.8	-576.5
1.35	3718.7	3050.4	2382.1	1713.7	1045.4	377.1	-291.2
1.40	4004.0	3335.7	2667.4	1999.1	1330.8	662.5	-5.9
1.45	4289.4	3621.0	2952.7	2284.4	1616.1	947.8	279.5
1.50	4574.7	3906.4	3238.1	2569.8	1901.4	1233.1	564.8
1.55	4860.0	4191.7	3523.4	2855.1	2186.8	1518.5	850.1
1.60	5145.4	4477.1	3808.7	3140.4	2472.1	1803.8	1135.5
1.65	5430.7	4762.4	4094.1	3425.8	2757.4	2089.1	1420.8
1.70	5716.0	5047.7	4379.4	3711.1	3042.8	2374.5	1706.2

Table A24

SENSITIVITY OF RATE OF RETURN TO SUGAR PRICES

Assume price of alcohol $1.25/gal.

	1987	1988	1989	1990	1991	1992
Price of sugar	0.07	0.08	0.09	0.09	0.09	0.09
Net Benefits	-4612.00	1811.39	1143.07	1143.07	1143.07	1143.07
INTERNAL RATE OF RETURN =		0.13				
Price of sugar	0.07	0.08	0.08	0.08	0.08	0.08
Net Benefits	-4612.00	1811.39	1811.39	1811.39	1811.39	1811.39
INTERNAL RATE OF RETURN =		0.28				
Price of sugar	0.07	0.08	0.09	0.10	0.11	0.12
Net Benefits	-4612.00	1811.39	1143.07	474.76	0.00	0.00
INTERNAL RATE OF RETURN =		-0.16				

	1987	1988	1989	1990	1991	1992
Price of sugar	0.07	0.08	0.09	0.09	0.09	0.09
Net Benefits	-4612.00	1811.39	1143.07	1143.07	1143.07	1143.07
INTERNAL RATE OF RETURN =		0.23 if price = 0.09 to 1997				
Price of sugar	0.07	0.08	0.08	0.08	0.08	0.08
Net Benefits	-4612.00	1811.39	1811.39	1811.39	1811.39	1811.39
INTERNAL RATE OF RETURN =		0.36 if price = 0.08 to 1997				

Table A25 3-29-86

Economic Analysis of Annexed Distillery 120,000 l/day

Global Method

(units U.S.$ 000's).

Base Case

YEAR	1987 Financial	1987 Economic	1988 Financial	1988 Economic
COSTS				
DISTILLERY				
Domestic				
Construction	-1200.0	-1500.0		
Import Duties (5%AV)	0.0	0.0		
Foreign				
Equipment and Materials(Azeo,120k ltrs)	-1932.0	-2415.0		
By-product Capital Costs	-680.0	-850.0		
Freight and Insurance	-500.0	-625.0		
Engineering	-300.0	-375.0		
LOANS AND AMORTIZATION				
Foreign				
Equipment Supplier (7.5%,5yrs.)				
Foreign banks (10%, 5yrs.)				
COSTS OF PROCESSING JUICE TO ALCOHOL				
Wages and Salaries, Domestic			-109.6	-109.
Fringe Benefits, Domestic			-32.9	-32.
Utilities and Misc., Domestic			-383.9	-383.
Operating Supplies, Foreign			-513.6	-642.
SHIPPING TO PORT (at $0.03/gal)				
Domestic (1/3)			-57.1	-57.
Foreign (2/3)			-114.1	-142.
TOTAL COSTS				
Domestic	-1200.0	-1500.0	-583.5	-583.
Foreign	-3412.0	-4265.0	-627.7	-784.
Total	-4612.0	-5765.0	-1211.2	-1368.
BENEFITS				
REVENUES FROM ALCOHOL SALES				
Foreign				
At $1.25/gal. FOB, POE			7133.4	8916.
At $1.00			5706.7	7133.
At $1.05			5992.1	7490.
At $1.10			6277.4	7846.
At $1.15			6562.7	8203.
At $1.20			6848.1	8560.
Less foregone revenues from sugar				
At $0.06/lb			-4009.9	-5012.
At $0.07			-4678.2	-5847.
At $0.08			-5346.5	-6683.
At $0.09			-6014.8	-7518.
At $0.10			-6683.1	-8353.
At $0.11			-7351.5	-9189.
At $0.12			-8019.8	-10024.
Less foregone revenues from molasses				
Foreign at $50/ton			-559.9	-699.
SALES OF BY-PRODUCTS				

Domestic				
Yeast at $0.066 per gal. alcohol			376.6	470.8
Carbon dioxide			0.0	0.0
Other			199.7	249.7
SAVINGS IN PROCESSING SUGAR AND MOLASSES				
Domestic			143.9	143.9
Foreign				
SAVINGS IN SHIPPING SUGAR				
Domestic			138.1	138.1
Foreign			276.2	345.3
SAVINGS IN SHIPPING MOLASSES				
Domestic			24.6	24.6
Foreign			49.3	61.6
REDUCTION IN ADMINISTRATIVE COSTS				
Domestic at $1.00 per ton cane			361.3	361.3
REDUCTION IN COST PER TON OF CANE (due to inclusion of cane tops)				
Domestic at $0.625/ton cane			225.8	225.8
TOTAL BENEFITS				
Domestic	0.0	0.0	1470.1	1614.2
Foreign	0.0	0.0	2889.1	3611.4
Total	0.0	0.0	4359.2	5225.6
NET BENEFITS				
Domestic	-1200.0	-1500.0	886.6	1030.7
Foreign	-3412.0	-4265.0	2261.4	2826.7
Total	-4612.0	-5765.0	3148.0	3857.5
			3148.0	3857.5
			1352.4	1836.4
			1795.6	2021.1

NOTES:

Daily capacity, gallons	31.7
Assumed annual capacity @180 days/year	5706.7
Gal. alcohol/ton of cane=218/13.8 See Table 2	15.8
Tons of cane required @15.8 gal./ton	361.3
Sugar displaced at 185 lbs/ton cane,lbs	66831.5
Molasses displaced at 5.2763 gal. per ton cane at density of 11.75 lbs./gal	11.2
Savings in transport costs sugar to port	414.4
Savings in transport costs molasses to port	73.9
Savings in Processing Costs of sugar	143.9

Sensitivity to Changes in World Sugar Price

	Net Benefits	Net Benefits
When world sugar price is $0.06	3148.0	3857.5
When world sugar price is $0.07	2479.7	3022.1
When world sugar price is $0.08	1811.4	2186.7
When world sugar price is $0.09	1143.1	1351.3
When world sugar price is $0.10	474.8	515.9
When world sugar price is $0.11	-193.6	-319.5
When world sugar price is $0.12	-861.9	-1154.9

Table A26
SENSITIVITY OF NET FINANCIAL BENEFITS
TO WORLD PRICES OF SUGAR AND ALCOHOL
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.65	-422.6	-1258.0	-2093.4	-2928.8	-3764.2	-4599.6	-5434.9
0.70	-65.9	-901.3	-1736.7	-2572.1	-3407.5	-4242.9	-5078.3
0.75	290.8	-544.6	-1380.0	-2215.4	-3050.8	-3886.2	-4721.6
0.80	647.4	-188.0	-1023.4	-1858.8	-2694.1	-3529.5	-4364.9
0.85	1004.1	168.7	-666.7	-1502.1	-2337.5	-3172.9	-4008.3
0.90	1360.8	525.4	-310.0	-1145.4	-1980.8	-2816.2	-3651.6
0.95	1717.4	882.0	46.6	-788.7	-1624.1	-2459.5	-3294.9
1.00	2074.1	1238.7	403.3	-432.1	-1267.5	-2102.9	-2938.3
1.05	2430.8	1595.4	760.0	-75.4	-910.8	-1746.2	-2581.6
1.10	2787.4	1952.1	1116.7	281.3	-554.1	-1389.5	-2224.9
1.15	3144.1	2308.7	1473.3	637.9	-197.5	-1032.9	-1868.2
1.20	3500.8	2665.4	1830.0	994.6	159.2	-676.2	-1511.6
1.25	3857.5	3022.1	2186.7	1351.3	515.9	-319.5	-1154.9
1.30	4214.1	3378.7	2543.3	1707.9	872.6	37.2	-798.2
1.35	4570.8	3735.4	2900.0	2064.6	1229.2	393.8	-441.6
1.40	4927.5	4092.1	3256.7	2421.3	1585.9	750.5	-84.9
1.45	5284.1	4448.7	3613.3	2778.0	1942.6	1107.2	271.8
1.50	5640.8	4805.4	3970.0	3134.6	2299.2	1463.8	628.4
1.55	5997.5	5162.1	4326.7	3491.3	2655.9	1820.5	985.1
1.60	6354.1	5518.8	4683.4	3848.0	3012.6	2177.2	1341.8
1.65	6710.8	5875.4	5040.0	4204.6	3369.2	2533.8	1698.5
1.70	7067.5	6232.1	5396.7	4561.3	3725.9	2890.5	2055.1

Table A27

SENSITIVITY OF RATE OF RETURN TO SUGAR PRICES

Assume price of alcohol $1.25/gal.

	1987	1988	1989	1990	1991	1992	
Price of sugar	0.07	0.08	0.09	0.09	0.09	0.09	
Net Benefits	-5765.00	2186.67	1351.28	1351.28	1351.28	1351.28	
INTERNAL RATE OF RETURN =		0.11					
Price of sugar	0.07	0.08	0.08	0.08	0.08	0.08	
Net Benefits	-5765.00	2186.67	2186.67	2186.67	2186.67	2186.67	
INTERNAL RATE OF RETURN =		0.26					
Price of sugar	0.07	0.08	0.09	0.10	0.11	0.12	
Net Benefits	-5765.00	2186.67	1351.28	474.76	0.00	0.00	
INTERNAL RATE OF RETURN =		-0.20					
	1987	1988	1989	1990	1991	1992	
Price of sugar	0.07	0.08	0.09	0.09	0.09	0.09	
Net Benefits	-5765.00	2186.67	1351.28	1351.28	1351.28	1351.28	1351.28
INTERNAL RATE OF RETURN =		0.23	if price = 0.09 to 1997				
Price of sugar	0.07	0.08	0.08	0.08	0.08	0.08	
Net Benefits	-5765.00	2186.67	2186.67	2186.67	2186.67	2186.67	2186.67
INTERNAL RATE OF RETURN =		0.36	if price = 0.08 to 1997				

Table A28
DIFFERENCE BETWEEN NET ANNUAL ECONOMIC AND
FINANCIAL BENEFITS AT VARIOUS PRICES OF SUGAR AND ALCOHOL
Capital Flows Excluded
(US$ 000's)

Price of Alcohol \ Price of sugar	.06	.07	.08	.09	.10	.11	.12
0.65	-146.6	-313.6	-480.7	-647.8	-814.9	-982.0	-1149.0
0.70	-75.2	-242.3	-409.4	-576.5	-743.5	-910.6	-1077.7
0.75	-3.9	-171.0	-338.1	-505.1	-672.2	-839.3	-1006.4
0.80	67.4	-99.6	-266.7	-433.8	-600.9	-768.0	-935.0
0.85	138.8	-28.3	-195.4	-362.5	-529.5	-696.6	-863.7
0.90	210.1	43.0	-124.1	-291.1	-458.2	-625.3	-792.4
0.95	281.4	114.	-52.7	-219.8	-386.9	-554.0	-721.0
1.00	352.8	185.7	18.6	-148.5	-315.5	-482.6	-649.7
1.05	424.1	257.0	89.9	-77.1	-244.2	-411.3	-578.4
1.10	495.4	328.4	161.3	-5.8	-172.9	-340.0	-507.0
1.15	566.8	399.7	232.6	65.5	-101.5	-268.6	-435.7
1.20	638.1	471.0	303.9	136.9	-30.2	-197.3	-364.4
1.25	709.4	542.4	375.3	208.2	41.1	-126.0	-293.0
1.30	780.8	613.7	446.6	279.5	112.5	-54.6	-221.7
1.35	852.1	685.0	518.0	350.9	183.8	16.7	-150.4
1.40	923.4	756.4	589.3	422.2	255.1	88.0	-79.0
1.45	994.8	827.7	660.6	493.5	326.5	159.4	-7.7
1.50	1066.1	899.0	732.0	564.9	397.8	230.7	63.6
1.55	1137.4	970.4	803.3	636.2	469.1	302.1	135.0
1.60	1208.8	1041.7	874.6	707.5	540.5	373.4	206.3
1.65	1280.1	1113.0	946.0	778.9	611.8	444.7	277.6
1.70	1351.4	1184.4	1017.3	850.2	683.1	516.1	349.0

APPENDIX B

ESTABLISHING A DISTILLERY AT VILLANUEVA

APPENDIX B: Establishing a Distillery at Villanueva

This appendix presents a hypothetical case of dedicating the CAHSA mill at Villanueva to an alcohol distillery. Although other sugar mills in Honduras could be dedicated to alcohol production, or would be good sites for annexation of a distillery in conjunction with sugar production, as discussed in Section 3 of the report, Villanueva was chosen for this exercise because it seems to represent the most attractive site in terms of location, cane supply, grinding season, irrigation system, access to by-product markets, and CAHSA's flexibility in processing cane at both Villanueva and its much larger Sta Matilde factory. Its scale is smaller than necessary to support the most economic distillery scale of 150,000 liters per day, but this penalty is small.

This technical/engineering analysis is designed to show expected alcohol production and energy balances based on known information concerning the existing factory and sugarcane produced in CAHSA's region. There is also a short cost analysis.

B.1 Technical Parameters

a) Alcohol Yield

The estimated alcohol yield from a short ton (st) of cane is shown below.

Item	Fermentable Sugars as Invert (lbs)
Sugar—190 lb @ 99.5º pol.	199
Molasses—5 gal @ 54% solids (3.5% non-ferm.)	32
Losses in sugar mill (0.5% of sugar)	1
Cane tops & leaves— add 5%	12
Total Fermentables/st of cane	244 lbs., or 110.68 kg
	Alcohol Production
Theoretical alcohol potential (x 0.48367)	53.53 kg
Fermentation conversion efficiency @ 91%	48.71 kg
Volume conversion @ 0.79365 kg/liter	61.37 liters
Distillation efficiency @ 98.5%	60.45 liters
Alcohol Yield (@ 100 GL, or 200 proof)	Use 60 l/st, or 15.85 gallons/st

b) Distillery Capacity

The capacity of the Villanueva factory for alcohol can be calculated as below.

Effective Daily Grinding Capacity	1,325 st cane/day
Alcohol Production @ 60 l/st	79,500 l/day
Nominal Daily Grinding Capacity	1,500 st cane/day
Alcohol Production @ 60 l/st	90,000 l/day
Annual Production @ 180 days/year	16.2 MM l/year, or 4.28 MM gal/yr.

The team recommends using the factory's nominal capacity of 1500 st/day for sizing the distillery because of economies of scale, and since cane availability does not appear to be a problem. In addition, it should be possible to grind additional cane tonnage when producing alcohol if it becomes desirable to "push" the distillery capacity for economic or processing reasons. Distilleries typically can operate at up to 20% over rated capacity.

B.2 Estimated Energy Requirements

a) Steam Requirements for Distillery

It is assumed here that the Villanueva factory high pressure steam production total of 70,000 lb/hr is exhausted at 12-15 psig. It is further assumed that mill practices and cane quality allow the transference of the juice directly from the pre-heaters (after clarification), through a chiller (to achieve a pasteurization effect) to the holding tanks (evaporators and/or vacuum pans) prior to fermentation. This results in the shut-down of the sugar mill from the evaporators to the sugar warehouse, and the saving of approximately 70% of the low pressure exhaust steam, estimated at some 49,000 lb/hr @ 15 psig. Thus, steam parameters are as follows:

High pressure steam (@ 1,325 st cane/day)	70,000 lb/hr @ 175 psig
Exhaust steam at 15 psig	49,000 lb/hr
Distillery steam consumption (est.)	4.2 kg steam/lt of alcohol
	or 35 lb/gal alcohol @ 100°gl
Total distillery steam (@ 21,000 gal/d)	30,700 lb/hr
Surplus low pressure steam	18,300 lb/hr

Therefore, the distillery absorbs some 65% of the low pressure steam savings from not operating the sugar factory, leaving about 18,000 lb/hr of steam @ 15 psig to be used elsewhere. It is worth considering whether these steam savings could be converted to real energy savings for the sugar mill. The possible uses might include condensing turbines for added electricity, or an increase of production at the distillery using blackstrap and/or high-test molasses from other sugar mills. It may also be possible to translate this energy saving into more excess bagasse that could be stored to extend the yearly schedule of the distillery.

It should be noted that the team obtained estimates of excess bagasse amounting to 25-to-28 st per day. Add to this the excess bagasse to be produced by feeding cane tops and leaves to the sugar mill, while producing alcohol, estimated at some 12 to 15 st/day; and assume that savings in low pressure steam could be translated into bagasse savings, estimated conservatively at 75 st/day. The total excess would amount to some 118 st/day of bagasse, or a total of 21,240 st of bagasse per 180-day season. This 21,000 st of excess bagasse would be sufficient to fuel the distillery for another 100 days.*

* Note: It may not be possible to translate low pressure steam savings into significant bagasse surpluses without investing in energy conservation measures or some new plant and equipment at Villanueva. These options were not investigated by the team.

Blackstrap molasses would likely be the feedstock for a distillery during the non-grinding season. Alcohol yields from blackstrap are approximately 280 liters, or 74 gallons per metric ton (at 100% Gl). Therefore, a distillery at a production rate of 21,000 gal/day will require 283.8 MT of blackstrap molasses per day, and 28,380 MT per 100 days run, an amount somewhat over half Honduran yearly exports (51,600 MT). Distilling these molasses, at no energy cost, would reduce the total cost (plus expenses) of alcohol by almost US$0.10 per gallon; this does not consider the extra costs of running the boilers for another 100 days, storing and retrieval of excess bagasse, and excess storage for blackstrap molasses.

In terms of raw material cost savings, if the value of molasses is its average export price of US$ 55/MT, there should be additional savings of US$ 0.52/gal of alcohol produced from molasses (raw material cost of US$ 0.743/gal).

b) Electric Power Requirements for Distillery

Electric power requirements for alcohol distillation are small (mostly pumps), since most process energy is steam. A conservative estimate for electric power consumption for a distillery is 0.07 kwh/liter of alcohol at 200 proof, or 0.25 kwh/gal. Similarly, electric power requirements for a sugar mill are estimated at 10 kwh/st of cane. It is assumed that the shut-down sections of the sugar mill (while producing alcohol) will save 30% of total consumption, or some 3 kwh/st of cane.

Cane Volume	1,325 st/day
Electric Power Savings (@ 3 kwh/st)	3,925 kwh/day
Distillery Requirements (21,000 gal x .25 kwh/gal)	5,250 kwh/day
Electric Power Deficit (est.)	1,325 kwh/day

Given conservative estimates above, the electric power deficit is expected to be less than 1300 kwh per day of operation at this level, and may not materialize at all. Electricity could be purchased from the grid to make up this deficit. Alternatively, turbines from the idle sugar mill may be installed temporarily at the distillery, using some of the excess steam, to power electrical equipment.

B.3 Alcohol Production Costs

The following is a cost analysis based on sugar mill expenses and cost information provided to the team by CAHSA managers in combination with estimates made by the team based on sugar industry data for 1985-86. The analysis is based on a capital investment of US$ 3.5 million (from estimate obtained from Zanini (Brazil) by F.C. Schaffer & Associates) for an installed 90,000 liter per day distillery with azeotropic distillation, financed at 10 percent. The distillery operates 180 days, and the mill grinds 1500 st of cane per day. (This analysis does not examine the case of extending the distillery operating season on molasses feedstocks and using potential bagasse surpluses for fuel.)

Alcohol Production Cost Estimate — Villanueva

1. Operating Expenses (annual)	US$ 000
a) Financing expenses	350
b) Depreciation (12 years)	292
c) Insurance and other taxes (2%)	70
d) Maintenance (US$ 2.7mm - 2%)	54
e) General, administration, others	30
f) Total Operating Expenses	$ 796
g) Total Operating Expenses/gal (@ 4.28mm gal)	$ 0.186

2. Operating Costs	US$/gal
a) Steam	-
b) Electricity	-
c) Materials (solvent, antiseptics, nutrients)	$ 0.05
d) Labor	0.06
e) Transportation & other costs	0.03
f) Total Operating Costs/gal	$ 0.140

3. Total Alcohol Costs & Expenses/gal (1+2)	$ 0.326

4. Sugar Mill Costs & Expenses (includes cane cost)		$/gal Alcohol
a) Administration cane (@ $15/st, 15.8 gal/st)	0.95/gal	
b) Producer cane (@ $14/st, 15.8 gal/st)	0.89/gal	
c) Avg cane cost (40% admin/60% producer)		0.912
d) Cost of operating factory (@ 0.031/lb of sugar, 199 lbs sugar/st)		0.366
e) Operating expenses, incl. financing (@ 0.031/lb of sugar)	0.366	
f) Savings in producing alcohol instead of raw sugar, including shipping (@ 0.032/lb of sugar)		(0.378)
g) Total Sugar Mill Operating Costs & Expenses		$ 1.266
h) Total Alcohol Costs & Expenses (1.#3 above)		0.326
SUBTOTAL		$ 1.592/gal
By-Product Credit (Table 3.6)*		.091/gal
TOTAL COST OF ALCOHOL		$ 1.501/gal

* Note: This is a net credit, which includes allowance for approximate capital costs for yeast recovery equipment. There may also be an additional credit for surplus bagasse from cane leaves and tops, not reflected above.

APPENDIX C

U.S. Alcohol Market and Trade Issues

APPENDIX C: U.S. Alcohol Market and Trade Issues

C.1 Background

Much of the interest in producing fuel alcohol in Honduras, as well as other countries covered by the Caribbean Basin Initiative (CBI), is based on the proximity of the expanding alcohol market in the United States and the incentive of duty-free export to the US under the CBI. This legislation permits CBI countries to export most products, including fuel alcohol, to the US exempt from import duties. Other alcohol exporting countries must pay a tariff of $0.60 per gallon (plus 3% ad valorem tax), which is equal to the US federal excise tax exemption for US-produced fuel alcohol blended with gasoline. In effect, CBI countries can capture the same subsidy for alcohol production as US producers.

The effect of the US subsidy is to offer a strong stimulus to ethanol production from CBI sugar industries which have excess capacity. Compared to the sale of sugar on the world market at $0.055/lb (average 1985 price), alcohol sales in the US market at $1.30/gallon (below 1985 average) produce twice the revenue from a ton of sugarcane, with approximately equal production costs. This is not to say that alcohol is profitable; but at prices which prevailed throughout 1984-85 alcohol was clearly superior to export of sugar to the world market (see table below).

	Units per ton of cane[1]	Price per Unit	Revenue per ton of cane	Production Cost[2]
Sugar	190 lbs	$0.05.5/lb	$10.45	$0.11/lb, or $20.90/ton cane
Alcohol	15.8 gals	$1.30/gal	$20.54	$1.45/gal, or $22.91/ton cane

1 Estimated averages for Honduras
2 Average marginal sugar production cost (no finance or administrative costs), vs. average alcohol cost including depreciation, finance and admin. costs (estimates for Honduras).

The US market for alcohol is expanding because of requirements to remove lead from gasoline. Ethanol competes with a number of additives which can increase the octane levels of unleaded gasoline (benzene, toluene, xylene, MTBE, methanol, ethylbenzene and others), and its use is determined by gasoline refiner and marketer requirements for octane, local costs and supplies of octane additives, federal and state incentives for ethanol, and other market factors. Ethanol has found a strong market niche, particularly in premium unleaded grades of gasoline, and its use has grown rapidly. From less than 100 million gallons in 1981, the US fuel alcohol market has grown to over 750 million gallons in 1985. Projections for 1986 vary from 825 million to 1.2 billion gallons. Furthermore, approximately 15-20 percent of the US market has historically been supplied by imported alcohol.[1]

[1] From US Department of Energy, "Annual Report on Fuel Alcohol...", and Information Resources Incorporated (IRI), Alcohol Outlook, March 1986, Wash., DC.

Distilleries in Costa Rica, El Salvador and Panama export to the US under the CBI, and new alcohol export plans are reportedly underway in Panama, Guatemala, Antigua, Dominican Republic and Jamaica. Non-CBI countries such as Brazil, Argentina and Saudi Arabia have been exporting ethanol to the US for several years despite having to pay the high tariff. In addition, an alcohol drying or "upgrading" plant is currently operating under CBI status in Jamaica, and plans are reported for new facilities in Costa Rica and Aruba.

Against this background, a number of developments in the US and world market have combined to create a great deal of uncertainty for existing and potential CBI alcohol producers. These developments have occurred, and are still taking shape, in the areas of oil and gasoline market prices, US import policies and trade issues, and proposed legislation. These are discussed below.

C.2 Oil and Gasoline Prices

The fall in international oil prices from approximately $28 per barrel to $11-to-14/bbl in recent months has caused average wholesale gasoline prices in the US to fall some $0.35-0.40 per gallon ($0.85/gal, December '85; $0.48/gal, April '86, unleaded regular).[2] Alcohol prices average $0.60-to-0.80 above gasoline, reflecting federal and state alcohol tax incentives as well as its high octane value for blending with unleaded grades of gasoline. Thus, alcohol prices have also fallen significantly, from $1.59/gallon in the fourth Quarter 1985, to $1.12/gallon in April 1986 (average, 34 terminals).[3] Most recently, by contrast, gasoline prices have risen $0.06-.07/gallon because of low inventories (drawn down during the price fall) and the seasonal surge in demand; a similar rise should soon occur in alcohol prices.

Low oil prices are likely to slow the rapidly expanding US alcohol market, or at least cause disturbances in the demand-supply balance. At prices in the $1.20 range, less efficient alcohol producers will not be able to meet costs and some production capacity will be idled. This could improve alcohol import prospects for low-cost CBI alcohol producers. Also, some gasoline refiners will find it more economical to process low-priced crude to the needed octane levels. These possibilities will require low oil prices for an extended period, but they appear to be underway already. Furthermore, most analysts expect that oil prices will remain well below $20 per barrel through 1986, and hover below or near this level to 1990.

On the positive side, the elimination of lead from the US gasoline supply is creating a shortage of octane, which will accelerate over the next half year as "lead credits" are used up and gasoline sales increase in response to low prices and the normal high travel season. It seems clear that alcohol will continue to enjoy premium status as an octane enhancer for some segments of the gasoline industry, and the near-term octane shortage is likely to push up prices for additives somewhat. Later price movements are very difficult to predict, but it would not be unreasonable to project US alcohol prices in the $1.20-$1.30 range ($1.13-$1.23/gallon for CBI producers allowing for shipping and a small discount) for the forseeable future.

[2] IRI, Alcohol Outlook, May 1986, Washington, DC.
[3] ibid., and Alcohol Outlook, February 1986, Washington, DC.

C.3 Trade Issues and Legislation

Because of fuel alcohol's protected status in the US, a number of special trade policies have evolved over the past two years. These policies and the controversies surrounding them are summarized below.

a) Alcohol Tax Exemption and Import Tariff: The $0.60/gallon import duty on fuel alcohol is equal to the US federal excise tax exemption for sales of alcohol blended with gasoline. The tax exemption is provided as a temporary stimulus (thru 1992) to the US alcohol industry. The intent of the duty is to prevent other countries from taking advantage of the US subsidy by offsetting it upon import. Brazil, in particular, is believed to have the capacity to dominate the US market with its surplus of subsidized low-cost alcohol, threatening the US alcohol industry at a time of rapid growth and continuing technology development, and corn interests at a time of economic crisis. CBI alcohol producers, however, are exempt from the duty by the provisions of the Caribbean Basin Economic Recovery Act (P.L. 98-67, August 1983).

Recently the tax exemption has come under attack as a costly subsidy ($375 million, 1985 estimate) to a single industry, at a time when US budget deficits exceed $200 billion. On the other hand, arguments in support of the subsidy point to direct federal budget savings exceeding the cost of the subsidy by reducing government grain purchases ($600 million 1985 est., mostly corn), additional revenue from ad valorem duties on imported ethanol, and substantial economic activity in plant investment and employment in the US agriculture sector.

Despite Administration support for repeal of the tax exemption, the Senate Finance Committee recently voted overwhelmingly to continue it through 1992, its scheduled expiration, by a vote of 17-1 (April 9, 1986). Continuation of the exemption was also included in the Finance Committee's recently passed tax reform bill (May 7, 1986).[4] The tax exemption does not appear to be in danger, given other key congressional support in both houses.

b) Drying: Hydrous or "wet" alcohol (95% alcohol, 5% water) can be shipped from a non-CBI country to a CBI country, dried in an azeotrope (or molecular sieve) to anhydrous specifications (99.5% alcohol), and shipped to the US duty-free. The US Customs Service has twice affirmed in letter rulings (most recently Nov. 19, 1985) that dehydration or upgrading constitutes "substantial transformation" and adds sufficient value to the product (at least 35%) to qualify for CBI status (51 Federal Register 2990, January 22, 1986).

There is a great deal of opposition to CBI drying-only plants in the US alcohol industry and among existing and potential CBI alcohol producers. It is feared that dehydration projects will prevent development of full fermentation facilities, and greater economic impacts, which would use locally produced sugarcane and molasses feedstocks. Since upgrading has been re-approved, it is thought that drying operations will spring up and that low-cost Brazilian alcohol will begin flowing through CBI countries. At present, Tropicana International (Jamaica) Ltd. has the only dehydration plant operating in the Caribbean Basin, drying Spanish alcohol for the US market. A Costa Rican plant is reportedly nearing completion, and a number of other projects (Jamaica, Aruba) are underway.

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[4] IRI, Alcohol Update, May 12, 1986, Washington, DC, pgs. 1-2.

The Administration (US Trade Representative) opposes changes in the CBI, implicitly supporting the US Customs letter rulings which affirm the duty-free status of CBI-dried alcohol. US alcohol producers and the National Corn Growers Association are appealing the rulings in the Court of International Trade, and have obtained key congressional support for imposing CBI source feedstock requirements for drying facilities. A number of bills have been proposed in the Senate (Senator Dole) and the House of Representatives (Reps. Durbin, Michel) during the last several months attempting to change the drying rulings. For example, a recently passed House Ways & Means Committee Comprehensive Trade Bill requires increasing amounts of CBI feedstocks (30% 1987, 60% 1988, 75% 1989-on), but is given little chance of passage in its current form.

A compromise on CBI drying is expected between US alcohol interests and their Congressional supporters on the one side, and the Administration (Customs, US Trade Representative) and US commercial interests in CBI drying plants on the other. The nature of such a compromise is difficult to predict, but is likely to have scaling-up provisions similar to the House Ways & Means bill and to set a cut-off date for qualifying facilities. In the interim, several new upgrading plants are likely to begin operation, with a total capacity of some 50-to-80 million gallons/year. Some of these plants, however, are expected to rely partially on CBI-source wet alcohol in anticipation of US import restrictions.

It should be noted also that the profitability of new dehydration plants is in doubt at this time. Supplies of low-cost wet alcohol are considered limited. With current oil, gasoline and ethanol prices in the US, wet alcohol prices could not exceed about $0.70/gallon (FOB Caribbean port)[5], which is below production cost in most locations. There are also indications that Brazilian alcohol production is leveling or declining, in response to the fall in oil prices, the increase in sugar prices, and changing policies in Brazil regarding expansion and subsidies for alcohol production. Any reduction of availability will tend to push alcohol prices upward.

c) Mixture "Loopholes:" In the second half of 1985, the "toluene loophole" allowed duty-free entry of a substantial amount of Brazilian (and Saudi) alcohol into the US. Ninety-three percent alcohol mixed with 7% toluene was at first ruled a different article of commerce than fuel alcohol, and thus subject only to the 5% ad valorem tax under the General System of Preferences (for preferred US trading partners). An estimated 44 million gallons of fuel alcohol entered the US in this way before the Customs Service, reacting to strong US industry and Congressional opposition, removed such mixtures from the GSP schedule effective November 1, 1985.[6]

Another alcohol import category, the "ETX loophole", was established in a Customs letter ruling issued January 15, 1986. This ruled that 80% ethanol-20% ethylbenzene/toluene/xylene ("ETX") mixtures are benzoids under the GSP, and thus subject only to the 5% ad valorem duty. Under the GSP, Brazil was allowed to land $68 million of benzoid by July 1, 1986. However, this mixture has also been removed from the GSP, effective April 7, 1986, with the US Trade Representative using its "emergency product review" procedure for only the second time.[7]

5 US price of $1.15/gal, minus $0.07/gal shipping & handling and $0.37/gal minimum value added (includes all upgrader costs plus depreciation and return).
6 Alcohol Week, Vol. 7, No. 3, January 20, 1986, Washington, DC, p.10.
7 Alcohol Week, Vol. 7, No. 14, April 7, 1986, Washington, DC, pgs. 1,7.

This action resulted again from Congressional pressure, responding to persistent criticism from the ethanol industry, agricultural interests and CBI countries of alcohol trade policies. Only about 18 million gallons of alcohol are thought to have entered the US during the short period of the benzoid ruling given the intensity of opposition.[8]

d) Dumping: A year-long antidumping case against Brazilian alcohol exports to the US, brought by the National Corn Growers Association and several US alcohol producers, recently came to an end. Dumping is the practice of selling in another country product which is subsidized by the state or sold below its cost of production, or both. The US International Trade Administration determined in February that substantial dumping had occurred, and set high antidumping penalties. In a companion finding, however, the International Trade Commission determined on March 4 that "no material injury" resulted for the US alcohol industry from Brazilian alcohol sales, in part because US production was insufficient to meet demand and prices remained at profitable levels. A determination of injury is required in order to impose the penalties.[9] Although this ruling is being appealed, it doesnot appear that any action will result at this time, given the market situation for gasoline and alcohol.

C.4 Conclusion

The US market for CBI alcohol over the next five years is clouded. While a growing market to help meet the octane needs of the US gasoline pool seems assured, the fall in gasoline prices, if sustained, may cause a number of US alcohol producers to cease operations and may make alcohol unprofitable in higher-cost CBI locations such as Honduras. With the US subsidy, prices in the $1.20 range seem realistic for CBI producers. US trade policy for alcohol has experienced a series of difficult developments, but the result has been strong sentiment in favor of CBI-produced alcohol and its duty-free status through 1992, and indications that restrictions on drying-only operations may soon result. Brazilian alcohol exports to the US, bitterly debated over the past two years and the subject of most alcohol trade disputes, may be decreasing because of a number of market forces and policy changes. This should act to further stabilize the outlook for CBI producers.

[8] IRI, Alcohol Update, April 7, 1986, Washington, DC, p. 4.
[9] IRI, Alcohol Outlook, March 1986, Washington, DC, p.19.

APPENDIX D

SUGAR COMPANY PROFILES: INDEPENDENT GROWERS

APPENDIX D: SUGAR COMPANY PROFILES: INDEPENDENT GROWERS

D.1 Introduction

This appendix presents additional information relevant to Section 6, Employment and Independent Producers. It addresses the financial, organizational and technical relationships that growers and cooperatives have with sugar companies; presents company profiles; and provides additional data, in table form, on farm size, cane transportation costs, and production costs of a number of alternative crops.

D.2 Grower Prices, Financing and Technical Assistance

All sugar companies have signed contracts with the independent growers who supply their mill. These contracts are similar across companies, with variations occuring mainly in prices paid per ton of cane. The 1986 prices, as in other years, are based on a short ton of cane (2000 lbs) with 180 lbs of recoverable sugar, with bonuses or deduction penalties if the sugar content varies. Bonuses can go as high as 4 Lps. per ton in the case of ACANSA, which typically has the highest sugar yield (e.g., 237 lbs) per ton of cane.

Some companies (e.g., AYSA) have a contract with the growers where a base price is set at the beginning of the season and then adjusted according to the prices received for sugar sold in the domestic and US quota markets. Most companies had this type of contract up to 1984-85, but have been moving toward a fixed price per ton of cane.

Independent growers obtain working capital from BANADESA (Banco Nacional de Desarrollo Agricola). The sugar companies also provide financing, generally in the form of services performed by the company such as pest and disease control, and fertilizers. The harvesting operation is financed by the companies as well; no finance charges are assessed since the mills will take some time (up to 3 months) to pay the grower for his cane.

The harvesting operation is coordinated between the companies and growers through a Harvesting Commission. This commission determines which areas are to be harvested based on the results obtained in the companies' labs regarding crop maturity.

Technical assistance is provided by the companies at no cost to the grower, but this assistance is limited. Only CAHSA has an established research department and its lab services are available to the growers at non-profit rates.

D.3 Company Profiles

ACANSA

This mill depends on independent growers for the highest proportion of its cane supply (93%). ACANSA is planning to increase by 1,000 hectares independent grower cane cultivation in lands that are located within a 5 km radius from the mill. The main limitations in the Cantarrannas valley region are the low rainfall (22 inches/year) and the poor irrigation infrastructure.

The independent growers are found in three districts, the farthest being 25 km away from the mill. Long distance transportation of cane is done on 20-ton capacity wagons owned by ACANSA, the rest on rented trucks (7-to-10 ton capacity). Transportation costs are higher than those of CAHSA and AZUNOSA (See Table D-2). ACANSA assesses a charge of 0.12 Lps/ton for road maintenance. Cane loading is mechanized and is done by the company at a cost of 1.25 Lps/ton. ACANSA finances the independent growers or acts as a guarantor for the independent growers before BANADESA. The interest rate in both cases is 15% since ACANSA does not charge the grower.

The cane price per ton is stipulated by contract, and for 1986 it is set at 28 Lps/ton with a sugar yield of 180 lbs. minimum. Anything in excess of 180 lbs. will receive a premium of 0.075 Lps per pound.

ACENSA

ACENSA has the greatest number of independent producers (344), of which 86 percent are smaller than 20 hectares. On the average the ACENSA independent growers are the smallest in the country (11.3 ha). One-third of the area under cane in ACENSA belongs to cooperatives and "Asentamiento" farms under the agrarian reform. All independent grower fields are rainfed.

Transactions between ACENSA and its independent growers are governed in some cases by 5-year contracts, and one- and two-year contracts for the most recent. The company finances growers smaller than 3.5 hectares, who are generally not able to obtain financing from other sources. The rest of the growers are financed mostly by BANADESA, which collects its money through the company. ACENSA finances the harvest by giving an advance of 15 Lps/ton at the beginning of the harvest. The 1986 cane price is 24.65 Lps/ton with a content of 180 pounds of sugar. It is expected that the price will go up to 26 Lps/ton once the adjustment for a higher sugar content is made at the end of the season.

The company provides technical assistance at no cost to the farmer and does have a schedule of visits every 15 days to each grower. The company also provides cane loading services and potable water for the cutters at a rate of 1.65 Lps/ton. The cooperatives load manually rather than mechanically and transport this cane on rented trucks. Transport costs of cane are 3 Lps/ton for distances up to 3 km and 10 centavos/ton per additional kilometer.

ACHSA

Eighty-three percent of ACHSA independent producers are smaller than 20 hectares, with an average size of 14.6 hectares. Average yield is 77 tons per hectare (below the national average of 80 t/ha). Ninety percent of independent growers own plantations that are 10-11 years old.

Most growers are located within a 7 km radius from the mill and all cane is transported on rented trucks. The company provides weekly advances with no interest charges for harvesting and cane transport. Financing for farm maintenance is provided by BANADESA and collected through the company. In 1986 the price per ton is 25 Lps. The company also provides technical assistance at no cost to the grower.

ACHUMSA

This company has the least number of independent growers (30). The average size of the farms is 13.4 hectares with average yields of 61 tons per hectare being the lowest in the industry. Twenty-four producers have signed contracts with the company, the rest do not but are given the same treatment. The cane price in 1986 is 24.18 Lps/ton, also the lowest in the industry. Most of the growers are located within 10 km from the mill. Cane is transported on rental trucks at a charge of about 3.5 Lps./ton for this distance. The company provides land preparation, fertilization and cultivation services. It also sells agricultural chemicals to the growers. The company finances harvest operations for about fifty percent of the independent producers, and also finances crop maintenance for 25 percent.

AYSA

AYSA has the smallest independent producers in the northern region. Eighty-two percent of the area serving this mill is owned by independent growers, and about 60% of the growers are located within a 20 km radius from the mill. Transactions are governed by a 5-year contract that is due in the 1986-87 season. For 1986, the base price per ton of cane is 26.50 Lps; this price will be later adjusted according to the average price obtained for the sugar sold on the three different markets, i.e., domestic, US quota and the world market.

The company finances some growers and serves as a guarantor before the banks for some others. Harvesting operations are financed by the company and cane loading is done with the company's equipment at a charge of 1.80 Lps/ton. Technical assistance is provided to the grower at no cost. The company has no plans to reduce cane area either from company land or independent growers.

CAHSA

A total 230 independent growers and cooperatives own 59% of all cane land that supplies CAHSA's two mills (Sta Matilde and Villanueva). This includes twenty-six cooperatives with a total membership of 412. The average size of the CAHSA independent grower is 29.4 hectares with an average yield of 85 tons/ha.

CAHSA provides financing of up to 420 Lps/ha for crop maintenance and finances harvesting operations by providing advances to the grower. Some cane transportation is done by the company and the rest is done by the growers on trucks. CAHSA operates the only research station in the industry. All cane growers can make use of the services this research station provides at non-profit rates.

Relations between the two parties are governed by contract. A substantial change has taken place this year: CAHSA established a fixed price per ton of cane instead of the average price under the old contract. The new contract was strongly opposed by the AHCI growers organization. Another area of friction is the so-called "Sugar Fund," created when the last domestic sugar price increase was authorized by GOH. The Sugar Fund was to be used to finance operations of the mills as well as those of the independent growers, but according to AHCI no funds have been made available to the growers.

The company's future plans are to reduce independent grower cane purchases as well as some company cane land, to be developed into a housing project.

AZUNOSA

Sixty-five percent of cane land serving AZUNOSA is in the hands of 64 independent growers. The average farm of 42.7 hectares is the highest in the industry. Most independent grower land belongs to cooperatives formed under agrarian reform. Yields are 57 tons/ha, far below the 80 tons/ha industry average.

Relations between the two parties are governed by a contract that establishes a price this year of 25 Lps/ton. During 1986-87, the company is planning to eliminate most independent growers that are more than 12 km away from the mill.

Table D-1: Size Distribution of Farms

	Unit	Hectares 0-5	5-20	20-50	50-100	100-700
ACANSA						
No. of Farms		11	16	20	9	4
Total	ha	43	180	674	569	717
Mean	ha	3.9	11.2	33	63.2	179
ACENSA						
No. of Farms		100	178	24	14	5
Total	ha	333	1478	683	904	725
Mean	ha	3.3	8.3	28.4	64.5	145
ACHSA						
No. of Farms		34	49	10	4	3
Mean	ha	3.2	13.2	27.6	61.2	178
CAHSA						
No.of Farms		35	64	36	18	19
Total	ha	124	701	1126	1246	2946
Mean	ha	3.5	10.9	31	69	155
AZUNOSA						
No. of Farms n/a						
Total	ha	7.3	251	377	607	1384
Mean	ha	2.4	10.9	31.4	101	197.8
AYSA						
No. of Farms n/a						
Total	ha	82	658	616	614	839
Mean	ha	3	11	30.8	61.4	167.8

Table D-2: Cane Transport Rates

KMS	ACANSA	AZUNOSA	CAHSA
0-3	3.30	2.80	2.85
3-6	3.73	3.24	3.06
6-9	4.16	3.68	3.33
9-12	4.59	4.13	3.61
12-15	5.02	4.57	3.88
15-18	5.45	5.01	4.35
18-21	5.88	5.46	4.62
21-24	6.31	5.89	4.90
24-27	6.74	6.32	5.17
27-30	7.17	6.66	5.54
30-33	7.60	6.81	5.81
33-36	8.03	7.25	6.09
36-39	8.46	7.69	6.36
39-42	8.89	8.13	6.63
42-45	9.32	8.57	6.90

Table D-3: Agriculture Sector Jobs (1983-85)

Crop	No. of Jobs	% of Sector
All Crops	335,034	100.0
Corn	111,339	33.3
Coffee	95,278	28.4
Bananas	26,000	7.8
Sugar Cane	19,600	6.0
Bean	14,863	4.4
Tobacco	13,593	4.1
Sorghum	8,244	2.4
African Palm	5,658	1.7
Plantain	4,693	1.4
Pineapple	4,133	1.2
Oranges	3,673	1.1
Cotton	2,567	0.8
Rice	2,155	0.6
Mandioca	1,483	0.4
Others	23,755	7.1
Livestock (all)	71,014	100.0%
Cattle	52,808	74.4
Dairy	11,879	16.8
Hogs	5,500	7.7
Layers	457	0.6
Broilers	370	0.5
Forestry	13,300	100.0%
Fishing	8,600	100.0%
Total Jobs	427,948	

Table D-4: Production Costs of Alternative Crops and Income Per Hectare

	Melon	Sesame	Corn	Soybeans
Yields	321 box/ha	1799 QQ/ha	2999 QQ/ha	4399 QQ/ha
Price	12 Lps/box	40 Lps/QQ	16 LPs/QQ	30 Lps/QQ
Sales (Lps/ha)	3852	680	464	1290
Costs*				
Labor	779	194	136	45
Equipment	250	150	164	444
Ag chemicals	1679	130	80	278
	2708	474	380	767
Margin (Lps/ha)	1144	206	84	523

* Does not include financial costs
Source: BANADESA