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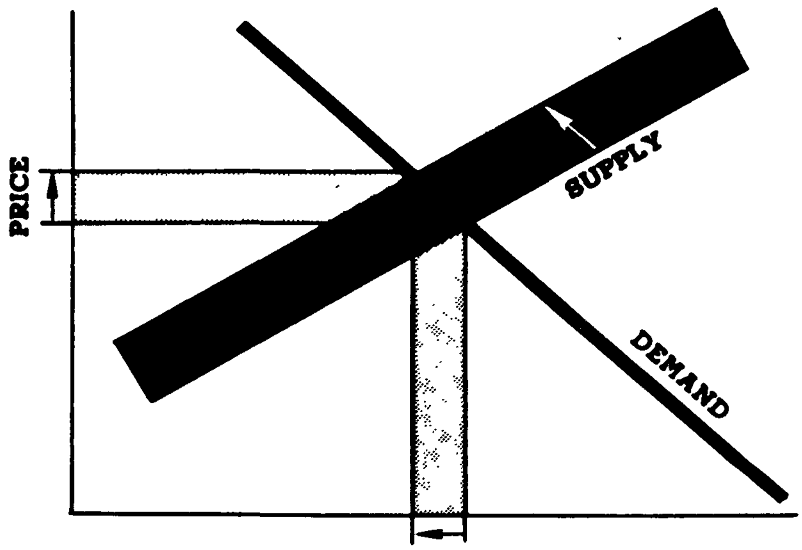
ECONOMIC ANALYSIS OF PROPOSED EFFLUENT GUIDELINES

SUGAR CANE MILLING INDUSTRY
PHASE II



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Planning and Evaluation
Washington, D.C. 20460

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ECONOMIC ANALYSIS OF PROPOSED

EFFLUENT GUIDELINES

SUGAR CANE MILLING INDUSTRY

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January, 1975

Prepared for
Office of Planning and Evaluation
Environmental Protection Agency
Washington, D. C. 20460

PREFACE

The attached document is a contractor's study prepared for the Office of Planning and Evaluation of the Environmental Protection Agency ("EPA"). The purpose of the study is to analyze the economic impact which could result from the application of alternative effluent limitation guidelines and standards of performance to be established under sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended.

The study supplements the technical study ("EPA Development Document") supporting the issuance of proposed regulations under sections 304(b) and 306. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports proposal based upon an analysis of the feasibility of these guidelines and standards in accordance with the requirements of sections 304(b) and 306 of the Act. Presented in the Development Document are the investment and operating costs associated with various alternative control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the required applications of various control methods and technologies. This study investigates the effect of alternative approaches in terms of product price increases, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Planning and Evaluation of EPA. This report was submitted in fulfillment of Contract No. BOA 68-01-1533, Task Order No. 5 by Development Planning and Research Associates, Inc., Manhattan, Kansas. Work was completed as of January, 1975.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed rule making under sections 304(b) and 306 of the Act for the subject point source category. The study is not an official EPA publication. It will be considered along with the information contained in the Development Document and any comments received by EPA on either document before or during proposed rule making proceedings necessary to establish final regulations. Prior to final promulgation of regulations, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who studied the subject industry. It cannot be cited, referenced, or represented in any suspect in any such proceeding as a statement of EPA's views regarding the subject industry.

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EXECUTIVE SUMMARY

INTRODUCTION

This report analyzes the economic impacts of proposed water pollution controls on cane sugar milling. It is one of a series of studies prepared under the supervision and review of the Office of Planning and Evaluation, U.S. Environmental Protection Agency, as required by the Federal Water Pollution Control Act Amendments of 1972.

Under the provisions of Section 304 and 306 of the Federal Water Pollution Control Act, EPA has proposed effluent guidelines which apply to the manufacture of raw cane sugar. The purpose of this study is to evaluate the potential economic impacts of those guidelines prior to their implementation.

The report describes and analyzes the industry structure in terms of:

- Number and types of firms and mills
- Size and location of mills
- Financial profiles of representative model mills
- Pricing practices and supply/demand relationships.

Then, pollution control costs are superimposed on the model mill financial profiles to analyze microeconomic effects, such as unit cost increments and potential closures. The micro analysis is followed by a macroeconomic analysis to evaluate effects on employment, communities, foreign trade and balance of payments.

Data for the study were taken from published governmental reports and industry studies and from confidential information provided by government and industry sources.

I. INDUSTRY STRUCTURE

Cane sugar milling (SIC 2061) is the intermediate step in cane sugar production. It is closely related to sugar cane production and to cane sugar refining (SIC 2062). Although geographic variations exist, there is much integration among firms in growing-milling and in milling-refining. As of 1971, integration from grower to mill accounted for about 92 percent of all cane in Hawaii, 90 percent in Florida, 53 percent in Louisiana and 24 percent in Puerto Rico. Mill-refinery integration accounted for 100 percent of all sugar in Hawaii and Puerto Rico, 22 percent in Louisiana and only 7 percent in Florida.

There are 59 firms operating 79 cane sugar mills in Louisiana, Florida, Texas, Hawaii and Puerto Rico. The firms include large diversified corporations, growers' cooperatives and government-owned and operated corporations (Puerto Rico) as well as specialized sugar companies. There are some fully integrated firms (farm-mill-refinery), some partially integrated (farm-mill or mill-refinery) and some non-integrated (mill only).

Cane sugar mills have been segmented by geographic region (subcategories) and by size. Size is expressed as grinding capacity of tons of cane per day. Except for Hawaii (Subcategories III and IV) where capacity is expressed as net tons of cane per day, size refers to gross tons of cane per day. Raw sugar output varies among mills according to the length of the operating season, sucrose content of the cane and the percentage utilization of the mills' capacities. Florida has the largest mills, followed by Hawaii, Puerto Rico and Louisiana. The newer mills tend to be larger, although most mills are generally very old (pre-World War II). Mills are located near the sugar cane growing regions.

Statistics on employment are vague, with an estimated 8,000 persons employed in the 79 mills.

II. FINANCIAL PROFILE

Precise financial data for cane sugar mills are not readily available. Some confidential data have been analyzed and synthesized to construct model mills for each subcategory. From published corporate reports and unpublished data, industry profitability has been estimated at approximately 8 percent on equity (1969-1973). Based on industry averages of debt to equity and the dividends paid from 1969 through 1973, the cost of capital has been estimated at 7 percent.

Model mills definitely show economies of scale, with the larger Florida mills having the highest estimated returns on invested capital. Small Louisiana, Hawaiian (Subcategory IV) and Puerto Rican mills appear unprofitable under 1973 cost-price conditions. Medium sized Louisiana mills and small Hawaiian (Subcategory III) mills operate at just about a break-even point, while large Louisiana and medium-sized Hawaiian mills earn very modest returns (3 to 4 percent) on invested capital. Florida mills earn 14 to 15 percent on investment.

Under 1973 economic conditions, Florida mill owners should be able to finance new investment, but smaller mills in Louisiana, Hawaii and Puerto Rico present a doubtful picture.

III. PRICING

Pricing of raw cane sugar is complex. Demand is derived from the final demand for sweeteners in general, which includes refined cane sugar, beet sugar, corn sweeteners, and non-caloric sugar substitutes. The U.S. imported about 45 percent of its estimated 1973 total supply of sugar (11.5 million short tons); domestic production of the remaining 6.2 million tons is divided 55-45 percent between beet sugar and cane sugar. Thus, the world sugar economy is critically important to the United States.

Furthermore, the U. S. sugar industry has been protected and regulated by the Federal government under a quota system which gives the effect of price administration. Prior to 1974, U.S. prices have been higher than world prices. The pricing picture has been complicated by the expiration in December, 1974, of the U.S. Sugar Act of 1948. The 1974 sugar prices have skyrocketed, leaving future sugar prices subject only to speculative estimates.

The record high prices of 1974 have started moving downward. How fast and how far prices decline is a matter for speculation, but a new equilibrium price level is not expected prior to 1980. The primary reason for this delay in reaching a new equilibrium is that world projected demand for sugar exceeds projected supply through 1980. It is doubtful that the necessary capital and managerial know-how is available to permit mill capacity expansion of a sufficient magnitude to overcome the supply deficiency.

In the short run, raw sugar prices may fall to $.20 to $.25 (1973 dollars) per pound. Over the long run, prices may fall to equal the economic costs of production, somewhere between $.10 and $.15 (1973 dollars) per pound of raw sugar, but prices are not likely to return to their low-points of the late 1960's.

IV. IMPACT METHODOLOGY

The fundamental methodology used in the impact analysis is the same as that normally used in capital budgeting studies of new investments. The model plant budgets provide the basic data for the analysis.

The model plants though not precisely representative of any single plant operation, reflect the financial and physical characteristics of the industry. Adjustments to model plant budgets to reflect pollution control investment and annual operating costs permit pre- and post-pollution control economic analysis for impacts on prices, profitability and production.

Probable plant closures, a key part of the analysis, are determined through a net present-value analysis, by which expected future cash proceeds are discounted at the firm's estimated cost of capital rate. A net present-value of less than zero implies that the owner would be better off to liquidate his plant and reinvest the salvage proceeds at the cost of capital rate.

Price increases required to return the plant to pre-pollution control levels of profitability are then calculated to estimate expected price effects. An evaluation of ability to pass on required price increases follows.

Finally, a qualitative analysis of economic determinants indicates the broad macroeconomic effects on agricultural production, employment, communities and balance of payments.

A detailed description of the methodology appears in Chapter IV.

V. EFFLUENT CONTROL GUIDELINES AND COSTS

Effluent control guidelines, technology and costs were furnished by the Effluent Guidelines Division of the Environmental Protection Agency. The cane sugar milling industry was divided into five subcategories:

I -- Louisiana

II -- Florida

III -- Hawaii (Hilo Coast)

IV -- Hawaii (Other)

V -- Puerto Rico

Effluent Guidelines Division of EPA has provided information on in-place technology for each mill and cost estimates for meeting proposed standards in 1977 with the best practical control technology currently available (BPT) and in 1983 with the best available technology economically achievable (BAT). Subcategories II (Florida) and IV (Hawaii-Other) reportedly have sufficient effluent control technology in place to meet proposed BPT and BAT guidelines. No impact analysis will be performed for these two subcategories.

The other three subcategories have varying percentages of impacted mills. Subcategory I (Louisiana) has 39 operating mills, of which eight must install new technology to meet proposed BPT requirements; these eight mills represent about 20 percent of daily grinding capacity in Louisiana. Twenty-six (26) mills, representing 65 percent of daily capacity, currently require new control facilities to meet BAT guidelines.

In Subcategory III (Hawaii-Hilo Coast), all four (4) of the mills need additional control facilities for both BPT and BAT guidelines. Ten (10) of eleven (11) mills in Subcategory V (Puerto Rico) must install new controls to meet BPT guidelines, and nine (9) mills will have additional investment in controls to meet BAT standards.

For the U.S. as a whole, mills accounting for about 24 percent of 1973 raw sugar production will need investment in BPT pollution controls and mills accounting for about 32 percent of 1973 production will require additional investment to meet BAT guidelines. An estimated 66 percent of production will require no pollution control expenditure.

Annualized pollution control costs (BPT) range from near zero up to 82 cents per hundredweight of sugar (Subcategory III). BAT costs are as high as 37 cents per hundredweight (Subcategory I), with BPT plus BAT reaching a high of 96 cents (Subcategory III).

VI. IMPACT ANALYSIS

The analysis of economic impacts of pollution controls on cane sugar mills was complicated by the uncertainty about future sugar prices. Accordingly, variable price alternatives were used, with a high of $20.00 per hundredweight (1977-79) and a low of $10.29 (1980 and after). Intermediate level prices ($15.00 and $12.50) were also used in the various price scenarios. In all, six price scenarios were used where applicable to evaluate BPT and BAT impacts.

Under the highest price alternatives, no closures are expected in any of the three subcategories. At the lowest projected price level, baseline closures (not due to pollution controls) may occur in Louisiana and Puerto Rico, with relatively few closures potentially attributable directly to pollution control costs. Effects of pollution control costs on model mills' rates of returns on invested capital and on net present values are most severe on small Louisiana and Puerto Rican mills.

Closure analysis is extremely complex, owing to the price variables. At the lowest prices, baseline closures are probable for nearly all of the impacted plants with few closures attributable directly to pollution controls. An estimated maximum of 4.5 percent of U. S. production might close due to BPT controls, and up to an estimated 4.8 percent of U. S. production might close due to BPT plus BAT. Another estimated 3.8 percent of U.S. production might close due to BAT controls required by plants already meeting BPT controls. The total closure due to BAT is estimated to be 8.6 percent of U.S. production.

Under the highest price scenario of $20.00 per hundredweight for 1977-1979, $15.00 per hundred for 1980-82 and $12.50 per hundredweight for 1983 and after, no closures due to BPT controls are anticipated. However, seven to twelve plants in Louisiana and Puerto Rico may close due to BAT controls under this price scenario. These plants represent approximately 2.7 to 6.0 percent of current U.S. raw cane sugar production.

The effect of new source performance standards (NSPS) on industry growth has not been analyzed quantitatively. EPA has not issued definitive NSPS investment and annual pollution control costs, although the Effluent Guidelines Division has estimated that NSPS will not exceed BPT plus BAT costs. Since new mills in Florida-Texas reportedly meet BPT-BAT standards, it appears that NSPS would not curtail new mill construction in that region. The impact on growth in Louisiana, Hawaii, and Puerto Rico is more difficult to evaluate, although at raw sugar prices above $.10 (1973 dollars) per pound, there should be little negative impact.

Effects of pollution controls on employment will be related to mill closures. Under the lowest price scenario, a maximum number of jobs lost due to pollution control induced closures would be approximately 1,750. At higher prices, the impact on jobs would be small. Lost jobs would be concentrated largely in Louisiana and Puerto Rico. It should be noted that baseline closures would probably cause a greater loss of jobs than would pollution controls, given the lowest price scenario.

The impact on balance of payments would be very small. If all production lost due to pollution control induced closures were replaced by imports, outflow of U.S. payments would increase by only about $500,000. Production losses due to baseline closures could account for an additional $1,000,000.

VII. LIMITS TO ANALYSIS

Based on available data, this analysis represents a systematic evaluation of the impact of proposed effluent guidelines on the cane sugar milling industry. It should be recognized, however, that the world sugar economy (prices, supply, demand) is in a state of flux. Future prices are especially uncertain, creating a major complication in estimating 1977 and 1983 industry conditions.

Model mill parameters, while representative of mills in the various subcategories, may not be representative of specific operating mills. Also, 1973 cost-price relationships may not reflect 1977 or 1983 conditions.

Economic data on Puerto Rico are sketchy and may not provide an adequate basis for analysis.

There is a major remaining question of future U.S. sugar policy. Although the Sugar Act of 1948 expired on December 31, 1974, future U.S. policy is unknown. Also, the ability of foreign producers to expand sugar production and the future costs of that production remain questionable.

The effects of new source performance standards on industry growth remain in doubt. Precise cost data for NSPS investment and operating costs are not available, precluding a meaningful quantitative analysis of NSPS on new mill construction.

I. INDUSTRY STRUCTURE

Cane sugar processing, a segment of SIC 206 (Sugar), is subdivided into SIC 2061 (Sugar Cane Milling) and SIC 2062 (Sugar Cane Refining). Although sugar cane milling is closely related to sugar cane refining (the subject of a separate report, 1/), the present report deals only with the sugar cane milling classification.

A. Types of Firms

Sugar cane milling is handled by four distinct types of business organizations: (1) large, diversified, integrated corporations, (2) smaller sugar producing corporations with varying degrees of integration, (3) growers' cooperatives, and (4) government owned and operated mills.

1. Size and Number of Firms

There are 59 firms operating 79 cane sugar mills in the United States (including Puerto Rico). These firms range in size from large diversified companies, such as Gulf and Western Industries and Castle and Cooke, Inc. down to relatively small, one-plant companies.

Nine firms have two or more plants. Listed below by estimated daily production capacity,the annual raw sugar production of these firms varies in terms of number of operating days and sugar content of the cane. Such variations make annual production data difficult to compare. Other large producers appear in the plant lists in the Appendix.

1/ Milton L. David and Robert J. Buzenberg, Economic Analysis of Proposed Effluent Guidelines: Cane Sugar Refining Industry, EPA-230/1-73-003, U. S. Environmental Protection Agency, Office of Planning and Evaluation, Washington, D. C., October, 1973.

Multi-plant Cane Sugar Milling Firms

		No. Mills	Estimated Capacity (Gross tons per day)
1.	U. S. Sugar Co.	2	22,000
2.	Amfac	5	19,050 1
3.	Alexander Baldwin Ltd.	4	15,100
4.	Zapata - Narvess (South Coast)	4	14,400
5.	Southdown Lands	3	10,900
6.	Castle & Cooke, Inc.	2	7,400 1/
7.	C. Brewer & Co.	3 2/	7,300 1/
8.	Hilo Coast Processing Co.	4	6,960 1/
9.	Theo H. Davis	2	5,700 1/

1/ Net tons per day

2/ C. Brewer, through a subsidiary, owns 50 percent of Hilo Coast Processing Co.

2. Level of Integration and Diversification

Cane sugar milling has considerable backward vertical integration into growing and harvesting. There are variations by growing area, but mill owners frequently grow cane and own cane land. There is also some forward integration into the refining and marketing of cane sugar, but to a much lesser degree. Tables I-1 and I-2 reflect the 1971 patterns of integration by area.

Puerto Rican operations, under government ownership and control, are totally integrated from milling through refining. But 76 percent of all cane is independently grown, mostly on thousands of small farms.

In Hawaii, integrated companies owned 26 mills operating in 1971 and produced 92 percent of the islands' cane. The mills from five of these companies own shares in the California and Hawaiian Sugar Company which refines and markets all of the sugar.

Florida has 90 percent of its raw sugar production integrated from grower to mill. Only one mill is integrated forward to refining, accounting for 7 percent of raw sugar output in the state.

Louisiana shows extensive independent ownership of both cane farms and mills. An estimated 53 percent of the Louisiana cane production is on mill-owned land. In 1971, eight of the 43 mills in the state were integrated forward to refineries and accounted for 22 percent of the state's raw sugar production. Seven of these mills owned by three companies are totally integrated from growing through to refining. In addition, the cooperative movement in Louisiana is spreading with growers organizing to purchase mills.

Table I-1 Cane sugar processing integration relationship, grower-mill integration, 1971 production

	Louisiana		Florida		Hawaii		Puerto Rico		Total	
	Production	Pct	Production	Pct	Production	Pct	Production	Pct	Production	Pct
Total Cane (000 acres)	301	34	194	22	232 1/	26	153	18	880	100
Total Cane (000 tons)	7,974	25	6,388	20	10,685	34	6,437	21	31,484	100
No. of Farms	1,513		130		528		4,202		6,373	
Total Raw Sugar (000 tons)	571	20	635	23	1,229	45	324	12	2,759	100
Total Mills	43		8		26		16		93	
<u>Grower-Mill Integration</u>										
Co-op Mills	8		3		4		0		15	
Administration Cane (000 tons)	2,536	86	2,127	99	914	70	0		5,577	87
Independent Cane (000 tons)	417	14	11	1	391	30	0		819	13
Total Cane	2,953		2,138		1,305		0		6,396	
Corporation Mills	35		5		22		0		62	
Administration Cane (000 tons)	1,663	33	3,630	85	8,911	95	0		14,204	76
Independent Cane (000 tons)	3,358	67	620	15	469	5	0		4,447	24
Total Cane (000 tons)	5,021		4,250		9,380		0		18,651	
Government Mills	0		0		0		16		16	
Administration Cane (000 tons)	0		0		0		1,568	24	1,568	24
Independent Cane (000 tons)	0		0		0		4,869	76	4,869	76
Total Cane (000 tons)	0		0		0		6,437		6,437	
Total Administration Cane (000 tons)	4,199	53	5,757	90	9,825	92	1,568	24	21,349	68
Total Independent Cane (000 tons)	3,775	47	631	10	860	8	4,869	76	10,135	32
Total Cane (000 tons)	7,974		6,388		10,685		6,437		31,484	

1/ Total cane acreage - only 1/2 harvested each year due to 22-24 month crop maturity.

Sources: <u>Hawaiian Sugar Planter's Association Sugar Manual</u>, 1973
<u>Gilmore Sugar Manual</u> 1971
USDA -ASCS various data
Puerto Rico Land Administration Data

Table I-2 Cane sugar processing integration relationship, mill-refinery integration, 1971

	Louisiana		Florida		Hawaii		Puerto Rico		Total	
	Production	Pct	Production	Pct	Production	Pct	Production	Pct	Production	Pct
Total Cane (000 acres)	301	34	194	22	232 1/	26	153	18	880	100
Total Cane (000 tons)	7,974	25	6,388	20	10,685	34	6,437	21	31,484	100
No. of Farms	1,513		130		528		4,202		6,373	
Total Raw Sugar (000 tons)	571	20	635	23	1,229	45	324	12	2,759	100
Total Mills	43		8		26		16		93	
Mill-Refinery Integration										
Integrated Mill	8		1		26		16		51	
Raw Sugar (000 tons)	124	22	46	7	1,229	100	324	100	1,723	62
Non Integrated Mill	35		7		0		0		42	
Raw Sugar (000 tons)	447	78	589	93	0	0	0		1,036	38
Total Raw Sugar	571		635		1,229		324		2,759	

1/ Total cane acreage - only 1/2 harvested each year due to 22-24 month crop maturity.

Sources: Hawaiian Sugar Planter's Assn. Sugar Manual, 1972.
Gilmore Sugar Manual 1971
USDA-ASCS Various data
Puerto Rico Land Administration Data

The amount of diversification varies widely. The Hawaiian companies are highly diversified corporations with cane sugar subsidiaries. The Louisiana firms are, for the most part, specialized sugar companies or cooperatives, with about one-third of the firms having other product lines (data are not available to determine the extent of diversification for these companies). Florida appears to have only one highly diversified firm. Generally, the large companies are diversified, while the small owners derive their revenues primarily from sugar sales.

B. Types of Plants

Cane sugar mills can be classified by size, age, location, level of technology and degree of integration.

1. Size

Cane sugar mills range in size from 12,000 tons of cane per day in Florida to 360 tons per day in Louisiana. There is some geographic variation with Florida having larger mills and Louisiana, smaller mills. Table I-3 presents the number of mills in various size ranges for each of the four producing areas. Appendix Tables 1 through 4 list each mill by daily tons of cane processed. Annual capacity is a function of daily capacity times number of operating days per year.

As an examination of Table I-3 and Appendix Tables 1 through 4 indicate, the largest Louisiana mill handled 6,000 tons of cane per day in 1973. Twelve of the area's 39 mills were over 4,000 TPD capacity and accounted for 44 percent of Louisiana's capacity. Fifteen mills were from 2,601 to 4,000 TPD and produced 38 percent of the area's capacity. Twelve plants were 2,600 TPD or less and made up 18 percent of Louisiana's capacity.

Florida's largest mill handled 12,125 tons per day. The eight Florida mills were divided into two size ranges, with three under 8,500 TPD and five over 8,500 TPD. The single Texas mill has a daily capacity of 8,500 tons of cane. Mills over 8,500 TPD handled 69 percent of Subcategory II's capacity.

Hawaii's largest mill had a daily capacity of 6,500 net tons of cane. Six mills ranged up to 2,000 net TPD (18 percent of Hawaiian capacity), 10 mills were in the 2,001 to 4,000 net TPD range (49 percent of Hawaiian capacity) and four mills were over 4,000 net TPD (33 percent).

Puerto Rico's largest mill produced 8,600 tons daily. Two mills were 7,500 and 8,600 tons per day (29 percent of Puerto Rican capacity), five mills fell in the 4,001 - 6,250 TPD range (48 percent) and four mills ranged from 1,200 to 4,000 TPD (23 percent).

Table I-3. Distribution of cane sugar mills by size by geographic area, 1973

Subcategory and size (TPD) Range	No. of mills	Total capacity 1/	Percent of area capacity
		(TPD)	
I -- Louisiana			
0 - 2,600	12	25,060	18
2,601 - 4,000	15	51,050	38
4,001 - 6,000	12	58,850	44
Subtotal	39	134,960	100
II -- Florida & Texas			
0 - 8,500	4	24,230	31
8,501 - 12,125	5	54,125	69
Subtotal	9	78,355	100
III and IV -- Hawaii			
0 - 2,000	6	10,810	18
2,001 - 4,000	10	30,150	49
4,001 - 6,500	4	20,600	33
Subtotal	20	61,560	100
V -- Puerto Rico			
0 - 2,000	1	1,200	2
2,001 - 6,000	7	31,500	57
6,001 - 8,600	3	22,350	41
Subtotal	11	55,050	100

1/ Gross tons of cane per day, except Hawaii, where net tons are used. Plant capacities are from the plant lists in the Appendix.

The size of mills has been stated in terms of tons of cane per day but the term requires clarification since three separate cane weight definitions can be found and will vary by geographic area.

- Gross cane, measured in short tons, is the field weight of cane as unloaded at the mill.

- Net cane is a calculated or estimated weight which is gross cane minus trash, mud, stones, and other non-cane material.

- A third term (not used in this report in expressing mill size) is standard cane. This, a theoretical weight, converts net cane into a standard weight of cane with a standard percent of sucrose (12%) in normal juice and with a purity of at least 76.00 but not more than 76.49 percent. If the quality of the cane is good, the standard cane weight will be greater than the net cane weight. Conversely, poor quality cane will have a standard weight less than net cane weight.

In Florida, for all practical purposes, gross cane equals net cane. Almost all Florida cane is hand harvested and is free of trash. As Florida converts to mechanical harvesting this will change.

At the other extreme, net cane in Hawaii is usually considered to be 50 percent of gross cane. All Hawaiian cane is mechanically harvested and the process picks up mud, stones, trash and other material to the point that gross cane is approximately double the weight of net cane.

In Louisiana a wide variety of harvesting methods is used. The 1973 average net cane weighed 86 percent of the field weighed gross cane. In 1971, the figure was 87.4 percent and in 1972, it was 85.8 percent. 1/

Comparative gross and net cane records for Puerto Rico are not available, but since most cane is hand harvested the assumption is that gross cane equals net cane.

In this report, capacity figures refer to gross cane in Florida, Louisiana and Puerto Rico and to net cane in Hawaii. This assumed convention will make the mills more nearly directly comparable with the exception of Louisiana where net cane is 86 percent of gross cane.

1/ According to records at the Louisiana State University Research facility and a sugar factory.

2. Age

Precise data on the age of most cane sugar mills are not available. Generally, mills are old; however, several mills were built after 1960 in Florida and one new mill was constructed in Texas in 1973 and began operations in 1974. Original construction dates are relatively meaningless for mills built prior to World War II, however, since remodeling and modernization have been extensive.

3. Location

In contrast to the usual practice of locating cane sugar refineries close to marketing or distribution areas, sugar cane mills are located near the four growing areas of Hawaii, Florida, Louisiana, and Puerto Rico (the new Texas mill is located near the mouth of the Rio Grande River). The principle locational determinant for milling is the rapid deterioration of harvested cane. Since it must be processed quickly, short hauls to mills are mandatory. This factor also accounts for the high degree of integration between grower and mill.

Appendix Tables 1 through 4 and Appendix Figures 1 through 4 give the specific location of each of the operating mills in the four major geographic areas.

4. Technology

Cane sugar milling is the first step in the processing of refined sugar from sugar cane. The milling process employs a relatively simple technology. The mills convert cane into raw sugar (96 percent sucrose) by (1) grinding and shredding the cane, (2) extracting the juice, (3) crystalizing the sucrose in the juice and (4) separating the crystals from the juice. The details of the various operations may differ slightly from mill to mill, but the manufacturing process is basically the same in all mills.

Pure sucrose (96 percent) is the ultimate product in raw sugar manufacturing. The exact amount of sucrose varies by sugar cane plant varieties and agronomic factors, but, typically, cane contains approximately 15 percent fiber and 85 percent juice by weight. The juice normally consists of about 82 percent water, 14 percent sucrose, and 4 percent non-sucrose soluble solids, including invert sugars and impurities.

The important sugars in cane juice are the simple monosaccharides and disaccharides composed of five or six carbon chains. Of these, sucrose, glucose, and fructose are the most important. Glucose and fructose (invert sugars) are six carbon monosaccharide isomers. The inversion or hydrolyzation of sucrose into glucose and fructose represents lost production.

In the milling process, the condition of the cane upon arrival at the mill is important. As mechanical harvesting techniques replace hand harvesting, the mud, dirt and leaf trash content of the cane increase, necessitating washing prior to grinding. This cane cleaning process requires large volumes of water. Some mills have adopted dry cleaning operations, but the process is not yet as effective as cane washing, especially when mud must be removed after heavy rains. Further improvements in the dry cleaning process can be important in reducing the amount of cane sugar mill effluents.

After the cane is cleaned, it is ground or shredded and the juice extracted. The extracted juice contains impurities, including fine particles of bagasse, fats, waxes and gums. Coarser particles (cush-cush) are removed by screening. A substantial portion of the remaining impurities are removed by clarification.

In the clarification process, the juice is divided into (1) clarified juice and (2) precipitated sludge (muds). The clarified juice constitutes from 80 to 90 percent of the original juice and is usually taken directly to the evaporator system. The sludge is usually treated by rotary vacuum filters.

The clarified juice is then evaporated to reduce its water content from about 85 percent to 40 percent, leaving about 60 percent solids. Most plants use multiple-effect evaporators for better fuel economy in concentrating the juice.

After evaporation, the juice is crystallized in vacuum pans--single-effect, batch-type evaporators. Calandria pans are commonly used. In this stage of processing, the sugar solution must be supersaturated to produce sugar crystals. This supersaturation occurs in three phases of sugar boiling: (1) the metastable phase in which existing crystals grow but new crystals do not form; (2) the intermediate phase in which existing crystals grow and new crystals form; and (3) the labile phase in which new crystals form spontaneously without the presence of other crystals.

Following the formation of crystals in the vacuum pans, the solution (massecuite) is discharged into a mixer where it is agitated gently. It then flows to a high speed centrifuge which separates crystals from the syrup. Crystals remaining in the contrifuge are washed with hot water to remove the remaining syrup. The crystalline sugar is then removed to storage.

Usually the crystalline sugar is moved to storage on belt or screw conveyors. From bulk storage in the warehouse, the sugar moves by truck, rail or ship to the refineries.

5. Degree of Integration

Integration of cane sugar milling with growing-harvesting and with refining has been discussed earlier under "Types of Firms." Tables I-1 and I-2 present the degree of integration in the various growing areas.

Seven mills are directly integrated on site with refining. Three of these are in Florida, three in Puerto Rico, and one in Louisiana. Several other mills, which are owned by corporations with refineries, operate at separate locations on a "stand-alone" basis.

While cane sugar mills produce raw sugar as a primary product, they do have by-products--bagasse and molasses. Bagasse, cane fiber and pulp, is frequently burned to produce energy for the milling process. Some bagasse is sold for animal feeds; some goes into building materials such as celotex. Revenue from the sale of bagasse is relatively insignificant as a percent of mill sales.

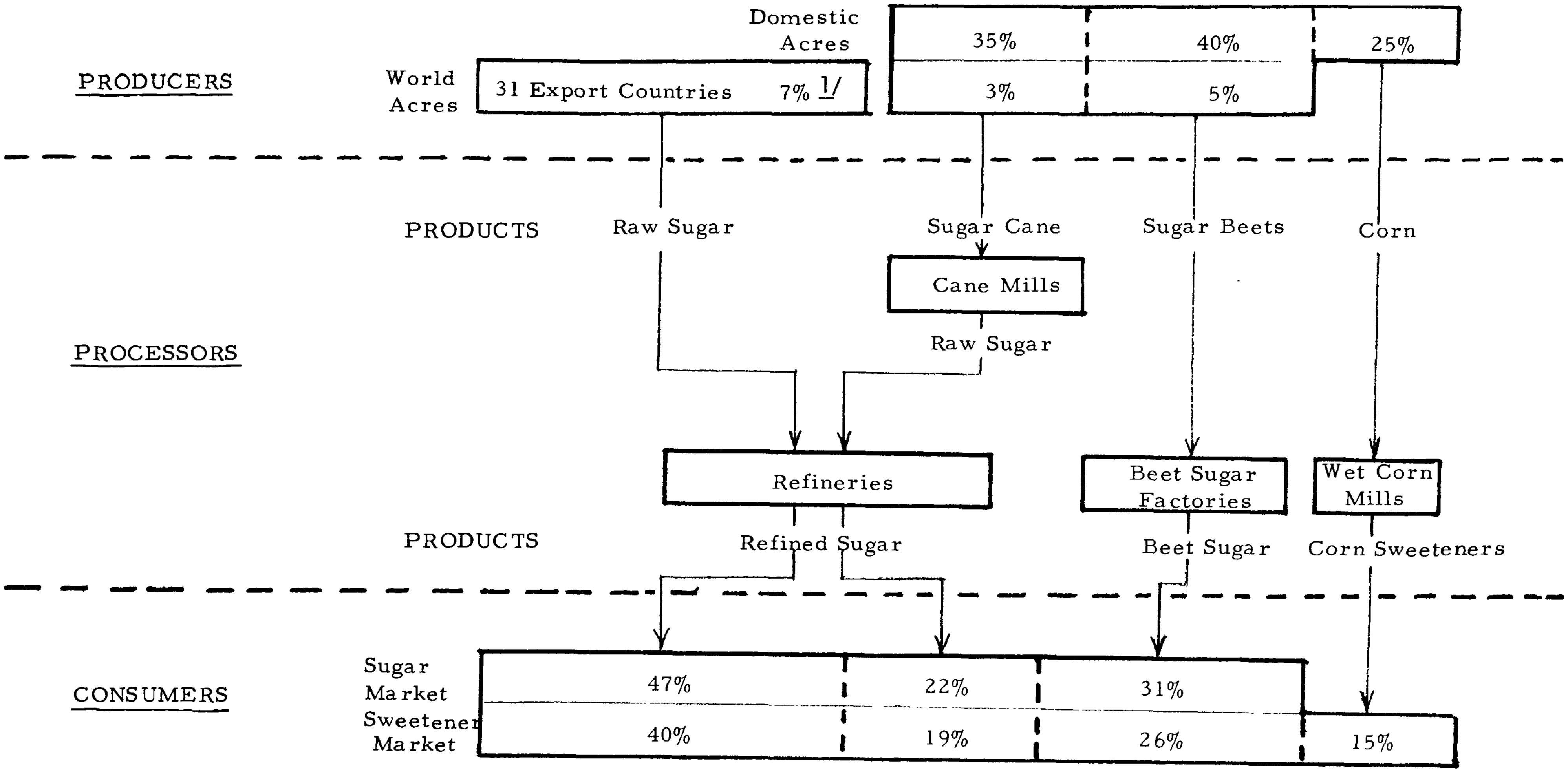
Molasses, on the other hand, is an important by-product and is used primarily as an animal feed supplement (a small percentage is used in food flavorings, colorings, and syrups). Puerto Rican molasses is utilized in rum production. Other uses include ethyl and butyl alcohol production and the manufacture of acetic and citric acids. Molasses sales historically have accounted for about 3.6 percent of total mill revenues, but in 1973 the percentage more than doubled owing to a sharp rise in molasses prices.

C. Number of Plants and Employees

Statistics on the number of employees in the cane sugar milling industry are neither current nor precise. The most recent year for which Department of Commerce Census data are available is 1971. Reported production workers in that year totaled 5,700 in 83 mills, with total employment at 7,500, according to the Annual Survey of Manufactures, 1971. 1/

From industry sources, it appears that the number of employees averages about 100 per individual plant. Based on this estimate, there were about 8,000 employees for the 79 U. S. cane sugar mills in 1973.

1/ M71(AS)-10, Bureau of the Census, U. S. Department of Commerce, Washington, D. C., 1973.



1/ Approximate percentage of total world acres used to produce U. S. raw sugar imports.

Figure I-1. Structure of the domestic sweetener industry. (Percentages as of 1971.)

D. Relationships to Total Industry

Cane sugar milling is directly tied to the growing of sugar cane and to the refining of raw sugar. It is also related to the beet sugar industry for refined cane and beet sugars are essentially identical products.

Milling represents the intermediate process in refined cane sugar production. Cane sugar mills are, thus, highly dependent on growers for their supply of cane and on refineries for the disposition of their raw sugar. For the total cane sugar industry, the number of farms, mills and refineries in the United States in 1973 is as follows:

6,373 cane farms
79 cane mills
29 refineries

In addition, there are 52 beet sugar plants in the United States producing 31 percent of U. S. refined sugar.

Foreign raw sugar imports are an additional consideration. Forty-seven percent of U. S. domestic sugar consumption is derived from imported raw sugar.

When the sugar industry is viewed in the broader terms of all sweetening products, corn sweeteners become important and represent 15 percent of the total sweetener market.

Figure I-1 shows the structure of the domestic sweetener industry and reveals the relationship of the cane sugar milling industry to the other segments.

E. Potential Impact

Under 1973 market conditions, small mills are most likely to be impacted by the imposition of pollution controls. All Louisiana mills, with apparent low profits, will probably suffer, as well as some Hawaiian mills on the Hilo-Hamakua Coast that have special difficulties resulting from terrain and high rainfall. It is very difficult to assess the economic impact of pollution control costs on the Puerto Rican mills, since governmental policies play such an important role.

II. FINANCIAL PROFILE

Financial data for individual operating plants are generally unavailable. Published financial data for the large publicly-held corporations do exist, but since these are generally diversified corporations, the data may not reflect specifically the cane mill operations. Limited confidential information on specific plants was obtained, and though not identified in this report, much of that data provided the basis for this analysis.

Given such data limitation, model plants provided the most reasonable insight into the financial aspects of the various cane milling operations. Model plant categories, matched to the size of typical operating mills in the various geographical locations, were established and are presented in Table II-1. Budgets for these model plants were used to construct the financial profiles for the various cane sugar milling segments.

A. Plants

The model plant budgets represent the best available estimates of actual cost-price data. In addition to these estimates, some further benchmarks concerning industry profitability, capital structure and cost of capital were derived from an examination of published sources (corporate annual reports and government economic studies) and from confidential operating data for cane mills. These sources made possible the developing of ranges of profitability and estimates of capital structures and capital costs. These gave additional perspective to the model plant profiles.

1. Industry Profitability

Published financial data for six of the ten largest firms in cane milling were analyzed to provide one measure of profitability. Again, it is necessary to offer a precautionary reminder that these are diversified companies which may not be representative of the specialized cane sugar mill operators. Even so, their performance may be regarded as somewhat of an upper range for the industry as a whole. Table II-2 presents selected average financial ratios for these six firms, based on available data for the five-year period, 1969-73.

While these simple averages do not apply specifically to cane mills as such, they do provide an indication of the financial strength of some of the leading companies which operate mills. Their net income to sales ratio is above the average for all U. S. corporations, while the 9.7 percent return on net worth is slightly below the U. S. average. The companies are in reasonably sound financial condition, with ample room for borrowing additional long-term capital. It is noteworthy that four of the companies showed rising returns on net worth in 1973.

Table II-1. Model plant segments

Subcategory	Subsegment	Size[1/]
I -- Louisiana	Small	2,200
	Medium	3,300
	Large	5,000
II -- Florida & Texas	Small	6,000
	Large	10,000
III -- Hawaii (Hilo Coast)	Small	1,800
	Medium	3,300
	Large	4,800
IV -- Hawaii (Other	Small	1,800
	Medium	3,300
	Large	4,800
V -- Puerto Rico	Medium	4,500
	Large	8,000

1/ Capacity shown in gross tons cane per day except for Hawaii which is stated in net tons..

Table II-2. Selected financial ratios for six diversified companies engaged in cane sugar milling, 1969-73

Range	Percent of sales			Net income as percent of net worth	Long-term debt as percent of total capital
	Operating income	Net income	Cash flow		
High	35.0	16.3	20.9	13.3	48
Low	7.7	2.8	5.5	6.3	2
Wtd. Av.	16.9	7.4	10.4	9.7	26

Geographic variations in profitability were reported in an earlier study released in 1973 by the United States Department of Agriculture. 1/ That report based on Agricultural Stabilization and Conservation Service Statistics analyzed operating data for each producing area. The data were for three-year periods, although the actual years vary. A summary of these results appears in Table II-3.

Table II-3 indicates that the ratio of net income to net worth was negative for small Louisiana and Florida mills and for both large and small Puerto Rican mills. Large mills in Louisiana and Florida had modest returns. Much higher returns, reflecting the area's longer operating season and consequently more efficient use of invested capital, were characteristic of Hawaiian mills.

2. Capital Structure

Adequate information was not available to definitively calculate the debt-equity structures for operating companies. As noted above, the debt as a percent of total capital ranged from 2 to 48 percent for these six companies, with the weighted average at 26 percent. It is reasonable to assume a debt-equity mix of about one-fourth and three-fourths. This is the ratio which was used in calculating the cost of capital.

3. Cost of Capital

The estimated cost of financing new investment was derived from an analysis of the financial reports of publicly held companies and from confidential industry data. Four factors were estimated: (1) common equity to total capital, (2) long-term debt to total capital, (3) five-year average for dividend yield on common stock, and (4) five-year average for earnings on common stock.

The estimated averages were as follows:

Common equity/Total capital	.75
Long-term debt/Total capital	.35
Dividend yield, 5-year average	.030
Earnings, 5-year average	.081

Other assumptions were: (1) long-term interest rates averaged 8.0 percent, (2) the corporate tax rate was 22 percent on the first $25,000 and 48 percent on income above $25,000, (3) the growth rate in dividends was at least equal to the annual inflation rate, which for this analysis is estimated at 5 percent.

1/ Bruce J. Walter and Peter M. Emerson, Initial Analysis of the Economic Impact of Water Pollution Control Costs Upon the U. S. Sugar Industry, Economic Research Service, U. S. Department of Agriculture, Washington, D. C., March, 1973.

Table II-3. Sugar cane mills: selected operating and financial data by production area and mill size, all domestic sugar cane areas, three year averages

Production area/time period/mill size 1/	Number of mills in industry	Number of mills in sample	Raw sugar production	Net worth	Returns	Costs: Sugar-cane	Costs: Proc-essing	Rent and interest paid (net)	Profit before taxes	Income tax	Profit after taxes	Ratio of profit to net worth: Before income taxes	Ratio of profit to net worth: After income taxes
			1,000 cwt.	Dollars per cwt. of sugar, raw value								Percent	Percent
Louisiana, 1969-71 aver.													
Small (≤ 3,600 tons/day)	27	8	208	5.703	8.711	5.493	3.337	.010	(.130)	(.027)	(.103)	(2.27)	(1.80)
Large (> 3,600 tons/day)	16	7	411	5.423	8.744	5.236	3.002	.212	.294	.108	.186	5.41	3.42
All mills	43	15	303	5.572	8.726	5.373	3.181	.104	.068	.036	.032	1.22	.57
Florida, 1967-69 aver.													
Small (≤ 7,000 tons/day)	4	4	723	3.169	8.111	4.844	2.994	.352	(.079)	(.034)	(.045)	(2.50)	(1.42)
Large (> 7,000 tons/day)	5	5	2,220	5,733	8.163	4.998	2.425	.260	.480	.244	.237	8.37	4.13
All mills	9	9	1,471	4.451	8.137	4.921	2.709	.306	.200	.105	.096	4.49	2.16
Hawaii, 1967-69 aver.													
Small (≤ 3,000 tons/day)	20	20	750	3.390	7.210	3.486	3.189	.006	.529	.239	.289	15.59	8.53
Large (> 3,000 tons/day)	6	6	1,506	3.363	7.249	3.547	2.666	.001	1.034	.476	.557	30.75	16.56
All mills	26	26	925	3.384	7.219	3.500	3.075	.005	.638	.292	.347	18.85	10.25
Puerto Rico, 1969-71 aver.													
Small (≤ 3,600 tons/day)	6	4	272	(2.947)	8.856	5.041	5.576	.409	(2.170)	0	(2.170)	2/	2/
Large (> 3,600 tons/day)	10	10	744	4.386	8.698	5.055	4.774	.152	(1.282)	0	(1.282)	(29.23)	(29.23)
All mills	16	14	599	2.130	8.747	5.051	5.021	.231	(1.555)	0	(1.555)	2/	2/
All areas and all mills	94	64	785	3.773	8.036	4.478	3.474	.120	(.307)	.142	(.178)	(.98)	(4.72)

1/ Mill size measured in terms of daily grinding capacity.

2/ Net worth and profit are negative amount.

Source: USDA-ASCS.

The cost of equity was then estimated by two methods--the dividend yield method and the earnings-stock price (E/P ratio) method. Both are simplifications of the more complex DCF methodology. The dividend method is:

$$k = \frac{D}{P} + g$$

where

k = cost of capital
D = dividend yield
P = stock price
g = growth

and the E/P method is simply

$$k = E/P$$

where

k = cost of capital
E = earnings
P = stock price

and is a further simplification of the first. The latter assumes future earnings as a level perpetual stream.

The after tax cost of debt capital was estimated from company data on interest expenses and multiplied by .52 -- assuming a 48 percent tax rate.

The above values were weighted by the respective equity and debt 1/ ratios to obtain estimated average costs of capital as follows:

Dividend Yield Plus Growth	Weight	Cost	Growth	Wtd. Cost
Equity	.75	.030	.05	.060
Debt (8% x 52%)	.25	.042	-	.010
Av. Cost				.070
Earnings/Price				
Equity	.75	.081		.061
Debt	.25	.042		.010
Av. Cost				.071

Thus, the estimated range for the cost of capital is 7.0 to 7.1 percent.

4. Pro Forma Income Statements - Model Plants

Table II-4 contains a summary of the pro forma income, cash flow and rate of return for 18 model cane sugar mills in the four geographic areas. These plants are representative of individual plants but do not necessarily

1/ It is recognized that liabilities contain non-interest bearing liabilities, but its weight is believed to be an adequate approximation for the weight of debt.

Table II-4. Estimated pre-tax and after-tax income, cash flow and rate of return for model cane sugar mills, 1973

Subcategory	Capacity 1/ TPD	Pre-tax Income			After-tax Income			Cash Flow	
		$000	ROI 2/	ROS 3/	$000	ROI 2/	ROS 3/	$000	Percent of investment
I-Louisiana	2,200	(36)	(4)	(2)	(36)	(4)	(2)	(9)	(1)
(Stand alone)	3,300	25	1	1	13	.7	.4	69	4
	5,000	227	7	5	118	4	3	223	7
Louisiana	2,200	13	.5	.7	10	.4	.5	84	3
(integrated)	3,300	71	2	2	43	1	1	157	4
	5,000	270	5	6	147	3	3	321	6
II-Florida	6,000	1,622	29	13	843	15	7	1,110	20
	10,000	4,530	27	19	2,356	14	10	3,166	19
III-Hawaii (Hilo Coast)	1,800	58	2	1	37	1	.5	183	6
(Stand alone)	3,300	263	5	2	143	3	1	501	10
	4,800	1,106	18	6	582	9	3	1,030	16
Hawaii (Hilo Coast)	3,300	1,632	18	13	855	9	7	1,747	19
(Integrated)	4,800	3,253	27	18	1,698	14	10	2,792	23
IV-Hawaii (Other)	1,800	(41)	(1)	(.6)	(41)	(1)	(.6)	109	3
	3,300	478	7	4	255	4	2	531	8
	4,800	985	11	5	519	6	3	920	11
V-Puerto Rico	4,500	(326)	(9)	(6)	(326)	(9)	(6)	(224)	6
	8,000	776	15	7	410	8	4	600	11

1/ Capacity stated in gross tons of cane per day, except Hawaii, where net tons per day are used.

2/ Return on book investment

3/ Return on sales

duplicate any one plant. Table II-5 summarizes the parameters used in developing the detailed pro forma tables. Tables II-6 through II-9 present detailed pro forma statements for each of the 18 model plants. The assumptions which were used in calculating values are explained below. Generally, the model plant estimates are based on the best available information concerning industry practices and procedures. While the estimates are reliable guides, they should not be taken literally for any given operating plant.

The parameters shown in Table II-5 are three to five year averages which reflect the regional variations in growing seasons (operating days), capacity utilization, the ratio of net to gross cane weight and the sugar content of cane. The cost structures and pro forma income statements were calculated with these parameters. Except for Hawaii, stated daily capacities are in gross cane.

Grower-mill integration varies so greatly both within and among geographical areas that "typical" firms do not exist. Because of the high percentage of integrated operations in Louisiana and Hawaii (the Hilo Coast) and because, too, pollution control impacts are likely to be most severe in these areas, models reflecting these areas' integrated operations were constructed. Not enough data were available to construct similar models for Puerto Rico.

<u>Annual Profits After Taxes</u> - Table II-4 indicates that 15 of the 18 model mills were profitable under 1973 conditions and that all but two had positive cash flows.

In Subcategory I - Louisiana, the smallest "stand alone" model mill (2,200 T PD) was unprofitable and had a negative cash flow. The medium-sized model mill (3,300 TPD) showed a very small profit, while the largest (5,000 TPD) earned a modest return on investment. These same model mills when integrated with a cane farm were slightly more profitable in all three size categories (the smallest integrated model produced a very small profit). It should be noted, however, that the small and medium-sized integrated models were only slightly above break-even and that the largest model had only a 3 percent return on investment.

Both model mills in Subcategory II - Florida showed good returns: the smaller mill had an after tax return of 7 percent on sales and 15 percent on investment; the larger one returned 10 and 14 percent.

Table II- 5. Parameters of operation for developing model sugar cane mills

Subcategory	I--Louisiana			II-Florida		III-Hawaii (Hilo Coast)			IV-Hawaii (Other)			V-Puerto Rico	
Tons Cane per day 1/	2,200	3,300	5,000	6,000	10,000	1,800	3,300	4,800	1,800	3,300	4,800	4,500	8,000
Operating days	70	70	70	110	120	230	219	236	182	182	182	100	100
Raw Sugar cwt/Ton	1.67	1.72	1.79	2.09	2.15	2.01	2.35	2.33	2.32	2.32	2.32	1.54	1.54
Ratio Net Cane to Gross Cane	.86	.86	.86	1.00	1.00	.50	.50	.50	.50	.50	.50	1.00	1.00
Utilization of capacity, percent	75	75	75	82	82	88	82	74	90	90	90	70	70
Raw sugar per year, 000 cwt	166	256	404	1,150	2,064	733	1,394	1.953	684	1,255	1,824	485	862

1/ Nominal capacities of all model plants except Hawaii are shown as gross tons of cane per day.

Table II-6a. Pro forma income statements and financial returns for selected non-integrated model plants in Subcategory I - Louisiana, 1973

Gross tons cane per day	2,200		3,300		5,000	
	($1,000)	(% sales)	($1,000)	(% sales)	($1,000)	(% sales)
Invested capital	866		1,749		3,162	
Sales						
Raw Sugar	1,708	90	2,634	90	4,157	90
Molasses	195	10	302	10	477	10
Total Sales	1,903	100	2,936	100	4,634	100
Direct expenses						
Cost of cane[1/]	1,296	68	1,943	66	2,961	64
Cost of milling	490	26	730	25	1,091	24
Total direct expense	1,786	94	2,673	91	4,052	87
Indirect expenses	123	6	177	6	242	5
Total operating expenses	1.909	100	2,850	97	4,294	93
Depreciation	27	1	56	2	105	2
Interest (long term)	3	<1	5	<1	8	<1
TOTAL COSTS	1,939	102	2,911	99	4,407	95
Net income before tax	(36)	(2)	25	1	227	5
Net income after tax	(36)	(2)	13		118	3
Cash flow	(9)	(.5)	69	2	223	5
Net income before tax as percent of invested capital	(4)		1		7	
Net income after tax as percent of invested capital	(4)		1		4	

Note: Percentages may not add to 100 percent due to rounding. Sales based on parameters in Table II-5.

1/ Includes costs for transporting cane of $.81, $.58 and $.33 per cwt. of sugar.

Table II-6b. Pro forma statements and financial returns for selected model integrated operations, Subcategory I -- Louisiana, 1973

Gross Tons per Day	2,200		3,300		5,000	
	($1,000)	(% sales)	($1,000)	(% sales)	($1,000)	(% sales)
Invested capital	2,405		3,569		5,262	
Sales						
Raw sugar	1,708	90	2,634	90	4,157	90
Molasses	195	10	302	10	477	10
Total	1,903	100	2,936	100	4,634	100
Direct expenses						
Cost of purchased cane 1/	685	36	1,204	41	2,108	46
Plantation production cost 2/	369	19	511	17	604	13
Costs of milling	490	26	730	25	1,091	24
Total	1,544	81	2,445	83	3,803	82
Indirect expenses						
Mill overhead	123	7	177	6	242	5
Plantation overhead	111	6	81	3	95	2
Total	234	12	258	9	328	7
Depreciation	74	4	114	4	174	4
Interest (long term)	38	2	48	2	59	1
Total costs	1,890	99	2,865	98	4,364	94
Net income before tax	13	1	71	2	270	6
Net income after tax	10	1	43	1	147	3
Cash flow	84	4	157	5	321	7
Net income before tax as percent of invested capital	0.5		2		5	
Net income after tax as percent of invested capital	0.4		1		3	

1/ Includes transportation costs per cwt of sugar of $1.26, $.84 and $.46.

2/ Assumes administration cane as a percent of total cane of 50, 40 and 30.

Note: Percentages may not total 100 due to rounding. Sales based on parameters in Table II-5.

Table II-7. **Pro forma income statements and financial returns for selected model plants,** in Subcategory II - Florida and Texas, 1973

Gross tons cane per day	6,000		10,000	
	($1,000)	(% sales)	($1,000)	(% sales)
Invested capital	5,625		17,000	
Sales				
Raw Sugar	11,834	92	21,239	91
Molasses	1,058	8	2,023	9
Total Sales	12,892	100	23,262	100
Direct expenses				
Cost of cane 1/	7,144	55	12,470	54
Cost of milling	2,829	22	4,396	19
Total direct expense	9,973	77	16,866	73
Indirect expenses	868	7	991	4
Total operating expenses	10,841	84	17,857	77
Depreciation	267	2	810	3
Interest (long term)	162	1	216	1
TOTAL COSTS	11,270	87	18,732	81
Net income before tax	1,622	13	4,530	19
Net income after tax	843	7	2,356	10
Cash flow	1,110	9	3,166	14
Net income before tax as percent of invested capital	29		27	
Net income after tax as percent of invested capital	15		14	

Note: **Percentages may not add to 100 percent due to rounding.** Sales based on parameters in Table II-5.

1/ Includes transportation costs.

Table II-8a. Pro forma income statements and financial returns for selected, non-integrated model plants, Subcategory III - Hawaii (Hilo Coast), 1973

Net Tons per Day	1,800		3,300		4,800	
	($1,000)	(% sales)	($1,000)	(% sales)	($1,000)	(% sales)
Invested capital	3,270		4,950		6,300	
Sales						
Sugar	6,634	95	11,354	90	15,907	90
Molasses	337	5	641	5	898	5
Processing fees	--		568	5	795	5
Total	6,971	100	12,563	100	17,600	100
Direct expenses						
Cost of cane 1/	5,204	74	8,193	65	11,478	65
Cost of milling	1,100	16	2,342	19	2,617	15
Total	6,304	90	10,535	84	14,095	80
Indirect expenses	403	6	1,255	10	1,758	10
Depreciation	146	2	358	3	448	3
Interest	60	1	152	1	193	1
Total costs	6,913	99	12,300	98	16,494	94
Net income before tax	58	1	263	2	1,106	6
Net income after tax	37	.5	143	1	582	3
Cash flow	183	2.5	501	4	1,030	6
Net income before tax as percent of invested capital	2		5		18	
Net income after tax as percent of invested capital	1		3		9	

1/ Includes transportation costs.

Note: Percentages may not total 100 due to rounding. Sales based on parameters in Table II-5.

Table II-8b. Pro forma income statements and financial returns for selected model integrated operations, Subcategory III - Hawaii (Hilo Coast), 1973

Net Tons per Day	3,300		4,800	
	($1,000)	(% sales)	($1,000)	(% sales)
Invested capital	9,070		11,950	
Sales				
Raw sugar	11,354	90	15,907	90
Molasses	641	5	898	5
Processing fees	568	5	795	5
Total	12,563	100	17,600	100
Direct Costs 1/				
Plantation	4,128	33	5,783	33
Mill	2,342	19	2,500	14
Total	6,470	52	8,283	47
Indirect costs	3,206	26	4,492	26
Depreciation	892	7	1,094	6
Interest	363	3	478	3
Total costs	10,931	87	14,347	82
Net income before tax	1,632	13	3,253	18
Net income after tax	855	7	1,698	10
Cash flow	1,747	14	2,792	16
Net income before tax as percent of invested capital	18		27	
Net income after tax as percent of invested capital	9		14	

1/ Includes transportation costs.

Note: Percentages may not total 100 due to rounding. Sales based on parameters in Table II-5.

Table II-8c. Pro forma income statements and financial returns for selected model plants, Subcategory IV, - Hawaii (other), 1973

Net Tons per Day	1,800		3,300		4,800	
	($1,000)	(% sales)	($1,000)	(% sales)	($1,000)	(% sales)
Invested capital	4,250		6,650		8,650	
Sales						
Raw sugar	6,190	91	11,358	91	16,507	91
Molasses	595	9	1,092	9	1,587	9
Total	6,785	100	12,450	100	18,094	100
Direct Expenses						
Cost of Cane 1/	5,130	76	9,412	75	13,680	76
Cost of Milling	1,081	16	1,456	12	1,860	10
Total	6,211	92	10,868	87.	15,540	86
Indirect Expense	390	6	640	5	821	5
Depreciation	150	22	276	2	401	2
Interest	75	1	188	2	347	2
Total Costs	6,826	100.6	11,972	96	17,109	95
Net income before tax	(41)	(.6)	478	4	985	5
Net income after tax	(41)	(.6)	255	2	519	3
Cash Flow	109	1.6	531	4	920	5
Net income before tax as percent of invested capital	<0		7		11	
Net income after taxes as percent of invested capital	<0		4		6	

1/ Includes transportation costs.

Nore: Percentages may not total 100 due to rounding. Sales based on parameters in Table II-5.

Table II-9. Pro forma income statements and financial returns for selected model plants in Subcategory V - Puerto Rico, 1973

Capacity - gross tons cane per day	4,500		8,000	
	$1,000	% sales	$1,000	% sales
Invested capital	3,460		5,230	
Sales				
Raw Sugar	4,991	87	8,870	87
Molasses	776	13	1,379	13
Total Sales	5,767	100	10,249	100
Direct Expenses				
Cost of cane 1/	3,371	58	5,991	58
Cost of milling	2,086	36	2,534	25
Total direct expense	5,457	94	8,525	83
Indirect expenses	490	8	672	7
Total operating expenses	5,947	102	9,197	90
Depreciation	102	2	190	2
Interest (long term)	44	1	86	1
TOTAL COSTS	6,093	105	9,473	93
Net income before tax	(326)	(6)	776	7
Net income after tax	(326)	(6)	410	4
Cash flow	(224)	(4)	600	6
Net income before tax as percent of invested capital	(9)		15	
Net income after tax as percent of invested capital	(9)		8	

Note: Percentages may not add due to rounding. Sales based on parameters in Table II-5.

1/ Includes $.60/cwt of sugar for transporting cane.

In Subcategory III-Hawaii (Hilo Coast), the stand-alone model mills were all profitable, although the 1,800 TPD mills and 3,300 TPD mills indicated very low returns on sales and investment. On an integrated basis, the 3,300 and 4,800 TPD model mills showed substantial profits and cash flows. No integrated model was developed for the 1,800 TPD mill because such an integrated operation does not exist in this size category.

The Subcategory IV-Hawaii (Other) small model mill (stand alone) operated at a loss, but with a positive cash flow of $109,000. The medium and large-sized model mills had modest returns on sales and investment. Since Subcategory IV model mills meet pollution control standards and no impact analysis was needed, no integrated models were developed for this subcategory.

For Subcategory V-Puerto Rico, the 4,500 TPD model mill had a loss of $326,000 and a negative cash flow of $224,000. The 8,000 TPD mill showed a profit of $410,000 and a cash flow of $600,000. The data from which these estimates were compiled are less reliable than those used for other subcategories and may overstate profitability somewhat. Furthermore, there are no reliable data to estimate the influence of integration on the Puerto Rican model mills.

5. Invested Capital

Tables II-10 through II-13 present the estimated investment in capital for the model mills. In Louisiana (Table II-10), lower book values reflected the age of the plants, when compared to those of other areas. Of the depreciable assets, buildings accounted for approximately 25 percent with the rest of the investment in equipment.

Table II-11 shows that the Florida mills were larger with a proportionately greater investment. These mills had a higher book value because they were built since 1960.

Table II-12 shows the higher land values in Hawaii where land is scarce. Investments in the Hawaiian mills are so closely tied to the plantations that it was not always possible to separate plantation from mill investment; however, the Hawaiian plants enjoy a relatively higher annual throughput than other U. S. sugar mills because of their longer operating season.

For Puerto Rico, plant data was particularly difficult to find. Best estimates appear in Table II-13. Many of these plants were operating below capacity, in part because of a shortage of cane.

Table II-10a. Estimated invested capital and salvage value of assets for non-integrated model plants in Subcategory I - Louisiana, 1973

	Small 2,200 TPD 1/			Medium 3,300 TPD 1/			Large 5,000 TPD 1/		
	Book value ($1,000)	Percent salvage	Salvage value ($1,000)	Book value ($1,000)	Percent salvage	Salvage value ($1,000)	Book value ($1,000)	Percent salvage	Salvage value ($1,000)
Net working capital	360	100	360	767	100	767	1,373	100	1,373
Land	30	100	30	40	100	40	50	100	50
Buildings	119	5	6	236	5	12	435	5	22
Equipment	357	10	36	706	10	71	1,304	10	130
Total fixed assets	506	13	72	982	13	123	1,789	11	202
Total investment	866	53	456	1,749	52	890	3,162	50	1,575
Estimated current replace-ment, cost of fixed assets	3,000 2/			3,800 2/			4,900 2/		

1/ Capacity in gross tons cane per day.

2/ Replacement costs estimated at $360, $300, and $245 per annual ton of sugar.

Table II-10b. Estimated invested capital and salvage value for integrated model operations in Subcategory I - Louisiana, 1973

Capacity - gross TPD	2,200			3,300			5,000		
	Book value	Percent salvage	Salvage value	Book value	Percent salvage	Salvage value	Book value	Percent salvage	Salvage value
	($1,000)	(%)	($1,000)	($1,000)	(%)	($1,000)	($1,000)	(%)	($1,000)
Net working capital	520	100	520	992	100	992	1,653	100	1,653
Land	1,130	100	1,130	1,340	100	1,340	1,550	100	1,550
Buildings	199	5	10	321	5	16	525	5	26
Equipment	557	10	56	916	10	92	1,534	10	153
Total investment	2,406	71	1,716	3,569	68	2,440	5,262	64	3,382

Table II- 11. Estimated invested capital and salvage value of assets for model plants in Subcategory II - Florida and Texas, 1973

	Small 6,000 TPD 1/			Large 10,000 TPD 1/		
	Book value	Percent salvage	Salvage value	Book value	Percent salvage	Salvage value
	($1,000)		($1,000)	($1,000)		($1,000)
Net working capital	1,125	100	1,125	3,400	100	3,400
Land	50	100	50	85	100	85
Buildings	1,100	5	55	3,378	5	167
Equipment	3,350	10	335	10,137	10	1,014
Total fixed assets	4,500	10	440	13,600	9	1,266
Total investment	5,625	28	1,565	17,000	27	4,666
Estimated current replacement Cost of fixed assets	14,400 2/			19,600 2/		

1/ Capacity in gross tons cane per day.

2/ Replacement costs estimated at $250 and $190 per annual ton of sugar.

Table II-12a. Estimated invested capital and salvage value for non-integrated model plants in Subcategory III-Hawaii (Hilo Coast), 1973

Capacity-net TPD	1,800			3,300			4,800		
	Book value ($1,000)	Percent salvage	Salvage value ($1,000)	Book value ($1,000)	Percent salvage	Salvage value ($1,000)	Book value ($1,000)	Percent salvage	Salvage value ($1,000)
Net working capital 1/	420	100	420	750	100	750	1,100	100	1,100
Land	250	100	250	250	100	250	250	100	250
Buildings	500	5	25	750	5	38	950	5	48
Equipment	2,100	10	210	3,200	10	320	4,000	10	400
Total investment	3,270	28	905	4,950	27	1,358	6,300	29	1,798
Estimated current replacement cost of fixed assets	12,000 2/			17,000 2/			21,000 2/		

1/ 6 Percent of sales.

2/ Replacement costs estimated at $325, $250, and $220 per annual tons of sugar.

Source: Industry data.

Table II-12b. Estimated invested capital and salvage value for non-integrated model plants in Subcategory IV-Hawaii (Others), 1973

Capacity-net TPD	1,800			3,300			4,800		
	Book value	Percent salvage	Salvage value	Book value	Percent salvage	Salvage value	Book value	Percent salvage	Salvage value
	($1,000)		($1,000)	($1,000)		($1,000)	($1,000)		($1,000)
Net working capital 1/	1,000	100	1,000	1,900	100	1,900	2,700	100	2,700
Land	250	100	250	250	100	250	250	100	250
Buildings	500	5	25	800	5	40	1,000	5	50
Equipment	2,500	10	250	3,700	10	370	4,700	10	470
Total investment	4,250	36	1,525	6,650	38	2,560	8,650	40	3,470
Estimated current replacement cost of fixed assets	11,000 2/			15,700 2/			20,000 2/		

1/ 15 Percent of sales.

2/ Replacement costs estimated at $325, $250, and $220 per annual ton of sugar.

Table II-12c. Estimated invested capital and salvage value for model integrated operations in Subcategory III-Hawaii (Hilo Coast), 1973

Capacity - net TPD	3,300			4,800		
	Book value ($1,000)	Percent salvage	Salvage value ($1,000)	Book value ($1,000)	Percent salvage	Salvage value ($1,000)
Net working capital	750	100	750	1,100	100	1,100
Land	1,850	100	1,850	2,650	100	2,650
Buildings	1,550	5	78	1,900	5	96
Equipment	4,920	10	492	6,300	10	630
Total Investment	9,070	35	3,170	11,950	37	4,476

Table II-13. Estimated invested capital and salvage value of assest for model plants in Subcategory V-Puerto Rico, 1973

	Medium 4,500 TPD 1/			Large 8,000 TPD 1/		
	Book value	Percent salvage	Salvage value	Book value	Percent salvage	Salvage value
	($1,000)		($1,000)	($1,000)		($1,000)
Net working capital	751	100	751	1,230	100	1,230
Land	170	100	170	200	100	200
Building	839	5	42	1,250	5	63
Equipment	1,700	10	170	2,550	10	255
Total fixed assets	2,709	14	382	4,000	13	518
Total investment	3,460	33	1,133	5,230	33	1,748
Estimated current replacement, cost of fixed assets	6,000 2/			8,500 2/		

1/ Capacity in gross tons of cane per day.

2/ Replacement costs estimated at $250 and $200 per annual ton of sugar.

Salvage Value - Estimated salvage values (or the sunk investment) for the 18 model mills are also shown in Tables II-10 through II-13 and assume a complete recovery of working capital and the book value of land. Though book values may understate land salvage values, this report assumed that only a recovery of book value is possible. Rates of 5 percent of book value as the salvage rate for buildings and 10 percent for equipment were used.

6. Cost Structure

Estimated sales and cost data for the model plants are shown in Appendix Tables 6-9. The data were based on average sugar prices, molasses prices and costs of cane as reported by the Department of Agriculture for 1973. Variations in the cost patterns in the geographic areas reflected differences in the percentage recovery of raw sugar and molasses. Differences in the cost of cane also reflected variations in sugar values resulting from different crops and growing conditions. The prices of cane paid to growers in Louisiana, Florida, and Puerto Rico are published in the Sugar Reports. The cost paid to the grower represented the cost of cane as a raw material to the mill. In Hawaii, however, the published costs differed because of accounting procedures. The Hawaiian mills, integrated with plantations, did not use a fixed cost of cane; therefore, in Appendix Tables 8a, 8b and 8c the cost of cane may vary somewhat from actual mill costs.

Most depreciation costs were approximately 7 percent of the book value of depreciable assets. Interest costs were 8 percent of the long term indebtedness.

B. Distribution of Data

Table II-4 presented the after-tax profits, return on sales and invested capital, and the cash flows for the model plant configurations. Since each model plant is included in Table II-4, the summary will not be repeated here.

C. Ability to Finance New Investment

The ability of a firm to finance a new investment for pollution abatement equipment is a function of several critical financial and economic factors. In general terms, new capital must come from one or more of the following sources: (1) funds borrowed from outside sources; (2) equity capital through the sale of common or preferred stock; (3) internally generated funds--retained earnings and the stream of funds attributed to depreciation of fixed assets.

For each of the three major sources of new investment, the most critical set of factors was the financial condition of the individual firm. Because the financial condition for specific producers was not known, model plant analysis provided estimates of financial strength and showed that conditions varied by geographic location. These variations are discussed below. It must be remembered, of course, that general economic conditions greatly influence a firm's ability to finance new investment.

The general economic outlook of the next few years is ambiguous because of uncertainties surrounding economic policies and the critical shortages of many basic resources, especially energy. Rates of economic growth, unemployment and inflation are subject only to speculative thinking. The rate of economic growth, down since the fourth quarter of 1973, is continually influenced by inflation and energy problems. Recovery to the historic annual growth rate of 3.5 percent will probably not occur prior to the last half of 1975. Unemployment rose in 1974, and also affected growth rates and patterns. Inflation, which soared in 1974 to annual rates above 10 percent, cannot be expected to drop below 5 to 6 percent in the immediate future.

These conditions will strongly affect the availability and costs of capital for pollution control. In the search for new energy sources and new production technologies, both public and private institutions will continue to exert a heavy demand on capital funds, more than offsetting any decline in private investment demand resulting from economic slowdown. This will keep upward pressure on money rates. In addition, inflation will push interest rates higher as lenders demand a larger inflation premium. In the next few years, capital funds are likely to be available, but at rates approaching the historically high levels of 1969-70 when long-term, high grade corporate bonds yielded 9 to 10 percent. The cost of financing any new investment will be high when compared to that of the 1950's and early 1960's.

Section II-A contains a discussion of the profitability, capital structure and cost of capital for the industry and for the segments under consideration. New financing capabilities varied by geographic region. The cane sugar milling industry could finance new investment in Florida, but many operators in Louisiana appeared to be in no condition to attract new funds. Although the small Hilo Coast plants were operating on thin margins, Hawaiian owners, in general, appeared to be in a resonably strong financial position with low debt-equity ratios and substantial cash flows. Under government operations in Puerto Rico, quite different financial constraints existed, thus, the ability to finance new investment depended in part on tax revenues as well as industry profitability.

There are some additional factors which may influence the ability of a particular firm to finance pollution control costs. First, government price policy for raw sugar will affect the profitability of cane sugar milling. Because, for instance, raw sugar prices, which will be discussed in Chapter III, cannot be controlled by the mill operators, this factor is beyond the owners' direct control.

Second, government benefit payments to cane growers can affect mill profitability in those instances in which the cane land and the cane mill are under common ownership. The profit on the total operation (growing-milling) may be adequate to support the new investment even though the mill operation by itself might be marginal or unprofitable.

Third, the increasing interest in cooperatives in Louisiana, where growers have united to purchase several mills, give growers a special stake in keeping mills operating since they are dependent on nearby mills for the disposal of their harvested cane. A growers' cooperative, providing cane growing is profitable, could conceivably finance any new investment for pollution control in order to keep a mill open.

Fourth, integrated mill-refining operations may also provide more financial strength for a new investment than would a "stand-alone" mill. A profitable refinery, desirous of maintaining a captive source of raw sugar, may be capable of supporting pollution control investment.

In summary, some firms in the cane sugar milling industry should be able to finance the required new investment, while others will find such financing either most difficult or impossible under 1973 prices. With higher prices, new investment could be handled relatively easily by all firms, but, as discussed in Chapter III, future price levels are most uncertain.

III. PRICING

The pricing of raw sugar, the primary product of the cane milling industry is complex. First, the demand for raw sugar is derived from the final demand for sweeteners in general. Second, raw sugar is traded extensively throughout the world. Third, raw sugar production, trade and prices in the United States and most countries have been highly regulated by governments, either unilaterally or multilaterally. Fourth, the United States, the world's largest importer, has apparently decided to remove all production subsidies and all sugar trade regulations in favor of free trade. Fifth, the world sugar economy is currently extremely volatile, with prices increasing over 400 percent in recent months. These various factors must be considered in understanding raw sugar prices.

A. Demand

1. Consumption

Virtually all domestic sugar is consumed as human food. U. S. per capita sugar consumption (Table III-1) has been fairly stable since the 1930's, ranging between 90 and 100 pounds per capita. Recent per capita increases to above 100 pounds are attributed to the Food and Drug Administration's restrictions on the use of cyclamates. Sugar and corn sweeteners (corn syrup and dextrose) are known as caloric sweeteners while cyclamates and saccharine are called noncaloric sweeteners. Since cyclamate sweeteners have been limited, the noncaloric sweetener segment has declined slightly, representing less than five percent of total per capita consumption on a sugar equivalent basis (Table III-1). Corn sweeteners have shown the most significant growth since 1950, but they still represent less than 20 percent of total sweetener consumption.

About two-thirds of all sugar is consumed in industrial uses, especially by food processing industries. Only one-fourth is purchased for personal home use. The remainder is used in restaurant and institutional meal preparation.

Industrial uses for sugar are found mainly in the food industries, including beverages (Table III-2). The beverage industry is the largest user of sugar and has made little use of corn sweeteners as a sugar substitute. The beverage industry is also the highest user of noncaloric sweeteners. Baking, the next largest user, has dropped its use of sugar slightly. Confectionary and canning uses are the next largest users.

Table III-1. Total sugar consumption and per capita consumption of sweeteners by type in the United States, 1950 to 1973

Year	Total sugar consumption 1/	Per capita					
		Caloric					
		Refined sugar	Corn sweeteners		Other	Total caloric	Non-caloric
			Corn syrup	Dextrose			
	million short tons	----------------lbs - sugar equivalent basis -----------					
1950	8.0	100.6	9.2	4.5	3.5	117.8	2.9
1960	9.0	97.6	10.1	3.7	2.5	113.9	2.2
1967	10.2	97.1	14.0	4.6	2.0	117.7	6.9
1969	10.6	99.9	15.0	4.8	2.2	121.9	6.9
1970	11.4	102.5	16.0	4.9	1.8	125.2	6.2
1971	11.3	102.4	16.2	5.2	1.7	125.5	5.7
1972	11.4	102.4	16.5	5.2	1.8	125.9	5.7
1973	11.4	102.4	NA	NA	NA	NA	NA

1/ Tons of raw sugar equivalent, 107 tons raw sugar equals 100 tons refined sugar.

Source: National Food Situation, Feb., 1973, USDA and subsequent issues.

Table III-2 Refined sugar consumption (deliveries) by use, 1950 to 1973

	Year							
	1950	1960	1967	1969	1970	1971	1972	1973
	Million short tons							
Industrial use								
Cereal and bakery products	.6	1.0	1.3	1.3	1.5	1.4	1.4	1.5
Confectionary products	.7	.8	1.0	1.0	1.1	1.1	1.0	1.0
Processed foods 1/	.6	.8	.8	.9	.9	1.0	1.0	1.0
Dairy products	.3	.4	.5	.5	.5	.6	.6	.6
Other food users	.2	.3	.4	.4	.4	.5	.5	.5
Subtotal	2.4	3.3	4.0	4.1	4.4	4.6	4.5	4.6
Beverages	.8	1.1	1.8	2.1	2.4	2.4	2.4	2.5
Total	3.2	4.4	5.8	6.2	6.8	7.0	6.9	7.1
Nonindustrial use								
Wholesalers	3.0	2.5	2.2	2.1	2.2	2.2	2.1	2.1
Retailers	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3
Other	.1	.2	.2	.2	.2	.2	.2	.2
Total	4.3	3.9	3.6	3.5	3.7	3.7	3.6	3.6
Total 2/	7.5	8.3	9.4	9.7	10.5	10.7	10.5	10.7

NOTE: 107 tons of raw sugar equals 100 tons of refined sugar.

1/ Fruits and vegetables and related products.
2/ Data may vary slightly from estimated consumption due to coverage differences.

Source: National Food Situation, February, 1973, USDA, and Sugar Reports, March 1974, USDA.

2. Substitutes

As indicated above, substitutes for sugar exist. Noncaloric sweeteners are used to meet the demands of those consumers seeking to limit sugar intake. Some substitution of noncaloric sweeteners for sugar is associated with relative price changes. However, for the noncaloric sweeteners, quality considerations appear to be more important. The future of noncaloric sweeteners is uncertain, and will depend heavily upon technological development relative to satisfying Federal Drug Administration clearances. For instance cyclamates were banned by FDA in 1970 after reaching a per capita consumption level of 1.6 pounds sugar equivalent basis (about one percent of total sweetener consumption). Presently G. D. Searles Company has received Federal Drug Administration clearance for an artificial product sweetener, but due to technical limitations, it is limited to table use only. However, if this product can be developed into a stable liquid form, it seems probable that it would find a large market in the canning and beverage industries. The likelihood of this development is not known, but with the incentive of today's high sugar prices, one could conjecture that research and development to create a liquid form would be underway.

Corn sweeteners (corn syrup and dextrose) are sugar's major competitor. Since corn sweeteners are used almost exclusively in the industrial markets, this substitution does not have a major effect on the household use of sugar.

Corn sweeteners represent nearly 20 percent of the total sweetener market (about 25 percent of the industrial sweetener market) compared to about 12 percent in 1950. The consumption of corn sweeteners, which increased from 1.2 million tons in 1960 to 2.1 million tons in 1972, is continuing.

A variety of technological factors have influenced this past and possible future growth. Key factors include:

1. Iso-enzymes are being used to convert at least part of the dextrose in corn syrup to levulose, a much sweeter carbohydrate than dextrose (e.g., about a 140 to 150 percent dextrose equivalent rating). Levulose can be mixed in various ratios with other corn syrups to produce syrups for different uses.

2. Corn syrup is now being used as a fermentation adjunct in the brewing industry. Begun by the Schlitz Brewing Company, this process, having improved quality control, is expected to be used by other brewers.

3. Corn syrups are liquids and, despite viscosity problems, especially in cold climates, the more automated processing industries can better utilize liquid ingredients which can be pumped.

4. Some major soft drink bottlers use a portion of corn syrups in certain diet drinks and may increase their use.

In addition to these technological factors, corn sweetener prices have been favorable relative to sugar prices as shown in Table III-3. A price war, beginning in December 1971, among the corn syrup producers dropped the equivalent cost of corn syrup relative to sugar from 70 percent to 44 percent. Even with the increase of corn syrup prices from a low of 5.78 cents to 15.23 cents per pound in New York July, 1974, the price was only 35 percent of the equivalent sugar price in the Northeast (Table III-3), due to the rapid increase in sugar prices.

A more rapid shift has also been limited by certain legal restrictions and user resistance. The laws requiring certain food, beverage and confectionary products to contain a given level of sugar have limited corn sweetener substitution. Further, the use of corn syrups requires food manufacturing techniques and equipment changes that food processors have been reluctant to develop.

However, within recent months, user resistance appears to be diminishing in the face of high sugar prices, and increasing numbers of processors are changing or seriously considering changing to liquid facilities and the use of corn syrups. Furthermore, legal constraints on the use of corn syrup in food preparations may be relaxed in the face of very high sugar prices.

In addition to sugar and sweetener related factors, the growth of corn sweeteners is also influenced by the characteristics of the wet corn milling industry. Corn sweeteners are among more than 500 products produced by this industry. Increases in the output of this industry are related to:

- Corn starches - Short-term demand is up in the paper industry. Pulp paper prices are high, and relatively more starch (at lower cost) is desired.

- Corn oil - This important by-product has a strong position in vegetable oil markets and prices are now relatively high.

- Feed by-products - Livestock feed prices have increased sharply and, consequently, so have feed by-product prices.

Although the corn refining process is physically limited in terms of its product mix, the industry has been shifting toward corn syrups at the expense of both starch and dextrose as shown below:

Table III-3. Wholesale prices of sugar, corn syrup, and dextrose

Year	Refined sugar Northeast	Dextrose N.Y.	Corn Syrup N.Y.	Dextrose relative to sugar	Corn syrup relative to sugar
	cents per pound, dry basis				
				(%)	(%)
1961	9.40	8.10	9.00	86	96
1962	9.60	8.04	8.73	84	91
1963	11.94	9.10	9.19	76	77
1964	10.68	8.85	8.36	83	78
1965	10.22	8.70	8.27	85	81
1966	10.36	8.87	8.34	86	81
1967	10.62	9.49	8.40	86	79
1968	10.84	9.49	7.85	86	72
1969	11.44	9.96	8.01	85	68
1970	11.97	10.20	8.45	85	
1971	12.48	10.71	8.77	86	70
1972	13.09	10.07	5.78	77	44
1973	14.07	10.79	8.53	77	60
1974					
January	15.65	11.52	10.85	74	69
February	18.49	11.52	10.85	63	59
March	20.90	11.52	10.85	55	52
April	23.78	11.52	10.85	48	46
May	27.61	11.52	10.85	42	39
June	31.04	11.52	10.85	37	35
July	32.50	16.58	13.45	51	41
August	36.83	n.a.	19.27	n.a.	52
September	40.74	n.a.	15.01	n.a.	37
October	43.59	n.a.	15.23	n.a.	35
Last 12-month ave.	26.80	n.a.	12.53	n.a.	47

Source: Sugar Reports, USDA-ASCS, selected issues.

	1972 (pct)	1973 (pct)
Corn syrups (all types, incl. solids)	45.6	49.0
Corn Sugar	14.6	14.0
Corn Starches (incl. dextrin)	39.8	37.0
	100.0	100.0

Source: Industry sources

The cost of corn syrup production varies directly with the price of corn as shown below:

Price of corn ($/bu)	Cost of Corn Syrup (42 D.E.) ($/lb dry basis)
$1.00	.055
2.50	.095
3.00	.110

Assuming the 1969-1973 ratio of corn syrup prices to sugar prices of 63 percent, $.10 per pound corn syrup would equate to about $.16 per pound sugar. With corn expected to be in the $2.50 to $3.00 per hundred weight range during the next few years, the cost of manufacturing corn syrup should remain in the neighborhood of $.095 to $.110 per pound. At this level, corn syrup appears to be in a favorable competitive position relative to sugar at today's prices.

All of these factors point toward a continued expansion of the corn refining industry and the use of corn sweeteners. Since 1965, total corn ground by the corn refining industry has increased from 204 million bushels to an estimated 310 million bushels in 1974 (Table III-4). Additional refining capacity is under construction or has been announced. Although corn sweeteners will not substitute quickly for sugar, their growth and availability will probably dampen domestic sugar prices.

3. Elasticity Estimates

Extensive elasticity estimates are not available for sugar, particularly on a market segment basis. George and King 1/ have estimated the price elasticity of all sugar at - .24 and corn syrup at -.44. These values indicate demand to be price inelastic, although corn syrup is relatively more elastic as suggested above in the discussion of substitutes. Likewise income has little influence with an income elasticity of .03 for sugar and .174 for corn syrup.

1/ George, P.S. and G. A. King, Consumer Demand for Food Commodities in the U.S. with Projections for 1980, Giannini Foundation, Monograph No. 26, Univ. of Calif., Berkeley, 1971.

Table III-4. Production in the corn refining industry

Year	Total Grind 1/	Percent Annual Change
	(mil. bu.)	
1965	204	--
1966	205	0.5
1967	213	3.9
1968	221	3.8
1969	226	2.3
1970	229	1.3
1971	242	5.7
1972	250	3.3
1973	280 2/	6.9
1974	310	10.7

1/ USDA/ERS estimates

2/ DPRA and industry estimates

For sugar at the household level, Bates and Schmitz[1/] estimate elasticities of -.16 (price) and of .15 (income). These values are comparable to the price and income elasticities for all sugar and corn syrup cited above.

The estimated cross elasticities are relatively high (in relation to other food products). The estimated cross elasticity of sugar (price) with corn syrup (consumption) is .05 and the cross elasticity of corn syrup (price) with sugar (consumption) is .13. [2/] As a point of reference the cross elasticity of beef with pork is .083 and pork with beef is .076.

These estimates are based on long term time series data and cross section data for 1955-56 and 1965-66. Generally, these periods do not contain the current high price levels. Whether or not these relationships hold for high prices is not known nor is it known whether structural changes have occurred, particularly with reference to corn sweeteners via the development of high levulose corn syrup. Furthermore, estimates are not available to identify differences among market segments.

Since household consumption accounts for only about one-quarter of total sugar consumption, one can speculate that the industrial segment too is relatively inelastic with respect to price and income. Because corn syrups are used primarily industrially, these estimates are an approximation of the overall industrial market situation. Although some buyer resistance may occur at the high price levels, it seems probable that sugar and corn syrup are still price and income inelastic and that little consumption change will occur overall in response to changes in these factors. This situation explains in part the current high prices, in that a small change in quantity creates a large price change.

The cross elasticity of sugar and corn syrup suggests the possibility of increased syrup use relative to sugar if sugar prices remain high. Due to the limits of existing corn refining capacity and the time required to expand capacity, the substitution will be limited. However, conversion of existing capacity to high levulose syrups could increase the industry's total sweetening production capability. An increase in corn refining capacity, a greater user acceptance of a "sweeter" product, and some increase in sugar quantity could serve to reduce sugar prices quickly.

1/ Bates, Thomas H. and Andrew Schmitz, A Spatial Equilibrium Analysis of the World Sugar Economy, Giannini Foundation Monograph No. 24, University of California, Berkely, 1969.

2/ George and King, *op. cit.*

B. Supply

1. Supplies

U.S. Sugar production has grown from a 1950 level of 8.2 million short tons to current levels of 11.5 to 12.0 million short tons (Table III-5). Since 1950, imports have consistently represented about 45 to 46 percent of this supply. Domestic production is currently about 55 percent beet sugar and 45 percent cane sugar. This compares to a 1950 situation when beet sugar represented less than 40 percent of total production. Cane sugar production has been relatively stable over the past twenty years ranging from 2.4 to 3.1 million tons. These data show that the growth in the U.S. domestic supply is attributable to increased beet sugar production and imports. Currently, domestically-produced cane sugar contributes only one-quarter of the U.S. sugar supply. Thus, as shown, the world sugar economy is important to the United States.

2. Government Sugar Policy

The U.S. sugar industry has been protected and regulated by the Federal Government since 1789. A quota system of control was initiated in 1934 and has been amended and extended periodically since then. The current legislation governing the industry is the Sugar Act of 1948 as amended in 1971. This legislation became effective January 1, 1972 and extended the Act through December 31, 1974.

The principal provisions of the U. S. sugar program were: 1/

1. the yearly establishment by the Secretary of Agriculture of the total annual U. S. consumption requirements;
2. the allocation of total consumption requirements among domestic cane and beet producing areas and foreign countries;
3. the establishment of import quotas to control shipments by foreign countries of both raw and refined sugar to the United States;
4. the establishment of limits on the quantities of direct-consumption of sugar from Hawaii and Puerto Rico shipped to the continental United States;
5. conditional payments made to domestic producers (including producers in Puerto Rico) for abiding by the terms of the Sugar Act;
6. a tax of $0.50 per hundredweight of raw sugar on all sugar used in the United States;
7. a tariff of $0.625 per hundredweight of raw sugar; and
8. the provisions for the "fair division of the benefits" of the sugar program.

1/ Walter, J. and Peter M. Emerson, Initial Analysis of the Economic Impact of Water Pollution Control Costs Upon the U. S. Cane Sugar Industry, Economic Research Service, U. S. Dept. of Agriculture, Washington, D. C. March, 1973, present a good summary of the provisions of the Sugar Act.

Tabl III-5 United States sugar supply, 1950 to 1973 (in raw sugar) 1/

Year	Beet	Cane	Total	Imports	Total supply
	million short tons				
195C	1.7	2.7	4.4	3.8	8.2
1960	2.2	2.4	4.6	5.0	9.6
1967	2.8	3.1	5.9	4.4	10.3
1969	3.2	2.7	5.9	4.8	10.7
1970	3.6	2.8	6.4	5.2	11.6
1971	3.4	2.5	5.9	5.4	11.3
1972	3.5	2.9	6.4	5.4	11.8
1973	3.4	2.8	6.2	5.3	11.5

1/ 107 tons raw sugar equals 100 tons refined sugar.

Source: National Food Situation, February, 1973 and Sugar Reports, January, 1974, USDA.

The sugar program has greatly influenced the U. S. sugar industry, particularly with respect to maintaining some level of domestic production through higher prices and subsidy payments. Sugar prices in the United States generally have been much higher than those prevailing in the world market (Table III-6). During the past two decades, world prices have exceeded the U. S. price only in 1950-51, 1957, 1963-64 and 1973-74. The first six months of 1974 witnessed a world price well above the U. S. price. Prices in July, 1974, in fact were about three times those of one year earlier. Imported sugar has been sold at the same level as domestically produced sugar.

High U. S. sugar prices have made this country a very desirable market for sugar exporting nations, especially those which did not have other preferred markets such as the United Kingdom or France. The value of the U. S. sugar market to an exporting nation was also affected by the importance of sugar exports to that nation's economy and the share of its sugar exports to the United States. In addition to being a dominant factor in determining domestic sugar prices, the U.S. sugar program, at times, influenced world sugar prices.

When domestic prices have increased, the Secretary of Agriculture has increased the U.S. sugar consumption requirement; this increases supply and lowers domestic prices. In 1950, the increase was from 7.5 million to 8.7 million tons; in 1957, from 8.8 million to 9.3 million tons; in 1963, from 9.8 million to 10.4 million tons; and in 1972 from 11.2 million to 11.8 million tons. More recently, in October, 1973, the requirements for 1974 were raised from 11.8 million tons to 12.5 million tons. In each earlier case, the increased supply of sugar for U.S. consumers moderated the price rise here but, by decreasing supplies available for other importing countries, caused world prices to rise even further than expected. Since the United States is by far the world's largest importer of sugar--taking 20 to 25 percent of the total world trade--unexpected changes in the volume of this country's imports have had an appreciable effect on all other sugar importing and exporting countries.

Current high sugar prices and various other factors apparently led to the expiration of the Sugar Act as of December 31, 1974. Excepting under provisions of the U.S. Tariff Schedules, which authorize the President to set import quotas and tariff rates (which action was announced on 18 November, 1974, for 1975), the U. S. sugar economy is under a free trade situation. Whether or not new legislation will be enacted and what its form may be is unknown. Congress will probably not act until sugar prices significantly decline from present high levels. With other farm programs tending towards minimum price floors below normal market price levels, a similar sugar program may emerge. New legislation would probably also provide for an import quota system. However, vocal and influential consumer interests may prevent prices from remaining much above world prices.

Table III-6. Raw sugar prices in New York and World, 1948-1974

Year	Raw sugar New York (N. Y. delivery)	World price (N. Y. delivery)	Difference	World Price Caribbean Basis Current	World Price Caribbean Basis Deflated 1/
	¢ per pound				
1948	5.54	5.13	.41	4.23	5.29
1949	5.81	5.03	.70	4.16	5.23
1950	5.93	5.82	.11	4.98	6.21
1951	6.06	6.66	-.60	5.67	6.52
1952	6.26	5.08	1.18	4.17	4.71
1953	6.29	4.27	2.02	3.41	3.81
1954	6.09	4.14	1.95	3.26	3.61
1955	5.95	4.19	1.76	3.24	3.56
1956	6.09	4.47	1.62	3.48	3.69
1957	6.24	6.10	.14	5.16	5.28
1958	6.27	4.36	1.19	3.50	3.50
1959	6.24	3.86	2.38	2.97	2.92
1960	6.30	4.09	2.21	3.14	3.04
1961	6.30	3.85	2.45	2.91	2.78
1962	6.45	3.87	2.58	2.98	2.82
1963	8.18	9.41	-1.21	8.50	7.93
1964	6.90	6.79	.11	5.87	5.40
1965	6.75	3.07	3.68	2.12	1.91
1966	6.99	2.81	4.18	1.86	1.63
1967	7.28	2.95	4.33	1.99	1.69
1968	7.52	2.96	4.56	1.98	1.62
1969	7.75	4.37	3.38	3.37	2.63
1970	8.07	4.88	3.19	3.75	2.77
1971	8.52	5.65	2.87	4.52	3.19
1972	9.09	8.53	.55	7.43	5.09
1973	10.29	11.99	.70	9.61	6.24
1974					
Jan.	12.63	16.87	-4.24	15.32	9.36
Feb.	17.09	22.84	-5.75	21.18	13.01
Mar.	18.11	22.86	-4.75	21.27	13.00
Apr.	19.25	23.40	-4.15	21.77	13.01
May	23.05	25.40	-2.35	23.65	14.14
June	26.30	25.40	.90	23.67	14.15
July	28.35	27.06	1.29	25.40	14.77
Aug.	32.60	33.08	-.48	31.45	18.29
Sept.	33.71	35.95	-2.24	34.35	19.98
Oct.	38.83	41.29	-2.46	39.63	23.05
Last 12-month aver.	22.70	24.93	-2.23	22.31	NA

1/ Deflated by GNP implicit deflator (1958 = 100).

Source: USDA, ASCS, Sugar Reports.

C. World Sugar Economy

Trade in world sugar has been an important factor in determining U.S. sugar supply under past sugar policies; it may become even more important under free trade.

1. Trade

World sugar trade is highly regulated, with approximately 60 percent moving under preferential and restricted market agreements. The three most important of these agreements in recent years were: (1) imports of sugar into the United States (the largest sugar importer) under the U.S. Sugar Act, (2) imports into the United Kingdom under the Commonwealth Sugar Agreement, and (3) Cuban exports to the USSR and other centrally planned countries. The world free-market sugar trade involves only about 40 percent of total trade. A large part of this market falls under the International Sugar Agreement which was negotiated in 1968 and reinstituted in 1973. The provisions of this agreement are designed to insure that appropriate supplies are available to the free market in order to maintain its stability. Since the United States is not a party to this agreement, U. S. sugar imports have not been subject to its provisions.

Important changes in these international agreements are expected. Both the Commonwealth Sugar Agreement and the U. S. Sugar Act expired at the end of 1974. With the realignment of the Common Market by the joining of the United Kingdom, Denmark, Norway, and Ireland, the EEC will change from a net exporter to a net importer. Even with the expiration of the Commonwealth Sugar Agreement, the developing countries will probably maintain their share of the United Kingdom market. However, with the reduction of the raw sugar requirements of the British refining industry, Australia is expected to gradually withdraw from this market under an agreement between the two countries.

In addition to major agreements regulations, further sugar trade control is exercised by most sugar producing countries. Tariffs are generally imposed by each country on its imports even though the country may not be self-sufficient in sugar production. Countries usually levy taxes on their sugar exports. Such domestic policies partially protect the self-sufficiency of the sugar industries. These policies are reflected in trade practices of countries which are the principal suppliers to the United States.

World sugar exports increased from an average of 19.2 million metric tons during 1965-69 to 21.5 million in 1971. However, in 1972 exports decreased to 21.2 million metric tons (Table III-7). This decrease can be attributed to the harvesting of two successive short world crops, and the rise in consumption in exporting countries. The decline in world exports was partly offset by increases in exports from the European countries brought about by the good beet harvest in 1971-72 and by the exports of Brazil which almost doubled in 1972 from 1971.

World sugar imports amounted to 20.7 million metric tons in 1971 and 20.6 million in 1972. 1/ This represented an increase from an average of 18.6 million tons during 1965-69. The slight decline from 1971 to 1972 reflected a decrease in imports to the East European countries because of their good 1971-72 harvest and also because of short supplies in the USSR and Cuba. Except for Japan, imports decreased for most Asian countries. Trade between major importers and exporters accounts for more than three-fourths of world exports as shown in Table III-7.

The major trading countries and regions are shown in Table III-8. As shown, twelve (12) exporting countries represent about 90 percent of total exports. Cuba is by far the largest exporter; Australia, Brazil, the Philippines, the USSR and the West Indies constitute a second group. Of these exporting countries, the Philippines is the major exporter to the United States.

The United States is the largest importer, representing over one-fifth of total trade, and the USSR is the second largest importer, depending almost solely on exports from Cuba. This points up the uncertainty involved in speculations about the future. Institutional actions involving the United States, the USSR and Cuba could easily restructure world trade patterns and could influence world prices significantly.

2. Consumption

The consumption of sugar has more than doubled during the postwar period. Comparing the three groups of countries, developed, developing and centrally planned, the centrally planned countries have the largest overall growth in consumption while the developed countries have the lowest (Figure III-1). Overall, sugar consumption has increased at a remarkably stable rate.

Although current consumption data are not available, apparently consumption in the developing countries increased at a more rapid rate during 1973 and 1974 than the historical trend.

1/ Reporting and accounting methods result in some slight imbalance between total imports and total exports.

Table III-7. World sugar trade, 1971-1972
(millions of metric tons)

	Imports		Exports	
	1971	1972	1971	1972
World	20.7	20.6	21.5	21.2
Developed Countries	12.7	13.0	4.9	6.5
North America	5.8	5.7	-	-
Canada	.9	.9	-	-
United States	4.8	4.8	-	-
Western Europe	4.2	4.3	2.0	2.7
Oceana	.2	.2	2.1	2.6
Australia	-	-	1.8	2.3
New Zealand	.2	2	-	-
Others	2.5	2.9	.8	1.2
Israel	.1	.1	-	-
Japan	2.4	2.8	-	-
South Africa	-	-	.8	1.2
Centrally Planned	3.4	3.9	2.2	.9
China, Mainland	.5	.8	.1	-
Eastern Europe	1.4	.1	.7	.8
U.S.S.R.	1.5	1.9	1.4	.06
Developing Countries	4.7	3.8	14.3	13.3
Africa	1.7	1.6	1.3	1.3
Latin America	.3	.3	10.5	10.3
Brazil	-	-	1.2	2.1
Cuba	-	-	5.5	4.1
Mexico	-	-	(.5	.5
Dominican Republic	-	-	1.0	1.1
Asia, Philippines	3.1	1.9	2.5	1.7

NOTE: Reporting methods result in some imbalance between total imports and exports.

Source: Foreign Agriculture Circular, U.S.D.A., Foreign Agriculture Service.

Table III-8. Sugar: 1970 Trade Between Major Importers and Exporters

(1,000 short tons, raw value)

Exporters/Importers	Canada	China (mainland)	EC	4 EC entrants 1/	Japan	U.S.S.R.	United States	Other	Total
Australia	326	0	0	478	645	0	212	149	1,810
Brazil	11	0	63	0	175	0	669	327	1,245
China (Taiwan)	0	0	0	0	138	0	86	246	470
Cuba	72	585	5	0	1,346	3,310	0	2,295	7,613
Dominican Republic	0	0	0	0	86	0	728	60	874
Mauritius	183	0	0	477	0	0	19	0	679
Mexico	0	0	0	0	0	0	674	0	674
Peru	0	0	0	0	0	0	444	0	444
Philippines	0	0	0	0	0	0	1,299	0	1,299
South Africa	235	0	0	37	407	0	79	3	761
U.S.S.R.	0	0	1	119	0	0	0	1,553	1,673
West Indies	34	0	0	801	0	0	221	2	1,058
Total	861	585	69	1,912	2,797	3,310	4,431	4,635	18,600

1/ Includes Denmark, Ireland, Norway, and United Kingdom. All exports shown were to the United Kingdom.
Source: ISO Statistical Bulletin, February, 1972.

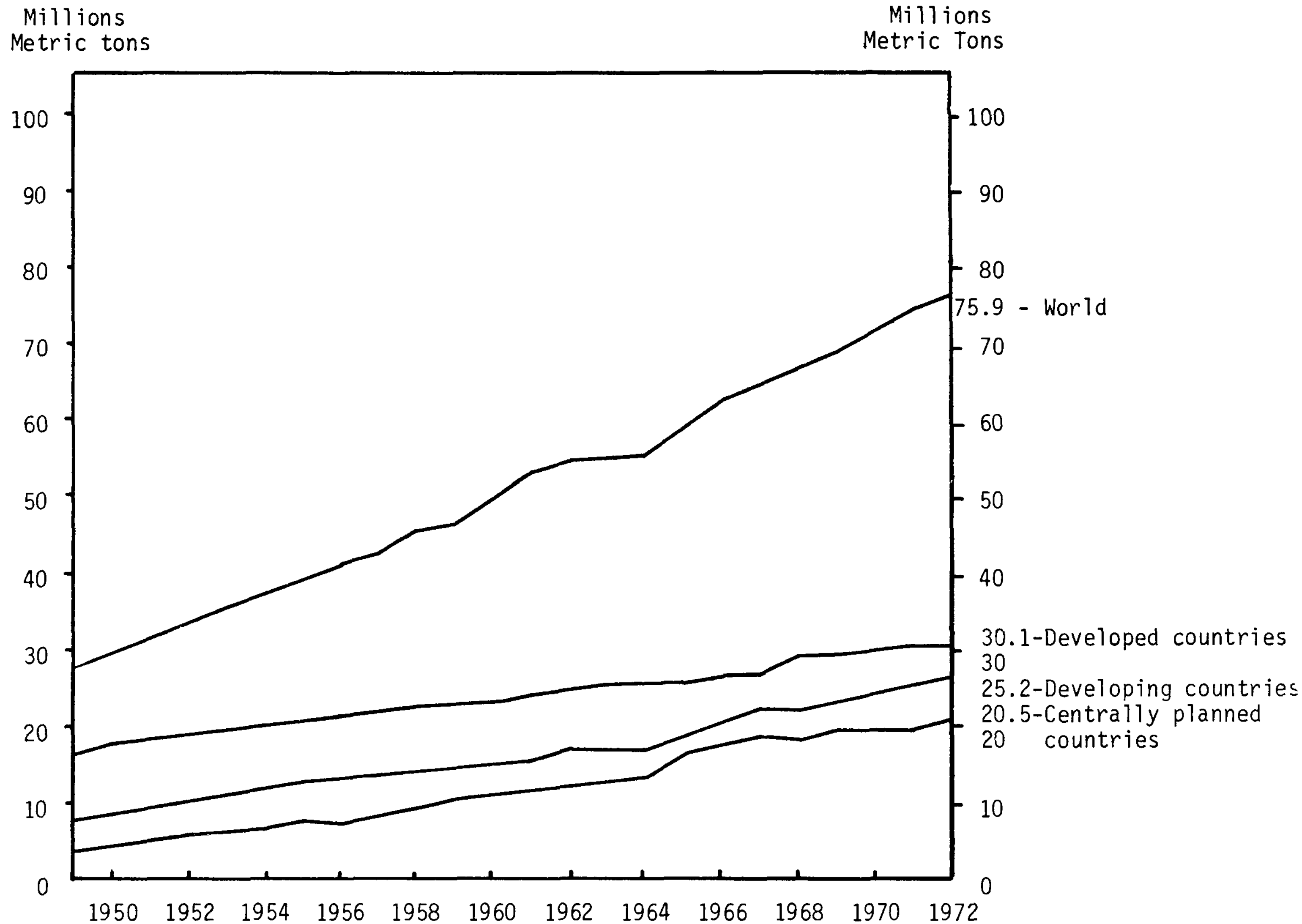


Figure III-1. Centrifugal sugar consumption in the world, 1949-1972

Source: Various publications, Food and Agricultural Organization, Rome.

The worldwide demand for sugar is inelastic. Because of this characteristic, scarcity due to short crops or shipping disruptions causes large price increases, while surpluses drive prices down.

Sugar demonstrates a high income elasticity except in the developed areas of Northern Europe, North America and Oceania where income elasticity approaches zero. The high income elasticities are illustrated in Figure III-2.

3. Stocks

Stocks of sugar have varied widely as shown in Figure III-3. Since 1970 stocks fell steadily from 21 million metric tons to just under 16 million tons in 1973. Although this level was higher than the 10 million ton level of the 1950's and during the Cuban shortfall of 1963 and 1964, stocks as a percent of production were down significantly. Historically, stocks have been 28 to 31 percent of production. In 1963 and 1964, stocks fell to about 20 percent of production, as they did again in 1973, although in absolute terms, 1973 stocks were higher. Stocks in 1974 were at an all-time low of 19 percent. This reflected the condition in which demand exceeded supply and relative stock levels were being worked down.

4. Production

Sugar production grew steadily (Figure III-4) during the past two decades, reaching an estimated 83 million metric tons in 1974. This represents a long-term average growth of 2 million metric tons per year. Production dipped to about 50 million metric tons during the short Cuban crop of 1963. This was followed by a rapid rise in production to 65.5 million metric tons in 1965. Following a decline in 1966, production grew steadily until 1970. From 1970 through 1972, production remained constant. In 1973 and 1974, large production increases occurred, with each year setting new record levels.

The largest single producer of sugar (essentially beet) is the USSR. Cuba is usually the largest producer of centrifugal cane sugar. India actually produces more sugar cane, but over one-half of its cane is processed as farm-made sugar. In regional terms, Europe is the largest producing region, followed by North America. These two industrialized areas have the bulk of the world's beet sugar production. Cane sugar is produced primarily in South America, Africa and Asia (Table III-9).

Cane sugar represented 63 percent of total sugar production while beet sugar accounted for 37 percent in 1973. This represents an increase in cane sugar's share from 59 percent in 1972 and returns cane's dominance to the mid-1950's level (Table III-10).

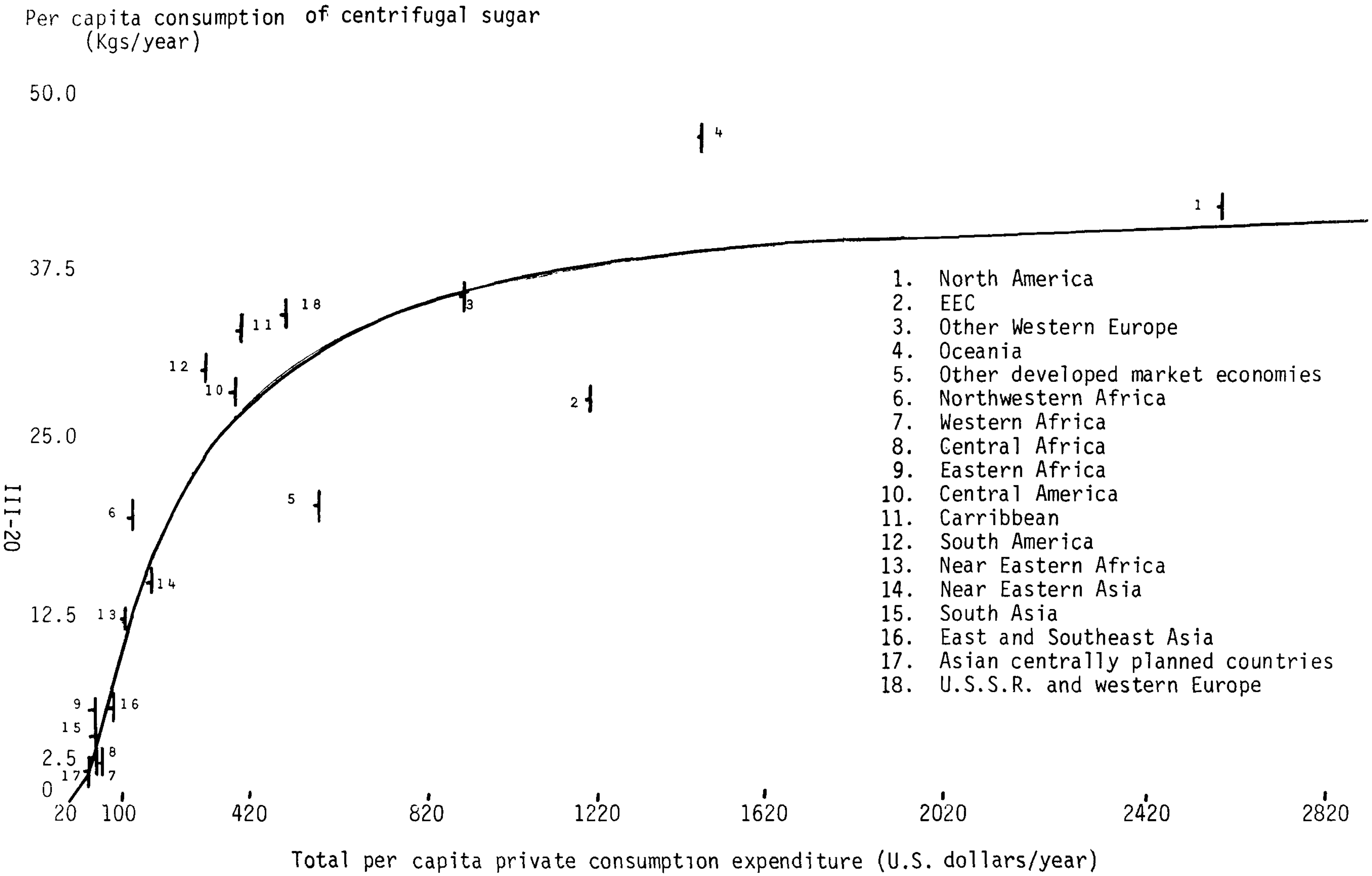


Figure III-2. Per capita consumption and private consumption expenditures for centrifugal sugar, 1965
Source: Agricultural Commodity Projections, 1970-1980, FAO, Vol. 11, Rome 1971.

Figure III-3. World sugar stocks and ratio to world production, 1953-1973

Source: State of Food and Agriculture, FAO, Rome.

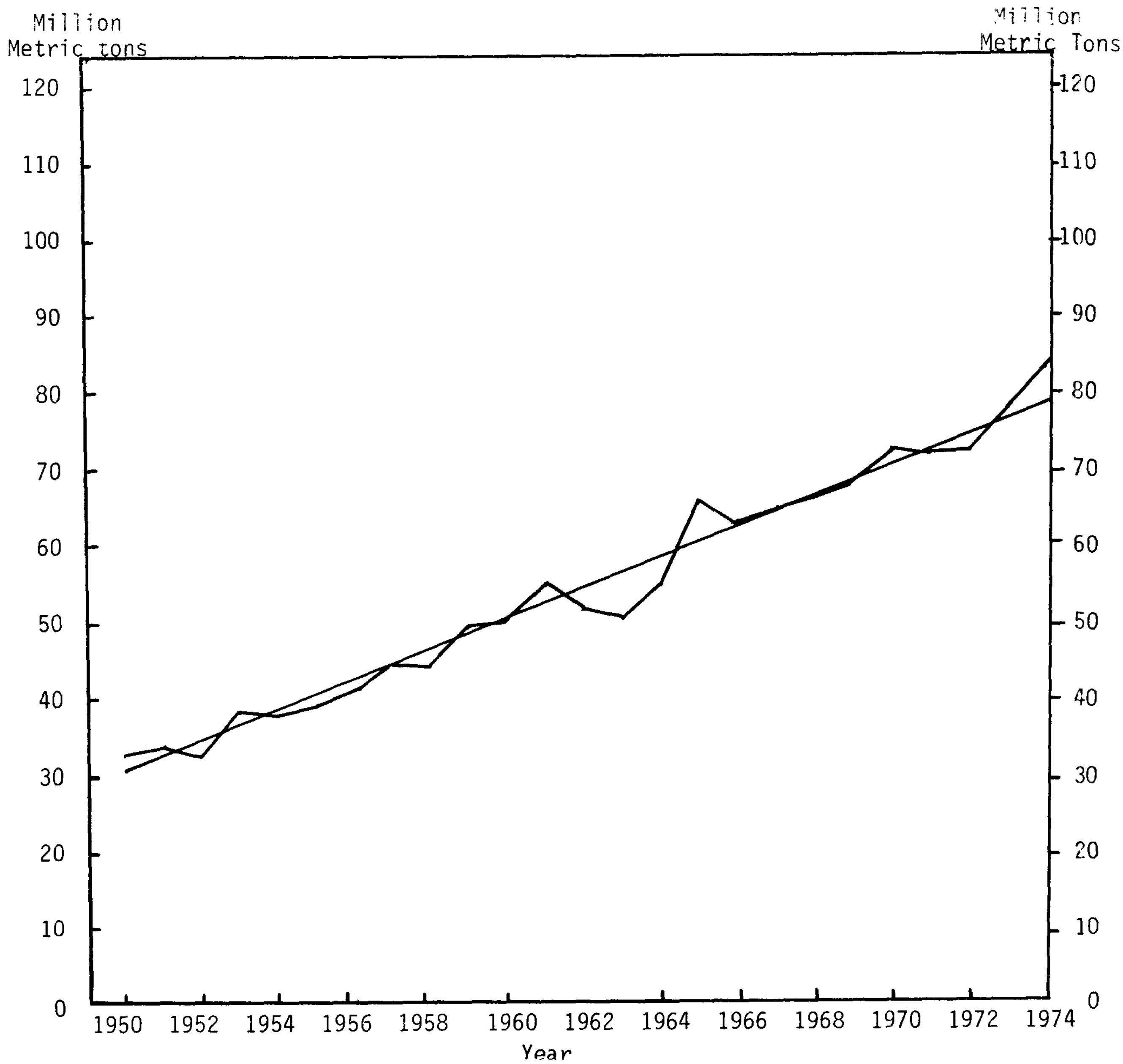


Figure III-4. World production of sugar, 1950-1974
Source: Various publications, Food and Agricultural organizations, Rome and FAS, U.S.D.A., Washington, D.C.

Table III-9. World sugar production by region, 1964 to 1973

Crop year ending	North America	South America	Europe	Africa	Asia	Oceania	Total
	Million metric tons						
1964-1968	17.1	8.4	25.4	4.3	11.0	2.7	68.9
1969	17.5	8.8	27.0	4.9	12.9	3.5	74.6
1970	21.3	9.3	26.1	5.0	14.4	2.8	78.9
1971	18.9	10.0	25.8	4.9	14.9	3.2	77.7
1972	17.4	10.6	26.7	5.6	14.0	3.5	77.8
1973	19.5	11.5	26.5	6.0	14.9	3.6	82.0

Source: Foreign Agricultural Service, U.S.D.A.

Table III-10. World sugar production by type of sugar, 1956 to 1973

Year	Sugar		
	Cane	Beet	Total
	pct		
1956	60.2	39.8	100.0
1960	56.4	43.6	100.0
1964	54.6	45.4	100.0
1968	55.4	44.6	100.0
1972	59.4	40.6	100.0
1973	63.3	36.7	100.0

Source: Foreign Agricultural Service, U.S.D.A.

5. Processing Capacity

Since 1905, ~~and~~ although marked short-term deviations occurred, the long-term growth rate in production of all sugar has been 2.0 million metric tons per year. Following the short crop of 1963, production increased 7.6 million metric tons for each of the next two years and then declined to the long-term average (Figure III-4). More recently, 1972 through 1974, production increased at an annual rate of 5.5 million metric tons.

This pattern suggests that in the short run the industry can expand production rapidly, but such increases are probably made possible by improved utilization of fixed plant capacity.

Industry analysts suggest that the 1974 world sugar processing (milling and slicing) capacity is 90.7 million metric tons. An estimated 2.3 million short tons of additional capacity is reported to be under construction and coming on stream in 1975 and 1976.

The above estimates are for rated capacities. Utilization of this capacity typically is 10 to 15 percent less, depending on weather, season, sugar content, breakdowns and related factors. For instance, 1974 production was estimated at 83 million metric tons, indicating a 91.5 percent utilization.

Present capital costs for sugar processing facilities are large, ranging from $400 to $500 per annual ton of sugar for beet sugar and $200 to $300 for cane sugar.

6. Cost of Production

Sugar milling production costs vary widely throughout the world. Generally, sugar cane production costs in the tropical countries are much lower than sugar beet production costs in the temperate countries. An approximate indication of the magnitude of these differences is shown in Table III-11. Although sugar content varies from country to country and year to year, these historical data indicate that tropical cane producers have a cost of about $.02 to $.04 per pound of raw sugar. This compared to $.06 to $.07 per pound of raw beet sugar.

Processing costs also vary widely depending on labor rates and related factors. The accepted rule of thumb figure for sugar cane processing costs is $.02 per pound raw sugar. 1/

When processing costs are added to growing costs, a raw cane sugar cost of $.04 to $.06 per pound is obtained. Allowing for freight to a Caribbean basing point, a $.06 per pound cost appeared reasonable for all efficient and low-cost producers during the recent past. 2/

1/ House of Representatives, Agricultural Trade and the Proposed Round of Multilateral Negotiations, Annex IX Sugar Trade Study, U. S. Printing Office, April, 1973.

2/ A similar conclusion is reported in the above reference.

Table III-11. Producer prices of sugar cane and sugar beets for selected countries

Countries	1967	1968	1969	1970	1971
	¢/pound raw sugar				
Sugar cane					
Australia	4.05	4.23	4.78	5.00	5.23
Costa Rica	3.77	3.69	3.73	3.82	3.96
India	4.46	4.46	4.46	4.46	--
Kenya	2.68	2.87	2.87	2.87	2.87
Mauritius	2.78	2.73	2.87	2.96	3.55
Mexico	1.91	1.91	1.91	1.91	3.18
Peru	2.28	2.23	2.14	2.37	2.37
Puerto Rico	5.00	4.23	4.19	3.91	--
United States	5.28	5.23	5.60	5.87	6.14
Sugar beets	¢/pound raw sugar equivalent				
Australia	4.78	4.81	5.88	5.56	6.30
Belgium	2.28	2.28	2.28	2.60	--
Denmark	4.23	4.55	5.20	5.52	6.18
France	4.88	5.18	5.20	5.52	6.50
Germany	6.18	5.52	6.18	5.52	6.50
Italy	5.52	5.20	5.85	5.85	7.15
Netherlands	5.52	5.20	5.52	5.85	6.82
Sweden	6.82	6.82	6.18	6.18	6.82
United Kingdom	5.52	5.20	5.52	5.85	6.50
United States	5.52	5.52	5.20	6.18	6.18

Source: Production Handbook 1972, Food and Agricultural Organization, Rome

This differential becomes very important when one considers the possible relaxation of trade agreements and import quotas. Under free trade, countries with a comparative advantage would compete very favorably with high cost producers. The high cost producers would be eventually forced to sell below cost. Probably in the short and intermediate run their production would be available, but as perennial cane plantings reach old age and fixed production and processing assets wear out, this production would disappear.

Estimated U. S. sugar costs demonstrate the high cost position of U.S. sugar cane producers. As shown in Table III-12, U. S. costs ranged from $.047 per pound on the Hilo Coast up to $.062 cents in Louisiana and $.098 cents per pound in Puerto Rico. Allowing $.02 for cane processing, U.S. costs were $.07 to $.08 cents per pound. When a $.50 per hundred pounds cost for handling, insurance and freight from the Caribbean were added to the $.06 per pound world cost, the U.S. producer still had higher costs.

Beet sugar prices in the United States are competitive with those of other world producing areas. Sugar beets are a higher cost source of sugar than sugar cane regardless of location.

7. Prices

As shown in Table III-6, world cane sugar prices have varied greatly both in current and real dollars. As recently as 1966, 1967 and 1968, current world prices were on the order of $.02 per pound. Since then they have steadily increased and during late 1973 and 1974, the world price skyrocketed to an October, 1974 value of nearly $.40 per pound. The reasons were no doubt numerous, but the primary factors included rising per capita incomes in the developing countries during recent years, the rapid consumption increases in response to those rising incomes without a corresponding increase in production, beet crop failures in the USSR for three consecutive years beginning in 1971, crop damage in the Philippines and Cuba, and price inelasticity.

Historically, world sugar production and prices have exhibited a 6 to 9 year cycle, with simultaneous production troughs and price peaks. In recent years, price peaks have occurred in 1957 and 1963.

Table III-12. Estimated sugar cane production costs by region, 1973

Item	Louisiana	Florida	Hawaii Hilo Coast	Hawaii Other	Puerto Rico
	$/hundredweight of raw sugar				
Direct Costs					
Labor	2.21	1.94	1.90	2.57	4.17
Supplies and services	2.28	1.91	1.89	1.57	3.07
Subtotal	4.49	3.85	3.79	4.14	7.24
Indirect Costs					
Administrative	.37	.29	.47	.38	.85
Taxes and insurance	.34	.36	.21	.25	.90
Subtotal	.71	.65	.68	.63	1.75
Depreciation	.57	.33	.19	.28	.45
Interest	.42	.39	1/	1/	.32
Total Costs	6.19	5.22	4.66	5.05	9.76

1/ Hawaiian plantations show little or no long-term debt.

Such cyclical patterns are due largely to the large amounts of capital required and to the biological nature of sugar cane. The production from a single planting of cane typically occurs over a period of 2 to 10 years. Furthermore, new plantings typically require a 15 to 24 month growth period prior to the harvesting; hence, new plantings may not be reflected in production levels for several years.

If one considered only the biological nature of sugar cane, one would expect a shorter cycle. However, producers do not immediately respond to price changes, waiting for a clear indication of one or two years of prices before responding with new plantings and plant construction. This psychological factor creates a further lag, thus the 6 to 9 year cycle.

As shown in Figure III-5, prices increased in 1969 and 1970 as expected with the cycle; however, since the prices did not decline, they reflected the emerging tight supply situation and rising consumption.

The price-quantity relationship (Figure III-5) shows interesting relationships reflecting the recent changes in supply-demand balance. At the outset, the relationships shown should not be taken as exhibiting either a supply or demand function but rather a mixture of both. The scatter diagram appears to group into two areas, one, a negative slope, for the period 1949 through 1970, and the other, a positive slope for 1971 through 1974. The first period is typical of many agricultural commodities whose demand is fairly constant and whose supply varies due to weather and related impacts. However, the latter period shows a distinct change. One would conjecture that in the early period price varied inversely with supply and that more recently price varied directly with demand as consumption and stocks increased relative to historical patterns.

The relationship of prices to the stock-production ratio is shown in Figure III-6. This relationship does not follow the distinct time trend shown in Figure III-3 but does indicate that prices increase significantly as this ratio declines. The level of stocks appears to be an indicator of possible price changes.

The reasons for this relationship are not fully clear, but, as with other agricultural commodities, there appears to be some normal level of stocks (about 25 percent), representing a neutral position between buyers and sellers. If stocks fall below this level, prices increase quite rapidly. As stocks exceed this level, prices remain relatively constant. The reduction of stock levels suggests the tight supply situation resulting from the more rapidly increasing demand relative to the normal supply growth.

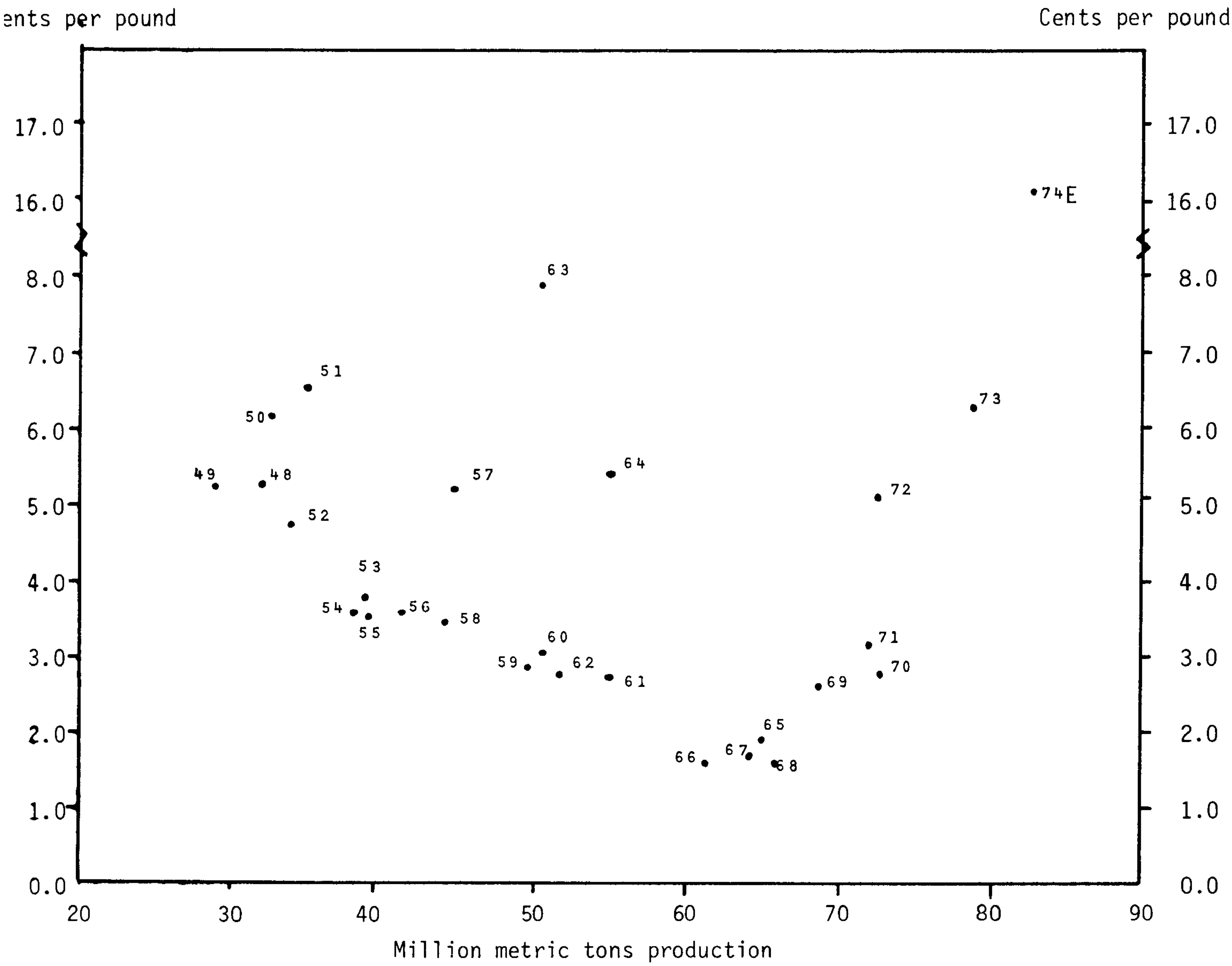


Figure III-5. World price-quantity relationship for sugar, 1949-1974 (1958 dollars)

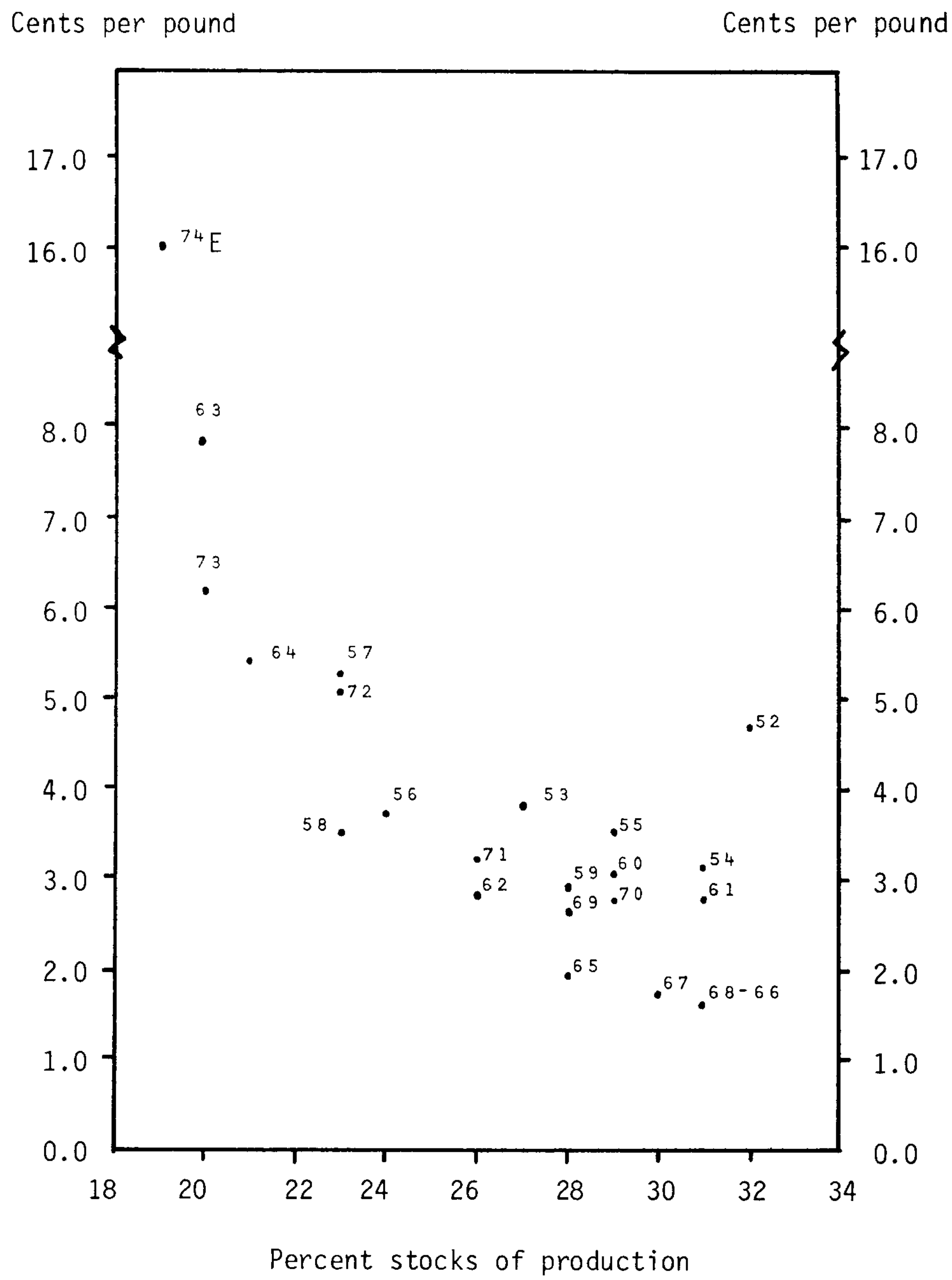


Figure III-6. World price - stock to production ratio, 1952-1974.

D. Outlook for Prices

The recent price characteristics of sugar make price projections tentative. The steep rise in world sugar prices during the 1973-74 period argues a delicate balance between supply and demand. Unfortunately, the market's response to eventual increased supplies can only be conjectured; how rapidly and to what level prices will fall must remain subjects for speculation.

Long-term price projections can employ two assumptions, however. First, even though the sugar trade is controlled in much of the world, sugar prices in the long run will tend to equal the overall economic costs of production and distribution plus return on investment (i.e., opportunity costs of production). Secondly, sugar prices cannot be less than the full cost of production, for in such a case, investors with limited funds, will soon seek alternative and profitable investments.

Even the estimation of a long-run cost is difficult, however, because wage rates appear to be increasing at a relatively rapid rate in many areas. Furthermore, world-wide sugar cane productivity increases slowly at an annual rate of about one percent (Table III-13).

Allowing for real cost increases and a relatively low productivity gain, long-run costs in 1973 dollars could be in the order of $.08 to $.10 per pound of sugar in the U. S. (Some industry sources have suggested a figure of $.15 per pound.) With costs at that level, prices are not likely to fall to their former lows of the late 1960's.

When this new equilibrium level is to be reached is not at all clear. FAO projects a world consumption of 93.2 million metric tons by 1980. This represents a growth of 38.7 million metric tons over the 1964-66 average of 54.5 million metric tons. 1/ More recent projections (unpublished) circulating among industry and government analysts place demand for 1980, closer to 100 million metric tons. This latter estimate presumes a continued growth of per capita income in the developing countries. With the widespread economic pressures attributable to oil and food, this assumption is tenuous. If such pressures depress long-run demand, the price equilibrium will be realized in a correspondingly shorter time.

1/ Agricultural Commodity Projections, 1970-80, Vol. 1, Food and Agricultural Organization, Rome, 1971.

Table III-13. Yield of sugar cane for selected areas and the world in kilograms per hectare.

Area	1961-65	1970	1971	1972
World	49,227	54,477	53,275	53,469
Africa	62,022	65,335	66,777	68,511
Central America	52,539	60,538	57,116	57,736
South America	48,850	51,832	52,337	52,600
Asia	44,885	49,499	48,205	47,798
North America	88,765	92,127	83,609	92,563
Oceania	73,331	80,016	83,311	78,359

Source: Production Yearbook, 1972, Vol. 26, Food and Agricultural Organization, Rome, 1973.

Clearly, existing capacity plus new construction would not be sufficient to meet a 1980 consumption level of about 100 million metric tons. Adjusting for effective utilization rates, total 1980 rated capacity would need to be about 111 million metric tons, a 22 percent (20 million metric tons) increase over current capacity, excluding current construction of 2.3 million metric tons. Even a more moderate consumption level of 95 million metric tons, about 15 million metric tons of new capacity would be required.

Although the high cost of new sugar cane plantings and cane mills suggests a relatively inelastic supply function, it would appear that under prospects of profits, many of the developing countries will expand capacity as a means of generating foreign exchange. Foreign exchange earnings from sugar exports in many countries are very important, as shown in Table III-14.

All in all, if per capita incomes grow at recent per annum rates, it is unlikely that the new price equilibrium will be reached until after 1980. If this income growth does not occur, the new equilibrium level may be realized before 1980. In the short-run, world prices may fall to $.20 to $.25 per pound within the next 18 months.

Although the world sugar economy influences the U.S. sugar situation, the latter can also influence the world sugar economy. A growing world supply and the increased industrial use of corn sweeteners will moderate U.S. sugar prices. The extent of the long-run impact of corn sweeteners is not clear, but it is potentially significant.

The United States will likely continue to be a high cost producer, although perhaps not at quite the differential of recent years. As prices approach the costs of production, U.S. producers would be forced to sell below their costs and as plantings and mills wear out, this production will cease. A loss in U.S. production will probably increase U.S. import requirements and increase competition for foreign supplies. The consequent pressure on foreign supplies would strengthen prices and encourage U.S. production.

With U.S. sugar consumption in the order of 12 million short tons and production at about 6.5 million short tons, complete dependence on imports by the U.S. would increase world trade by 5.5 million short tons, or a 30 percent increase over recent trade levels. A simultaneous increase of this magnitude in production and processing capacity elsewhere in the world in addition to the growing demand for sugar appears highly improbable within a five year period.

Thus, the above conditions argue that even under a free trade policy U.S. sugar production is unlikely to decline significantly. A major production decline would, by stimulating world sugar prices, simultaneously strengthen U.S. production.

Table III- 14. Value of sugar exports as percent of total exports for major sugar exporting countries, 1966-1969

Country	1966	1967	1968	1969
	----------------	percent	----------------	----------------
Mexico	4.78	6.07	7.20	8.54
Dominican Republic	51.09	52.56	50.92	48.37
Brazil	4.65	4.84	5.42	4.98
Peru	6.04	7.00	--	4.50
British West Indies	12.81	11.88	11.08	NA
French West Indies	29.27	32.35	31.17	31.88
Australia	4.31	5.08	4.99	3.76
Taiwan	9.91	6.08	5.61	4.38
South Africa	2.73	2.46	2.61	2.52
Mauritius	90.14	90.48	90.63	89.39
Philippines	14.75	15.25	15.57	15.46

Source: Trade Yearbook, Food and Agricultural Organization, Rome.

The likelihood of the Congress enacting a new sugar program is not known. The current Act expired on 31 December, 1974. A new program may well be different. In view of recent new programs for other agricultural commodities and a trade liberalization policy by the United States, one would speculate that a new program would feature the establishment of target prices at the producer level with deficiency payments to growers when actual market prices fall below the target price. The elimination of input quotas and domestic marketing allocations is also probable. On the other hand, with the pressure of high world prices, quotas could be continued to increase U. S. sugar industry profitability (at a level between past and present conditions) for both producers and processors and increase domestic production in an effort to bring about intermediate price levels.

Legislation reflecting free trade conditions and deficiency payments would probably set target prices which approximate the long-run opportunity costs of domestic cane and beet sugar production. Such a policy would discourage significant expansion of production in the face of less costly foreign supplies.

Any legislation reestablishing quotas, including production stimulating price supports, could increase U.S. price levels above long-term world prices and long-run opportunity costs of production.

E. Expected Price Impacts

The expected price impacts will depend upon future U.S. sugar policy, i.e., free-trade or a deficiency payments policy.

Under free-trade policies, mills would probably pass along cost increases to refiners so long as the resultant price was less than the price of imported raw sugar. Considering that it may be near or past 1980 before a new world price equilibrium is reached, the U.S. sugar industry should remain competitive with world prices. However, the extent to which this will be realized will depend upon which portion of the milling industry has pollution control in place, the relative cost of control among the remaining plants, the degree of integration, and in the case of Puerto Rico, the commonwealth's position toward subsidization of that segment.

In the case of a policy of deficiency payments to growers and relatively free trade, mills should be able to pass along cost increases, subject to the conditions of free trade listed above, so long as the price of imports is higher than the cost of manufacturing. Depending upon the target producer price, it is possible that the ability of the mills to pass along the costs of pollution control is improved under this scenario over that of free trade, since under free trade, growers may cease production sooner than under support payments.

IV. ECONOMIC IMPACT ANALYSIS METHODOLOGY

This study's economic impact analysis was based upon the industry information developed in Chapters I-III and data concerning pollution abatement technology and costs provided by the Environmental Protection Agency. The impacts examined included:

- Price Effect
- Financial Effects
- Production Effects
- Employment Effects
- Balance of Trade Effects
- Other Effects

The analysis was not a simple sequential analysis, but rather, it was composed of a number of interacting steps. The schematic of the analytical approach is shown in Figure IV-1. Due to the fundamental relationships of potential plant shutdowns (financial and production effects) to the other impacts, a disproportionate amount of time will be devoted to the plant closure analysis. Because of the severe effect of plant shutdowns on other effects, the impact study emphasized the analysis of financial and production effects.

The fundamental aspect of the impact analysis was similar to that usually done for any capital budgeting study of new investments. The problem was one of deciding whether a commitment of time and money to a project is worthwhile in terms of the expected benefits. The problem was complicated by the fact that the analysis dealt with <u>future</u> benefits and costs and obviously could not have complete and precise information for future projections. For this reason, the model plant budgets presented in Chapter II provided the financial returns and costs used in the impact analysis. Key non-quantifiable factors were incorporated into the analysis to interpret the quantified data. Actual financial results will differ from the model results, and these variances were considered in interpreting the findings based on model plants.

A. Fundamental Methodology

The fundamentals of analysis are basic to all impact studies. The core methodology is here described as a unit. Specific impact analyses are then discussed under the appropriate headings following this section.

The core analysis for this inquiry was based upon a synthesis of the physical and financial characteristics of models of cane sugar mills. Estimated financial profiles and cash flows were presented in Chapter II. The primary factors involved in assessing the financial and production impacts of pollution control are profitability changes which are a function of the cost of pollution control and the ability to pass along these costs in higher prices. In reality, closure decisions are seldom made

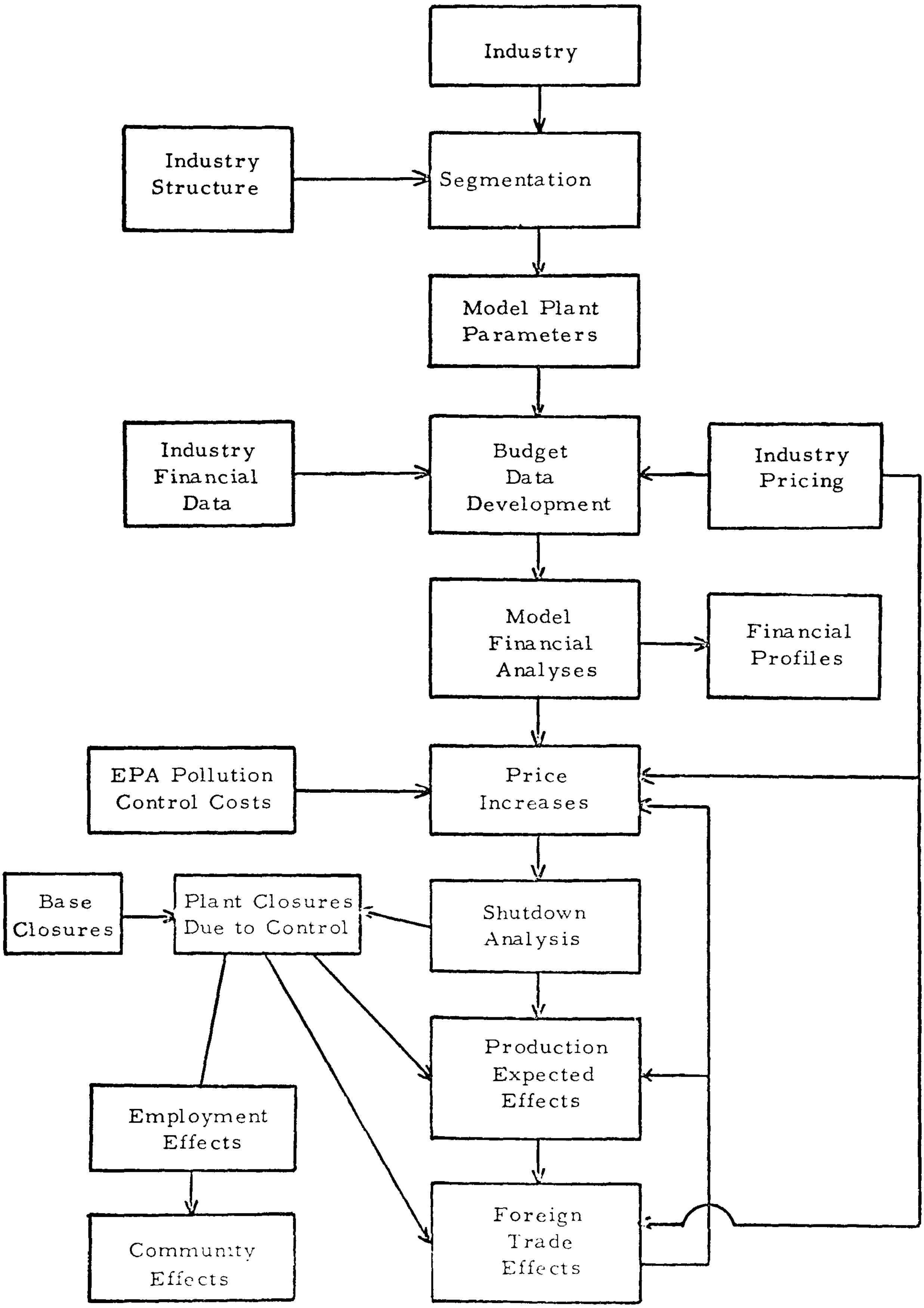


Figure IV-1. Schematic of impact analysis of effluent control guidelines.

on a set of well-defined and documented economic rules. For the individual firm, crucial considerations include the ability to obtain financing and, in integrated operations, the effect of closure on the total enterprise. Additionally, a wide range of personal values and external forces are involved. Such circumstances include but are not limited to the following conditions:

1. A lack of knowledge on the part of the owner-operator concerning the actual financial condition of the operation due to faulty or inadequate accounting systems or procedures. This is likely to occur among small, independent operators who do not have an effective cost accounting system.

2. Plant and equipment are old and fully depreciated and the owner has no intention of replacing or modernizing them. He continues production as long as he can cover labor and materials costs and/or until the equipment becomes inoperable.

3. Personal values and goals associated with business ownership prevent rational economic decisions. This complex of factors may be referred to as the value of psychic income.

4. The plant is a part of a larger integrated entity and either uses raw materials being produced profitably in another of the firm's operating units for which an assured market is critical or, alternatively, it supplies critical raw materials to another of the firm's operations. When the profitability of the second operation offsets the losses in the first plant, the unprofitable operation may continue indefinitely because the total enterprise is profitable.

5. The owner-operator expects that losses and the conditions causing them are temporary. His ability to absorb short-term losses depends upon his access to funds through credit or personal resources not presently utilized.

6. There are very low (approaching zero) opportunity costs for the fixed assets and for the owner-operator's managerial skills and/or labor. As long as the operator can meet labor and materials costs, he will continue to operate. He may even operate with gross revenues below variable costs until he has exhausted his working capital and credit.

7. The value of the land on which the plant is located is appreciating at a rate sufficient to offset short-term losses, funds are available to meet operating needs, and the opportunity cost of the owner-operator's managerial skills are low.

These factors are generally associated with proprietorships and closely held enterprises rather than publicly held corporations.

While the above factors are present in and relevant to business decisions, common economic rules are sufficient to provide useful and reliable insight into potential business responses to required investment and operating costs in pollution control facilities.

The question of whether or not a particular plant is a part of an integrated operation warrants further discussion. The impact analysis for cane sugar mills was based on the assumption that each mill "stood alone". Since many mills are part of a cane growing-milling, a growing-milling-refining or a milling-refining complex, the impact analysis was expanded for those integrated mills which were negatively impacted by the imposition of pollution control in the "stand alone" operations. Where growing or refining is highly profitable, an integrated mill might continue to operate under adverse financial conditions, with losses absorbed by the profitable phase of the total enterprise.

The following discussion presumed an investment in pollution control facilities. The rules presented apply to on-going operations. In the simplest case, a plant will be closed when variable expenses (Vc) are greater than revenues (R) since by closing the plant, losses can be avoided.

A more probable situation is where $VC < R$ but revenues are less than variable costs plus cash overhead expenses (TCc) which are fixed in the short run. In this situation a plant would likely continue to operate as contributions are made toward covering a portion of these fixed cash overhead expenses. The firm cannot operate indefinitely under this condition, but the length of this period is uncertain. Basic to this strategy of continuing operations is the firm's expectation that revenues will increase to cover cash outlays. Identification of plants where $TCc > R$, but $Vc < R$ led to an estimate of plants that should close over some period of time if revenues do not increase. However, the timing of such closures was difficult to predict.

The next level is where $TCc < R$. Where $TCc < R$, it is likely that plant operations will continue so long as the capitalized value of earnings (CV), at the firm's (industry's) cost of capital, is greater than the realizable or salvage value (S) of sunk plant investment. If $S > CV$ or $CV - S > 0$, the firm could realize S in cash, reinvest and be financially better off, assuming reinvestment at least at the firm's (industry's) cost of capital.

The computation of CV involved discounting the future earning flows to present value through the discounting function:

$$NPV = \sum_{n=1}^{t} A_n (1 + i)^{-n}$$

where

NPV = net present value
A_n = a future value in the n^{th} year
i = discount rate at cost of capital
n = number of conversion periods, i.e., 1 year, 2 years, etc.

It should be noted that a more common measure of profitability is the return on investment (ROI) where profits are expressed as a percent of invested capital (book value), net worth or sales. This should not be viewed so much as a different estimate of profitability from present value measures but rather as an entirely different profitability concept.

The data requirements for ROI and NPV measures were derived from the same basic financial information although the final inputs were handled differently for each measure.

1. Returns

For the purpose of this analysis, returns for the ROI analysis were defined as pre-tax and after-tax income and for the NPV analysis as after-tax cash proceeds. The computation of each is shown below:

Pre-tax income = (R-E-I-D)

After-tax income = (1 - T) X (R-E-I-D)

After-tax cash proceeds = (1 - T) X (R-E-I-D) + D

where

T = tax rate

R = revenues

E = expenses other than depreciation and interest

I = interest expense

D = depreciation charges

Interest was omitted in the cash proceeds computation since it is reflected in the discount rate, the after-tax cost of capital. Depreciation was included in the NPV measure only in terms of its tax effect and was then added back to obtain cash proceeds.

A tax rate of 22 percent on the first $25,000 income and 48 percent on amounts over $25,000 was used throughout the analysis. Accelerated depreciation methods, investment tax credits, and carry forward and carry back provisions were not used due to their complexity and special limitations.

2. Investment

Although investment is normally thought of as outlays for fixed assets and working capital, in evaluating the closure potentiality of an on-going plant where the basic investment is sunk, the value of that investment must be made in terms of its liquidation or salvage value, that is in its opportunity cost or shadow price.1/ For purposes of this analysis, sunk investment was taken as the sum of equipment salvage value plus land at current market value plus the value of the plant's net working capital (current assets less current liabilities, see Chapter III for values). This amount was taken as a negative investment in the terminal year. Replacement investment for plant maintenance was considered to be equal to annual depreciation, a procedure which corresponds to the operating policies of some managements and which serves as a good proxy for replacement in an on-going business.

Incremental investments in pollution control facilities were the estimates provided by EPA as shown in Chapter VI.

3. Cost of Capital - After Tax

Return on invested capital is a fundamental notion in U.S. business. It provides both a measure of actual performance of a firm as well as expected performance. In this latter case, it is also called the cost of capital. The cost of capital is defined as the weighted average of the cost of each type of capital employed by the firm; in general terms, this can be expressed as owner's equity and interest-bearing liabilities. There is no methodology that yields the precise cost of capital, but it can be approximated within reasonable bounds.

The cost of equities was estimated by two methods--the dividend yield method and the earnings stock price (E/P ratio) method. Both are simplifications of the more complex NPV methodology. The dividend method is:

$$k = \frac{D}{P} + g$$

where

k = cost of capital
D = dividend yield
P = stock price
g = growth

and the E/P method is simply

$$k = E/P$$

1/ This should not be confused with a simple buy-sell situation which merely involves a transfer of ownership from one firm to another. In this instance, the opportunity cost (shadow price) of the investment may be different.

where

k = cost of capital
E = earnings
P = stock price

and is a further simplification of the first. The latter assumes future earnings as a level perpetual stream.

The after-tax cost of debt capital was estimated from reported (annual financial reports and financial statistics) company outlays for interest expenses and multiplied by .52 -- assuming a 48 percent tax rate. These values were weighted by the respective equity to total asset and total liabilities to total asset ratios.

The estimated cost of capital for the cane sugar milling industry was indicated in Chapter II.

4. Construction of the Cash Flow

Two periods of analysis were used in the following analysis to reflect potential raw sugar price levels. For BPT alone a six year period, 1977 through 1982, was used. For BPT and BAT, the cost of the DCF analysis was done for the period 1983-1999, assuming a new closure decision would be required in 1983. The rationale for this approach was that prices appear to be headed downward in the long run, but that in the intermediate run prices may remain high enough to preclude immediate closures and to justify BPT investment, though not high enough to permit BAT investment.

The BPT cash flow was constructed as follows:

1. Sunk investment (salvage value of fixed assets plus net working capital) taken in year t_0 (1976).

2. After-tax proceeds, including incremental pollution control expenses, taken in two three-year periods, t_1 through t_3, and t_4 through t_6, at various price level alternatives and summed.

3. Annual replacement investment for the existing facility equal to depreciation for years t_1 through t_6.

4. Incremental pollution control investment taken in year t_0.

5. Terminal value (salvage value of fixed assets plus net working capital) taken in year t_7.

The BAT (only) and the BPT plus BAT cash flows were constructed as follows:

1. Sunk investment (salvage of fixed assets plus net working capital) taken in year t_0 (1982).

2, After-tax proceeds, including incremental pollution control expenses, taken for years t_1 through t_{16}.

3. Annual replacement investment for the existing facility equal to depreciation for years t_1 through t_{16}.

4. Incremental pollution control investment (BAT only) taken in year t_o.

5. Replacement of BPT investment, where applicable, taken in year t_4 and t_{14}.

6. A replacement of BAT investment taken in year t_{10}.

7. Terminal value equal to net working capital and land taken in year t_{17}.

B. Price Effects

As shown in Figure IV-1, price and production effects are interrelated. In fact, the very basis of price analysis is the premise that prices and production are functionally related variables which are simultaneously resolved.

Solution of this requires knowledge of demand growth, price elasticities, supply elasticities, the degree to which regional markets exist, the degree of dominance exerted by large firms in the industry, the market concentration exhibited by both the industry's suppliers of inputs and purchasers of outputs, organization and coordination within the industry, the relationship of domestic output to the world market, the existence and nature of complementary goods, cyclical trends in the industry, current utilization of capacity, and exogenous influences upon price determination (e.g., governmental regulation).

In view of the complexity and diversity of the factors involved in the determination of the market price, a purely quantitative approach to the problem of price effects was not feasible in this study. Hence, the simultaneous and somewhat qualitative considerations suggested above were made. The judgment factor was heavily employed in determining the supply response to a price change and to alternative price changes to be employed.

The basic premise in the price analysis was that prices will be exogenously determined via the world market and that mills will take the price offered by refiners. This further presumed that any losses in U.S. production due to pollution control per se, would not influence world price.

C. Shutdown Analysis

The shutdown analysis was based upon the technique described above under Section A and the expected price increase from the preceding analysis. In addition to this analysis, estimates were made of plant closures without the imposition of pollution control, or the so-called "baseline" closures. This analysis involved the same financial analysis technique, without pollution control, and the factoring in of other information such as trends in the industry itself and in competing products.

Based on the results of the NPV analysis of model plants, potential closures were identified where $NPV \leq 0$. Segments or plants in the industry were equated to the appropriate model results. Mitigating circumstances, such as association with an integrated operation, captive raw material sources, unique market advantages, in-place controls, and the ability to finance new non-productive investments were factored in quantitatively to obtain an estimate of closures. If BAT costs differed from BPT costs, closure estimates were required for each level of control. Because of the inexactness of this analysis, these closures were estimated in terms of ranges.

Due to the uncertainty of future prices the shutdown analysis was performed for various price scenarios. As described above, the shutdown analysis was done for the period 1977 through 1982 and 1983 and after.

D. Production Effects

Potential production effects included changes in capacity utilization rates, plant closures, and stagnation of industry growth. Plant closures may be offset in total or in part by increases in mill capacity by plants remaining in operation or by the increased use of substitutes such as corn sweeteners.

E. Employment Effects

The production effects of estimated production curtailments, potential plant closings, and changes in industry growth, are major effects upon employment. The employment effects stemming from each of these production impacts in terms of jobs lost were estimated using the model plant information.

F. Community Effects

The direct impact of job losses upon a community are immediately apparent. Additionally, in many cases, plant closures and cutbacks have through multiplier effects a greater impact than just that of employment loss.

However, income, investment and job multipliers were not available for specific areas; thus, these indirect effects were not estimated.

In addition to these direct and indirect impacts on communities, growers may also be affected. The closing of a cane sugar mill could affect area cane growers and could produce serious dislocation of agricultural activity. However, alternative uses of land are present; thus the loss would not be total. A detailed estimate would require farm budget studies beyond the scope of this study. Such dislocations were, therefore, qualitatively discussed.

G. Other Effects

Other impacts such as the direct balance of payments effects were also included in the analysis. They, too, required qualitative analyses.

V. EFFLUENT CONTROL GUIDELINES AND COSTS

The proposed effluent control guidelines, technology, and costs used in this analysis were provided by the Effluent Guidelines Division of the Environmental Protection Agency.

Due to various and unique characteristics, the cane sugar milling industry was segmented into five subcategories as follows:

Subcategory I - Louisiana

Subcategory II - Florida and Texas

Subcateogry III - Hawaii (Hilo Coast)

Subcategory IV - Hawaii (other than Hilo Coast)

Subcategory V - Puerto Rico

A. Effluent Control Levels

The proposed effluent guidelines are contained in the Development Document for Effluent Limitations Guidelines and Standards of Performance - Sugar Cane Milling Industry. The costs supplied by the EPA and given in Section "C" below, were based on the proposed guidelines.

B. Current Levels of Control

The cane sugar milling industry uses various levels of effluent control in its plants, varying by and within geographic areas. The Effluent Guidelines Division of EPA furnished information on in-place technology and the additional technologies required to achieve proposed BPT and BAT guidelines.

Subcategory I - Louisiana

Of the 39 factories in Louisiana, only eight factories (19.7 percent of daily capacity) are reported by Effluent Guidelines Division to require installation of facilities to attain BPT. Twenty-six (26) plants, representing 65.4 percent of existing daily capacity reportedly need new control facilities to meet BAT standards. These groups are not inclusive since two of the plants are reported to be able to meet BAT with their added facilities for meeting BPT. The technology requirements for meeting the proposed guidelines are summarized in Table V-1.

Subcategory II - Florida and Texas

The 9 mills in Subcategory II are all relatively new and currently have sufficient in-place effluent control technology to meet BPT and BAT guidelines. As no additional investment nor annual operating costs were required, Subcategory II was excluded from further impact analysis.

Subcategory III-Hawaii (Hilo Coast)

All 4 mills of Subcategory III (expected to be operating in 1977) need extensive additional technology to meet BPT and BAT guidelines. Two of the mills are currently dry hauling filter mud and cane trash. All of the mills require full treatment of cane wash water and recirculation and treatment of condenser cooling water as shown in Table V-2.

Subcategory IV - Hawaii (Other)

The 16 factories in Subcategory IV have sufficient effluent control technologies in place to meet both BPT and BAT proposed guidelines. Since no additional investment or annual operating costs were required, mills in Subcategory IV were excluded from further impact analysis.

Subcategory V - Puerto Rico

Only one factory in Puerto Rico has operating treatment controls to meet BPT and BAT proposed guidelines without further investment or cost.

Table V-1. Estimated technology requirements to meet proposed BPT and BAT guidelines--Subcategory I, Louisiana

Factory Number	Condenser Water: Repiping		Condenser Water: Recirculation System		Cane Wash Water: Settling Pond		Cane Wash Water: Recirculation System		Cane Wash Water: Oxidation Pond		Cane Wash Water: Repiping		Filter Mud & Ash: Slurry		Filter Mud & Ash: Impound		Summary	
	BPT	BAT	BPT	BAT	BPT	BAT	BPT	BAT	BPT	BAT	BPT	BAT	BPT	BAT	BPT	BAT	BPT	BAT
1				X														X
3					X		X										X	
5								X										X
6								X										X
7				X	X		X										X	X
9				X														X
10					X		X								X		X	
11				X					X				X				X	X
13				X				X										X
14				X														X
16				X			X								X		X	X
18				X				X										X
19							X										X	
21								X										X
22				X	X		X		X				X				X	X
25				X				X										X
26				X				X										X
27				X				X										X
29								X										X
31				X				X										X
32				X														X
33								X										X
34												X						X
36				X				X										X
38		X																X
39				X			X										X	X
40				X														X
41				X				X										X
43				X				X										X
TOTAL	0	1	0	19	4	0	7	14	2	0	0	1	2	0	2	0	8	26

Table V-1. Estimated technology requirements to meet proposed BPT and BAT Guidelines, Subcategory III-Hawaii (Hilo Coast)

Factory No.	Condenser water			Cane wash water			Filter mud	Fly ash	Trash	Summary	
	Aerated lagoon	Spray pond	Settling pond	Thicken CW stream	Vacuum filter	Haul mud	dry haul	Dry haul	Dry haul		
	BAT	BAT	BAT	BPT	BPT	BPT	BPT	BPT	BPT	BPT	BAT
67	X	X	X	X	X	X		X		X	X
66	X	X	X	X	X	X		X		X	X
69	X	X	X	X	X	X	X		X	X	X
70	X	X	X	X	X	X	X	X	X	X	X

Of the remaining 10 factories, all will require varying additional treatment technologies to meet BPT requirements. In addition, 9 of the 10 will also have additional investment and annual operating expenditures to meet proposed BAT guidelines. The specified requirement for each plant is shown in Table V-3.

Table V-4 summarizes estimated U. S. raw sugar production, based on expected mill operations as of 1977. The table includes the production affected by BPT and BAT requirements for each subcategory. Of a total estimated U.S. production of 54,993,000 cwt. of raw sugar, mills representing 36,170,000 cwt or 66 percent of U.S. total production reportedly have technology in place to meet proposed BPT and BAT requirements. Twenty-seven percent of Louisiana's production and 10 percent of Puerto Rican production need no new investment for pollution control. Subcategories II and IV production, also, needs no further investment.

Table V-4 further shows that approximately 24 percent of U.S. production will be affected by BPT controls and about 32 percent by BAT requirements. It should be noted that because not all mills require both BPT and BAT investment, BAT is not additive to BPT. About 10 percent of U.S. production is double-counted in the BPT and BAT percentages.

C. Effluent Control Costs

The effluent control investments and annual costs used were based upon data provided by Effluent Guidelines Division. To reflect the variances in requirements, each of the plants were grouped into one of the model plant groups (Chapter II). The costs of the various effluent control requirements for these plants as shown in Tables V-5 to V-13 were estimated on a model plant equivalent basis in 1973 dollars. Thus, the resulting costs do not reflect any one plant *per se*, although the model generally reflects plants in its grouping.

The total annual costs for each of the subcategories include depreciation at 10 percent of pollution control investment (10-year straight line depreciation). Total annual costs also include interest charges of 8 percent on one-half the pollution control investment on the assumption that the entire amount is borrowed for 10 years and retired in 10-equal installments. Thus, the "average" interest over 10 years would be only one-half that of the first year. Operating and maintenance costs, furnished by EPA, are essentially functions of mill size and the different effluent control alternatives. These costs were converted to model plant equivalents and are stated in 1973 dollars.

Table V-3. Estimated technology requirements to meet proposed BPT and BAT Guidelines Subcategory V- Puerto Rico

Factory Number	Condenser Water: Entrainment Control		Condenser Water: Repipe	Condenser Water: Recirculate	Cane Wash Water: Settling Pond	Cane Wash Water: Recirculate	Cane Wash Water: Oxidation Pond	Filter Mud, Ash, Chemicals, Misc.: Dry Handle	Filter Mud, Ash, Chemicals, Misc.: Slurry Impound	Filter Mud, Ash, Chemicals, Misc.: Repipe	Summary	
	BPT	BAT	BAT	BAT	BPT	BPT	BPT	BPT	BPT	BPT	BPT	BAT
52		X		X				X			X	X
56		X		X					X		X	X
58		X		X						X	X	X
59	X			X		X	X				X	X
62												
64			X	X		X	X				X	X
53				X 2/	X	X	X	X	X 1/		X	X
54	X			X	X	X	X	X	X 1/		X	X
57					X	X	X				X	
63	X			X					X		X	X
60	X			X	X	X	X		X		X	X
Total	4	3	1	9	4	6	6	3	5 1/	1	10	9

1/ Alternative to dry handling.

2/ May not need.

Table V-4. Estimated production of raw sugar affected by pollution control requirements, 1977 and 1983.

Subcategory	Mill Size Category	Annual Production of raw sugar: Total	BPT	BAT[1]	No P.C. required	Percentages of raw sugar production: Total	BPT	BAT[1]	No P.C. required
		(000 cwt.)				(percent)			
I-Louisiana	Large	4,756	824	2,796	1,960	8.7	1.5	5.1	3.6
	Medium	3,965	738	2,932	528	7.2	1.3	5.3	1.0
	Small	1,890	520	1,561	329	3.4	1.0	2.8	0.6
		10,611	2,082	7,289	2,817	19.3	3.8	13.2	5.2
II-Florida and Texas	Large	11,453			11,453	20.9	0.0	0.0	20.9
	Small	4,567			4,567	8.3	0.0	0.0	8.3
		16,020			16,020	29.2	0.0	0.0	29.2
III-Hawaii (Hilo Coast)	Large	1,954	1,954	1,954		3.6	3.6	3.6	0.0
	Medium	2,912	2,912	2,912		5.3	5.3	5.3	0.0
	Small	732	732	732		1.3	1.3	1.3	0.0
		5,598	5,598	5,598		10.2	10.2	10.2	0.0
IV-Hawaii (Other)	Large	7,828			7,828	14.3	0.0	0.0	14.3
	Medium	8,228			8,228	15.0	0.0	0.0	15.0
	Small	684			684	1.2	0.0	0.0	1.2
		16,740			16,740	30.5	0.0	0.0	30.5
V-Puerto Rico	Large	2,409	2,409	2,409		4.4	4.4	4.4	0.0
	Medium	3,396	2,803	2,426	593	6.2	5.1	4.4	1.1
	Small	129	129	129		0.2	0.2	0.2	0.0
		5,934	5,341	4,964	593	10.8	9.7	9.0	1.1
TOTAL		54,903	13,021	17,851	36,170	100.0[2]	23.7	32.4	66.0

1/ Figures contain some duplication of production reported under BPT.

2/ May not add to 100.0 due to rounding.

Table V-5. Estimated costs for BPT in cane sugar mills--Subcategory I, Louisiana (1973 Dollars)

Model	Mill	Invest-ment	Annual Cost			Total	Annual Cost per Cwt Sugar
			O & M 1/	Deprec.	Interest		
(TPD)	No.	--------	--------	$1,000	--------	--------	
2,200	10	195	66	20	8	94	.57
	16	84	13	8	3	24	.14
	19	64	11	6	3	20	.12
3,300	22	271	99	27	11	137	.54
	3	163	72	16	7	95	.37
	40	81	15	8	3	26	.10
5,000	7	209	132	21	8	161	.40
	11	229	36	23	9	68	.17

1/ Operation and maintenance

Table V-6. Estimated costs for BAT in cane sugar mills--Subcategory I, Louisiana (1973 Dollars)

Model	Mill	Invest-ment	Annual Cost			Total	Annual Cost per Cwt Sugar
			O & M 1/	Deprec.	Interest		
(TPD)	No.	$1,000					
2,200	36	245	26	25	10	61	.37
	13	256	25	26	10	61	.37
	25	240	24	24	10	58	.35
	9	210	14	21	8	43	.29
	1	181	13	18	7	38	.23
	10	171	13	17	7	37	.22
	19	161	13	16	6	35	.21
	16	161	13	16	6	35	.21
	6	64	12	6	3	21	.13
3,300	27	319	35	32	13	80	.31
	41	207	27	21	8	56	.22
	14	236	20	24	9	53	.21
	40	218	18	22	9	49	.19
	21	82	15	8	3	26	.10
	33	82	15	8	3	26	.10
	5	81	15	8	3	26	.10
5,000	43	359	43	36	14	93	.23
	26	359	43	36	14	93	.23
	18	311	40	31	12	83	.21
	31	311	40	31	12	83	.21
	7	197	28	20	8	56	.14
	11	259	25	26	10	61	.15
	39*	253	23	25	10	58	.14
	29	105	21	11	4	36	.09
	32	72	9	7	3	19	.05
	34	52	2	5	2	9	.02
	38	36	2	4	1	7	.02

1/ Operation and maintenance
* May have zero costs

Table V-7. Estimated costs for BPT & BAT in cane sugar mills--
Subcategory I, Louisiana
(1973 Dollars)

Model	Mill	Invest-ment	Annual Cost			Total	Annual Cost per Cwt Sugar
			O & M 1/	Deprec.	Interest		
(TPD)	No.	--------	--------	$1,000	--------	--------	
2,200	36	245	26	25	10	61	.37
	13	256	25	26	10	61	.37
	25	240	24	24	10	58	.35
	9	210	14	21	8	45	.27
	1	181	13	18	7	38	.23
	10	366	79	37	15	131	.79
	19	225	24	23	9	56	.34
	16	245	26	25	9	60	.36
	6	64	12	6	3	21	.13
3,300	22	271	99	27	11	137	.54
	3	163	72	16	7	95	.37
	27	319	35	32	13	80	.31
	41	207	27	21	8	56	.22
	14	236	20	24	9	53	.21
	40	299	33	30	12	75	.29
	21	82	15	8	3	26	.10
	33	82	15	8	3	26	.10
	5	81	15	8	3	26	.10
5,000	43	359	43	36	14	93	.23
	26	359	43	36	14	93	.23
	18	311	40	31	12	83	.21
	31	311	40	31	12	83	.21
	7	406	160	41	16	217	.54
	11	488	61	49	19	129	.32
	39 *	253	23	25	10	58	.14
	29	105	21	11	4	36	.09
	32	72	9	7	3	19	.05
	34	52	2	5	2	9	.02
	38	36	2	4	1	7	.02

1/ Operation and Maintenance

* May have zero costs

Table V-8. BPT pollution control investment and annual operating costs for model mills, Subcategory III - Hawaii (Hilo Coast) (1973 dollars)

Model Mill Net TPD	Invest-ment	O&M 1/	Depreci-ation	Interest	Total Annual	$/cwt	Land cost 2/
	$000						
1,800	1,517	389	152	61	602	.82	89
3,300 High	2,248	625	225	90	940	.67	157
Low	1,925	554	193	77	824	.59	68
4,800	2,484	625	248	99	972	.50	68

1/ Operation and Maintenance

2/ Land cost estimated at $300 per acre of income foregone. Estimated costs may vary from zero to amounts shown, depending on number of acres removed from production.

Table V-9. BAT pollution control investment and annual operating costs for model mills, Subcategory III - Hawaii (Hilo Coast) (1973 dollars)

Model Mill Net TPD	Invest-ment	O&M 1/	Depreci-ation	Interest	Total Annual	$/cwt	Land cost 2/
	$000						
1,800	257	39	26	10	75	.10	1
3,300 High	495	61	50	20	131	.09	2
Low	472	45	47	19	111	.08	2
4,800	687	80	69	27	176	.09	2

1/ Operation and Maintenance

2/ Land costs estimated at $300 per acre of income foregone.

Table V-10. BPT plus BAT pollution control investment and annual operating costs for model mills, Subcategory III - Hawaii (Hilo Coast) (1973 dollars)

Model Mill Net TPD	Invest-ment	O&M 1/	Depreci-ation	Interest	Total Annual	$/cwt	Land cost 2/
	-----------------	----------	---------	$000	----------	----------	-----------------
1,800	1,774	428	177	71	676	.92	90
3,300 High	2,743	686	274	110	1,070	.77	159
Low	2,397	599	240	96	935	.67	70
4,800	3,171	705	317	126	1,148	.59	70

1/ Operation and maintenance

2/ Land costs estimated at $300 per acre of income foregone. Estimated costs may vary from the BAT land costs up to the BPT plus BAT estimate, depending on number of acres removed from production.

Table V- 11. Estimated cost for BPT in cane sugar mills, Subcategory V-Puerto Rico (1973 dollars)

Model	Mill No.	Investment	Annual Costs O&M 1/	Depreciation	Interest	Total	Cost per cwt.	Less sugar savings	Net total cost	Net cost per cwt
			$1,000				$	$1,000		$
4,500										
	60 2/	203	55	20	8	83	.64	30	53	.41
	53	308	131	31	12	174	.36	--	174	.36
	57	248	121	25	10	156	.32	--	156	.32
	64	156	23	16	6	45	.09	--	45	.09
	59	298	40	30	12	82	.17	65	17	.04
	56	4	0.4	0.4	0.2	1	.002	--	1	.002
	63	157	22	16	6	44	.09	64	(20)	(.04)
8,000										
	54	742	286	74	30	390	.45	111	279	.32
	52	65	34	7	3	44	.05	--	44	.05
	58	2	0.1	0.2	0.1	0.4	.0004	--	0.4	.0004

1/ Operation and maintenance

2/ Represents a mill that is a special case and does not fit model.

Table V- 12. Estimated cost for BAT in cane sugar mills, Subcategory V-Puerto Rico (1973 dollars)

Model	Mill No.	Investment	Annual Costs				Cost per cwt.	Less sugar savings	Net total cost	Net cost per cwt
			O&M 1/	Depreciation	Interest	Total				
TPD			------------------	$1,000	---------------		$	-------$1,000	---------	$
4,500										
	60 2/	81	8	8	3	19	.14	--	19	.14
	63	284	39	28	11	78	.13	--	78	.13
	59	208	22	21	8	51	.08	--	51	.08
	53	170	18	17	7	42	.07	--	42	.07
	64	79	6	8	3	17	.03	--	17	.03
	56	136	19	14	5	38	.06	63	(25)	(.05)
8,000										
	54	254	24	25	10	59	.05	--	59	.05
	58	138	22	14	6	42	.04	108	(66)	(.08)
	52	177	24	18	7	49	.05	111	(62)	(.07)

1/ Operation and maintenance

2/ Represents a mill that is a special case and does not fit model.

Table V-13. Estimated cost for BPT & BAT in cane sugar mills, Subcategory V-Puerto Rico (1973 dollars)

Model	Mill No.	Investment	Annual Costs: O&M[1]	Annual Costs: Depreciation	Annual Costs: Interest	Annual Costs: Total	Cost per cwt.	Less sugar savings	Net total cost	Net cost per cwt
			$1,000	$1,000	$1,000	$1,000	$	$1,000	$1,000	$
4,500										
	60 [2]	284	63	28	11	102	.79	30	72	.55
	53	478	149	48	19	216	.45	--	216	.45
	57	248	121	25	10	156	.32	--	156	.32
	59	506	62	51	20	133	.27	65	68	.14
	64	235	29	24	9	62	.13	--	62	.13
	63	441	61	44	17	122	.25	64	58	.12
	56	140	19	14	6	39	.08	63	(24)	.05
8,000										
	54	996	310	100	40	450	.52	111	339	.39
	52	242	58	24	10	92	.11	111	(19)	(.02)
	58	140	22	14	6	42	.05	108	(66)	(.08)

1/ Operation and maintenance
2/ Represents a mill that is a special case and does not fit model.

Unique circumstances regarding annual costs prevail in each of the three impacted subcategories. In all three, land costs associated with pollution controls are based on the economic costs of taking land out of production, since Effluent Guidelines determined that no mill would need to purchase land for pollution control use. In Louisiana and Puerto Rico, the profitability of cane land is marginal under 1973 price and cost conditions (some studies show negative returns to land in both geographic regions); therefore, no land costs have been assigned to Louisiana and Puerto Rico. Obviously, as sugar prices rise, some economic costs would be incurred. On the other hand, the amount of land involved is small for most mills in Louisiana and Puerto Rico. Acreages range from 3.3 to 18.6 acres in Louisiana and from one-half to 44 acres in Puerto Rico.

Subcategory III is different. Because mills on the upper Hilo Coast require considerable acreage to be removed from production, substantial land costs would be incurred. These dollar values are shown in Table V-8 through V-10, based on an annual loss of net income of $300 per acre. Such a figure would fluctuate with sugar prices; therefore, in building land costs into the model mill pro forma income and expense statements shown in Chapter VI, sales revenues and operating costs were reduced to reflect the acreage taken out of production at each of the various assumed price levels.

An additional factor had to be considered for Puerto Rican mills. Some of the control technology would include in-mill modifications of equipment to prevent loss of sucrose in the manufacturing process and also to permit some sucrose recovery from the process effluent. Thus, "sugar savings" will result for seven of the mills. These savings are shown in Tables V-11 through V-13, based on 1973 sugar prices. In Chapter VI, the savings were adjusted for the various price alternatives in the impact analysis. In each case, savings were added to sales revenues.

Tables V-5 through V-13 also show the pollution control annual costs in dollars per hundredweight of raw sugar. The costs per cwt. were derived by dividing the throughput of each of the model mills (Table II-5) into the total annual costs.

D. Total Effluent Control Costs

Based on the control investment and costs provided by the Effluent Guidelines Division used to develop model plant costs, total effluent control investment and annual costs were estimated in 1973 dollars as shown in Table V-14. Also shown in Table V-14 are the total cost estimates of the Effluent Guidelines Division in August, 1971 dollars. In 1973 dollars, total estimated investment for BPT was $11.90 million with a total annual cost of $5,250 million. About 70 percent of these costs are represented by Subcategory III - the Hilo Coast of Hawaii. Total estimated costs for BAT are lower than BPT requirements with only $8.49 million (1973 dollars) investment and $1,913 million (1973 dollars) total annual costs. In the case of BAT technology, Subcategory I - Louisiana would have about 60 percent of the investment costs and 65 percent of the annual costs.

Differences in the two estimates are explained by several factors. The most obvious factor is the difference due to the use of 1973 dollars and August, 1971 dollars. The conversion factor used to convert from August, 1971 dollars to 1973 dollars was 1.1426. The different time base explains all variances in investment costs, except Hawaii, where $101,000 (1973 dollars) less investment for BAT was taken based upon information from Hawaii indicating this amount of investment to be in place which was not reflected in the Effluent Guidelines estimate.

Variances in total annual costs are explained by the different time base, depreciation rate and base, interest base and prices used for estimating sugar savings. The depreciation rate used in this report was 10 percent while that used in the Effluent Guidelines estimate was five percent. A minor difference in depreciation and interest costs resulted from a different matching of investment ranges with annual cost ranges. This report used the highest investment estimate, with the highest annual costs and thus the costs used in this report are conservative. The small reduction in BAT investment for BAT in Hawaii contributed slightly to this annual cost difference through depreciation and interest costs.

The price used to compute sugar savings in Puerto Rico, which were treated as negative costs, varied between the two years. A price of $10.29 per hundredweight was used for 1973 and price of $8.52 for hundredweight was used for 1971.

Normalizing the two estimates to 1973 dollars, the estimated annual costs for BPT of this report exceeded that of Effluent Guidelines by 13 percent. Ninety-nine percent of this difference was composed of the higher depreciation used in this report. In the case of annual BAT costs, the estimate in this report exceeded the Effluent Guidelines estimate by 30 percent, of which 94 percent of the difference was due to depreciation.

Table V-14. Total estimated costs for effluent control by technology and subcategory

Technology	Subcategory	1973$ Investment	1973$ Total annual costs	1971$ 1/ Investment	1971$ 1/ Total annual costs
		(mill.)	(mill.)	(mill.)	(mill.)
BPT	I - Louisiana	$ 1.31	$ .680	$ 1.15	$ .528
	III - Hawaii (Hilo coast)	8.32	3.810 2/	7.28	2.940 2/
	V - Puerto Rico	2.27	.783 3/	1.98	.592 3/
	Total	$11.90	$5.273	$10.41	$40.60
BAT	I - Louisiana	5.00	1.248	4.38	.874
	III - Hawaii (Hilo coast)	1.84	.492 2/	1.70	.383 2/
	V - Puerto Rico	1.65	.145 3/	1.45	.068 3/
	Total	$ 8.49	$1.885	$ 7.53	$ 1.325

1/ August 1971 dollars for the high estimate as provided by the Effluent Guidelines Division in the Development Document for Sugar Cane Milling.

2/ Includes value of production foregone annually due to use of land for disposal.

3/ Includes sugar savings as negative costs.

VI. IMPACT ANALYSIS

The analysis of the impacts of effluent limitations on the cane sugar industry is difficult when the industry is experiencing the highest prices on record. The increase to these record levels has occurred in the last 12 to 18 months and raises the question of what prices will prevail in the future. The impact analyses at alternative price levels are described below. The impacts due to effluent controls even under the lowest price scenario do not appear to be catastrophic. The impacts include:

A. Price effects
B. Financial effects
C. Production effects
D. Employment effects
E. Balance of payments effects
F. Other

A. Price Effects

As concluded in Chapter III, prices will play a pivotal role in the future of U.S. cane mills and in determining the extent to which pollution controls will effect plant shutdowns. It seems clear that prices will fall from current high levels. However, the rate of the price decline is uncertain. To accommodate this uncertainty the impact of pollution controls was analyzed under alternative price scenarios. The specific price alternatives used were as follows:

Alternative (No.)	Period	Price 1/ ($/cwt)
BPT		
1	1977-79	20.00
	1980-82	15.00
2	1977-79	15.00
	1980-82	12.50
3	1977-79	12.50
	1980-82	10.29
BAT		
1	1983 and after	15.00
2	1983 and after	12.50
3	1983 and after	10.29

1/ Expressed in 1973 dollars. Hawaiian prices were reduced by $1.24 per hundredweight to reflect the long-term difference due to freight to the mainline.

Six combinations of prices over time for BPT and BAT, where applicable, were used as follows:

Alternative (No.)
1-1
1-2
1-3
2-2
2-3
3-3

Unless the United States imposes a highly protective sugar policy, mill receipts will depend on the prices that the refiners will pay, governed by the world price for raw sugar.

With approximately 60 percent of the U. S. cane mill production integrated with refineries, the likelihood of passing along cost increases is increased; however, because of the dependence of the United States on sugar imports (about 45 percent), the world price situation appears to be overriding.

Although these conditions set important potential limits, the amount of production requiring pollution control investment is very important. As shown in Chapter V, only 24 percent of the U.S. cane mill production is estimated to require additional investment to reach BPT control levels. In terms of both BPT and BAT levels, 32 percent of the production will require additional investment. With so large a portion of the industry with controls already in place (generally the larger, lower cost plants and production areas), the ability of impacted mills to pass along cost increases appears to be severely limited.

While it is true that because sugar demand is inelastic (due to the availability of imports and substitute sweeteners) a small reduction in quantity would raise prices substantially, serious price impacts will not result from the relatively light production curtailments expected under pollution controls.

Table VI-1 contains the estimated costs of pollution control per hundredweight by segment. Subcategory III (Hilo Coast) is the highest cost segment while subcategory V is the lowest. In total, the average estimated cost per hundredweight is about \$.36-\$.37 per hundred for the affected production. Assuming a constant output, the cost of BPT per hundredweight of cane sugar production is \$.08 and \$.12 for BPT and BAT. Under current price levels, the amount of increased cost would be quite small. At 1973 price levels the average cost increase would be about three-fourths of one percent for BPT and about one percent for BPT and BAT combined.

Although the above percentages represent an approximate required price increase, it is again noted that the world price appears to be the overriding factor and that costs will not be passed on per se, particularly if prices remain above the 1973 level.

B. Financial Effects

The effects of pollution controls on the financial conditions of model cane sugar mills are shown for each of the geographic subcategories in Tables VI-2 through VI-13. There are two sets of tables: the first set (VI-2 through VI-6) reports estimated after-tax returns on investment and cash flows before and after pollution controls; the second set (Tables VI-7 through VI-13) shows estimated net present values before and after pollution controls. Both sets of tables include values at the several price alternatives reported previously under "Price Effects."

1. Effects on Rates of Return and Cash Flows

Subcategory I - Louisiana --Tables VI-2 (non-integrated operations) and VI-3 (integrated operations) present the appropriate data on rates of return and cash flows for Louisiana model mills. Rates of return and cash flows are generally slightly higher for integrated operations. This results from economies in general overhead and cane transportation costs.

Pollution control impacts are shown in Tables VI-2 and VI-3 for both the highest and the lowest levels of pollution control annual operating costs. Return on investment moves from positive to negative in only two cases in Table VI-2, e.g.,(1) the 2,200 TPD mill at a $12.50 price under BPT plus BAT (High) and (2) the 3,300 TPD mill at a $10.29 price under BPT and BPT plus BAT. Several other returns are reducd to near zero at the $10.29 price. In Table VI-3, positive returns move to negative for the 2,200 TPD and 3,300 TPD mills at the $10.29 price under certain pollution control conditions. Even the 5,000 TPD integrated mill has its rate of return reduced to near zero at a $10.29 price.

Cash flows are adversely affected by pollution controls for nearly all mills in both Tables VI-2 and VI-3, especially for the two smaller mills at the $10.29 price. The most severe cash flow condition among non-integrated mills is for the 2,200 TPD and 3,300 TPD mills at the $10.29 price. The same two mills are also most severely impacted in the integrated model at the $10.29 price. At all higher prices, cash flows appear quite strong.

Table VI-1. Estimated pollution control costs per hundred-weight by subcategory and United States

Subcategory	Model	BPT	BPT and BAT
	TPD	-------$/cwt	------------
I - Louisiana	2,200	.27	.37
	3,300	.35	.20
	5,000	.28	.30
	All	.30	.27
III - Hilo Coast	1,800	.82	.92
	3,300	.67	.77
		.59	.67
	4,800	.50	.59
	All	.61	.70
V - Puerto Rico	4,500	.13	.21
	8,000	.13	.11
	All	.13	.16
Affected production	-	.36	.37
All U. S. production	-	.08	.12

Table VI-2. Estimated book rates of return and cash flows after-tax under different pollution controls and at various sugar price levels. Subcategory I -- Louisiana, non integrated mills

Model	Sugar Price	After-Tax ROI							Cash Flow						
		Base	BPT		BPT & BAT		BAT		Base	BPT		BPT & BAT		BAT	
			Low	High	Low	High	Low	High		Low	High	Low	High	Low	High
	$/cwt	Percent							$000						
2,200 TPD	10.29	(4)	(6)	(12)	(8)	(13)	(6)	(8)	(8)	(22)	(82)	((41)	(102)	(23)	(44)
	12.50	7	6	1	7	(2)	6	3	90	85	58	83	41	85	82
	15.00	17	15	9	11	6	15	10	174	169	145	167	143	169	167
	20.00	36	33	25	26	20	33	25	342	338	313	336	311	337	335
3,300 TPD	10.29	1	0	(6)	(2)	(6)	0	(3)	76	64	(28)	37	(28)	64	34
	12.50	8	7	3	4	4	7	5	191	185	147	167	147	185	181
	15.00	15	14	10	10	11	14	11	320	315	276	297	276	315	311
	20.00	31	28	23	23	26	28	24	580	575	536	557	536	575	571
5,000 TPD	10.29	4	3	1	2	0.4	4	2	230	217	167	211	154	230	217
	12.50	10	8	7	7	16	9	7	411	399	348	412	257	411	399
	15.00	16	13	13	12	11	16	10	615	603	553	606	544	616	499
	20.00	29	26	25	24	23	29	25	1,025	1,013	962	1,026	953	1,025	1,015

Note: "Low" and "High" are the lowest and highest pollution control (annual) costs for the various operating mills in each model mill subcategory.

Table VI- 3. Estimated book rate of return and cash flows after tax under different pollution controls and at various sugar price levels, Subcategory I-Louisiana, Integrated mills

Model	Sugar Price	After-Tax ROI							Cash Flow						
		Base	BPT Low	BPT High	BPT & BAT Low	BPT & BAT High	BAT Low	BAT High	Base	BPT Low	BPT High	BPT & BAT Low	BPT & BAT High	BAT Low	BAT High
TPD	$/cwt	Percent							$000						
2,200	10.29	0.4	(0.3)	3	(2)	(4)	(0.3)	(2)	84	73	13	40	(5)	72	51
	12.50	6	6	4	4	3	5	4	220	216	191	213	189	215	213
	15.00	12	12	9	10	8	12	10	370	365	341	363	339	365	362
	20.00	25	24	21	22	19	24	21	670	665	646	663	639	665	663
3,300	10.29	1	1	2	0	(2)	1	(0.2)	157	152	75	140	75	152	137
	12.50	6	8	4	5	4	8	5	345	398	300	336	300	398	335
	15.00	14	13	11	12	11	13	12	550	544	506	541	506	544	540
	20.00	26	25	22	23	22	25	22	972	966	928	963	928	966	962
5,000	10.29	3	2	1	1	0.5	3	2	316	304	254	298	244	317	304
	12.50	8	7	6	6	5	8	6	582	570	520	564	511	583	570
	15.00	13	12	15	15	14	17	15	882	870	819	864	810	882	870
	20.00	25	23	22	22	21	25	23	1,482	1,469	1,419	1,463	1,410	1,482	1,469

Note: "Low" and "High" are the lowest and highest pollution control annual costs for the various operating mills in each model mill subcategory.

Table VI-4. Estimated book rates of return and cash flows after tax under different pollution controls and at various sugar price levels
Subcategory III-Hawaii (Hilo Coast), non-integrated

Model	Sugar price 1/	After Tax ROI					Cash Flow				
			BPT		BPT & BAT			BPT		BPT & BAT	
		Base	High	Low	High	Low	Base	High	Low	High	Low
		percent					$000				
1,800	9.05	1	(11)	--	(12)	--	183	(246)	--	(295)	--
	11.26	9	2	--	1	--	431	380	--	367	--
	13.76	17	8	--	6	--	710	660	--	647	--
	18.76	34	19	--	18	--	1,271	1,221	--	1,208	--
3,300	9.05	3	(9)	(8)	(9)	(9)	501	(94)	(22)	(111)	(81)
	11.26	19	9	10	8	8	1,302	1,202	1,230	1,217	1,216
	13.76	32	17	19	16	17	1,933	1,833	1,861	1,847	1,846
	18.76	58	35	38	32	34	3,205	3,105	3,133	3,119	3,118
4,800	9.05	9	1	--	(1)	--	1,030	772	--	723	--
	11.26	27	16	--	14	--	2,143	2,066	--	2,044	--
	13.76	41	26	--	23	--	3,034	2,957	--	2,935	--
	18.76	69	46	--	42	--	4,817	4,739	--	4,717	--

1/ Equivalent to other region prices of 10.29, 12.50, 15.00, 20.00.

Table VI-5. Estimated book rate of return and cash flows after tax under different pollution controls and at various sugar price levels
Subcategory III - Hawaii (Hilo Coast), Integrated

Model	Sugar price	After Tax ROI					Cash Flow				
		Base	BPT		BPT & BAT		Base	BPT		BPT & BAT	
			High	Low	High	Low		High	Low	High	Low
		percent					$000				
3,300	9.05	12	1	3	0.4	2	1,747	1,245	1,406	1,223	1,390
	11.26	25	13	16	12	14	3,191	2,569	2,798	2,545	2,781
	13.76	43	26	30	24	28	4,823	4,066	4,371	4,035	4,352
	18.76	79	53	58	50	55	8,086	7,058	7,517	7,030	7,493
4,800	9.05	14	7	--	8	--	2,792	2,316	--	2,601	--
	11.26	31	20	--	21	--	4,814	4,288	--	4,596	--
	13.76	50	36	--	36	--	7,099	6,516	--	6,822	--
	18.76	88	67	--	61	--	11,670	10,973	--	10,648	--

Subcategory III- Hawaii (Hilo Coast) --Tables VI-4 (non-integrated operations) and VI-5 (integrated operations) reveal pollution control impacts on rates of return and cash flows among Hilo Coast model plants. BPT impacts rates of return severely for all of the model mills (both integrated and non-integrated). While cash flows are reduced for all mills, the severest impact is on the 1,800 and 3,300 TPD non-integrated mills at the $9.05 price level. The integrated mills have very large cash flows under both baseline and BPT conditions.

BAT impact on financial conditions is relatively minor in all models. The most severe situation is the heavy negative cash flow for the 3,300 TPD non-integrated mill at a $9.05 price.

Subcategory V - Puerto Rico -- The financial effects of pollution control on Puerto Rican mills are shown in Table VI-6. The effects on both rates of return and cash flows are somewhat nominal for most models at almost every price alternative. There is a substantial drop in rate of return for some of the mills (i.e., the 4,500 TPD model at $10.29, $12.50 and $15.00 and the 5,000 TPD model at $10.29). Cash flows for the most part remain fairly stable.

Much of the explanation for the rather modest effect of pollution controls in Puerto Rico is that sugar savings tend to offset pollution control costs in most of the mills. Thus, better earnings result, along with higher depreciation charges for pollution control investment.

2. Effects on Net Present Values

Tables VI-7 through VI-13 include net present values for model mills with and without pollution controls and at the various price alternatives discussed earlier. Tables VI-7 through VI-9 are for Louisiana, VI-10 and VI-11 for Hawaii (Hilo Coast) and VI-12 and VI-13 for Puerto Rico. A range of pollution control costs (high and low) was used to estimate the lowest and highest net present values for all of the model mills in each size group in Subcategories I and V. Hawaii (Hilo Coast) did not have a range of costs since there was only one cost for each model mill.

The impact on NPV's is most severe in Louisiana and moderately severe in the other two subcategories. In each case, under price scenario 3, the net present values fall drastically, with Louisiana mills virtually all moving to negative NPV's under the weight of BAT. The closure analysis under "Production Effects" covers these impacts in greater detail.

Table VI-6 Estimated book rate of return and cash flows after tax under different pollution controls and at various sugar price levels, Subcategory V-Puerto Rico, Non-integrated

Model	Sugar	After-Tax ROI							Cash Flow						
			BPT		BPT & BAT		BAT			BPT		BPT & BAT		BAT	
Model	Price	Base	Low	High	Low	High	Low	High	Base	Low	High	Low	High	Low	High
TPD	$/cwt	Percent							$000						
4,500	10.29	(9)	(9)	(13)	(14)	(14)	(10)	(11)	(224)	(224)	(347)	(186)	(392)	(233)	(274)
	12.50	3	3	1	4	0.4	3	2	213	213	152	246	165	212	200
	15.00	12	12	8	12	7	11	10	509	509	449	550	445	508	496
	20.00	29	29	24	29	23	28	26	1,102	1,102	1,042	1,159	1,037	1,101	1,039
8,000	10.29	8	8	4	8	3	7	7	600	600	519	648	466	554	581
	12.50	17	17	13	18	11	16	16	1,087	1,087	1,028	1,147	953	1,041	1,081
	15.00	27	27	22	28	19	25	25	1,614	1,614	1,568	1,687	1,480	1,568	1,608
	20.00	47	47	46	48	36	45	45	2,668	2,668	2,651	2,768	2,533	2,623	2,661

Note: "Low" and "High" are the lowest and highest pollution control annual costs for the various operating mills in each model mill subcategory.

Table VI- 7a. Net present values of non-integrated model mills with and without BPT pollution controls in Subcategory I-Louisiana under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */ Base 1/	BPT	Base 2/	BPT	Base 3/	BPT
		000		$000					
2,200	3	529	high	984	688	363	62	(68)	(467)
			low		913		289		(160)
3,300	3	738	high	1,628	1,201	670	241	84	(472)
			low		1,538		577		(23)
5,000	2	824	high	2,951	2,467	1,438	954	371	28
			low		2,727		1,215		289
Total mills	8	2,082							

*/ Net present value assumes sugar prices per hundred weight for the three scenarios as follows:

Scenario	1977-79	1980-82
1	$20.00	$15.00
2	$15.00	$12.50
3	$12.50	$10.29

Note: "High" and "low" are the highest and lowest pollution control annual costs for the various operating mills in each model mill subcategory.

Table VI-7b. Net present values of integrated model mills with and without BPT pollution controls in Subcategory I-Louisiana under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */					
				Base 1/	BPT	Base 2/	BPT	Base 3/	BPT
		000		$000					
2,200	3	529	high	1,733	1,438	624	328	(61)	(446)
			low		1,659		552		(145)
3,300	3	738	high	2,122	1,709	988	557	7	(505)
			low		2,029		1,019		69
5,000	2	824	high	3,954	3,464	1,737	1,249	381	(106)
			low		3,729		1,514		157
Total mills	8	2,082							

*/ Net present value assumes sugar prices per hundred weight for the three scenarios as follows:

Scenario	1977-79	1980-82
1	$20.00	$15.00
2	$15.00	$12.50
3	$12.50	$10.29

Note: "High" and "low" are the highest and lowest pollution control annual costs for the various operating mills in each model mill subcategory.

Table VI- 8a. Net present values of non-integrated model mills with and without BPT & BAT pollution controls in Subcategory I-Louisiana under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */					
				Base 1/	BPT&BAT	Base 2/	BPT&BAT	Base 3/	BPT&BAT
		000		$000					
2,200	3	520	high	1,075	441	281	(522)	(645)	(1,873)
			low		874		79		(1,091)
3,300	1	233		1,894	1,369	675	141	(411)	(1,086)
5,000	2	824	high	3,753	2,697	1,827	760	116	(987)
			low		3,201		1,368		(531)
Total mills	6	1,577							

*/ Net present value assumes sugar prices per hundred weight for the three scenarios as follows:

Scenario	1983-96
1	$15.00
2	$12.50
3	$10.29

Note: "High" and "Low" are the highest and lowest pollution control annual costs for the various operating mills in each model mill subcategory.

Table VI-8b. Net Present values of integrated model mills with and without BPT and BAT pollution controls in Subcategory I-Louisiana under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */					
				Base 1/	BPT&BAT	Base 2/	BPT&BAT	Base 3/	BPT&BAT
		000		$000					
2,200	3	520	high	1,962	1,324	544	(90)	(740)	(1,431)
			low		1,664		246		(1,255)
3,300	1	233		3,012	2,617	934	540	(842)	(1,312)
5,000	2	824	high	4,880	3,773	2,046	948	(507)	(1,573)
			low		4,231		1,398		(1,115)
Total mills	6	1,577							

*/ Net present value assumes sugar prices per hundred weight for the three scenarios as follows:

Scenario	1983-96
1	$15.00
2	$12.50
3	$10.29

Note: "High" and "Low" are the highest and lowest pollution control annual costs for the various operating mills in each model mill subcategory.

Table VI- 9a. Net present values of non-integrated model mills with and without BAT pollution controls in Subcategory I-Louisiana under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */					
				Base 1/	BAT	Base 2/	BAT	Base 3/	BAT
		000		$000					
2,200	6	1,561	high	1,075	718	281	(86)	(645)	(1,275)
			low		959		166		(854)
3,300	6	2,932	high	1,894	1,451	675	222	(411)	(1,166)
			low		1,754		525		(618)
5,000	9	2,796	high	3,753	2,249	1,827	1,304	116	(415)
			low		3,719		1,782		72
Total mills	21	7,289							

*/ Net present value assumes sugar prices per hundred weight for the three scenarios as follows:

Scenario	1983-96
1	$15.00
2	$12.50
3	$10.29

Note: "High" and "Low" are the highest and lowest pollution control annual costs for the various operating mills in each model mill subcategory.

Table VI-9b. Net present values of integrated model mills with and without BAT pollution controls in Subcategory I-Louisiana under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */					
				Base 1/	BAT	Base 2/	BAT	Base 3/	BAT
		000		$000					
2,200	6	1,561	high	1,962	1,595	554	187	(740)	(1,343)
			low		1,845		429		(922)
3,300	6	2,932	high	3,012	2,559	934	481	(842)	(1,317)
			low		2,863		1,342		(931)
5,000	9	2,796	high	4,880	4,335	2,046	1,522	(507)	(991)
			low		4,883		2,009		(504)
Total mills	21	7,289							

*/ Net present value assumes sugar prices per hundred weight for the three scenarios as follows:

Scenario	1983-96
1	$15.00
2	$12.50
3	$10.29

Note: "High" and "Low" are the highest and lowest pollution control annual costs for the various operating mills in each model mill subcategory.

Table VI- 10. Net present values of model mills with and without BPT pollution controls in Subcategory III-Hawaii (Hilo Coast) under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */ Base 1/	BPT	Base 2/	BPT	Base 3/	BPT
		000		------------	------------	------------	$000 ------	------------	------------
1,800 (Non-integrated)	1	732	NA	4,094	2,628	2,024	556	760	(1,519)
3,300 (Integrated)	2	2,912	High	27,835	21,691	15,776	10,635	8,399	3,873
			Low	--	21,804	--	10,178	--	3,980
4,800 (Integrated)	1	1,954	NA	41,208	40,346	24,317	23,877	13,989	13,805
Total mills	4	5,598							

*/ Net present value assumes a sugar price per hundred weight for the price scenarios as follows:

Scenario	1977-79	1980-82
1	$18.76	$13.76
2	$13.76	$11.24
3	$11.24	$ 9.05

Table VI-11 Net present values of model mills with and without BPT & BAT pollution controls in Subcategory III-Hawaii (Hilo Coast) under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */ Base 1/	BPT&BAT	Base 2/	BPT&BAT	Base 3/	BPT&BAT
		000		$000					
1,800 (Non-integrated)	1	732	NA	5,172	3,114	2,536	469	194	(5,784)
3,300 (Integrated)	2	2,912	High	38,217	28,478	22,800	14,402	9,158	1,914
			Low	--	31,737	--	16,896	--	3,765
4,800 (Integrated)	1	1,954	NA	57,953	52,633	36,368	31,605	17,267	12,759
Total mills	4	5,598							

*/ Net present value assumes a sugar price per hundred weight for the three scenarios as follows:

Scenario	
1	$13.76
2	$11.74
3	$ 9.05

Table VI-12. Net present values of model mills with and without BPT pollution controls in Subcategory V-Puerto Rico under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */					
				Base 1/	BPT	Base 2/	BPT	Base 3/	BPT
		000		$000					
4,500	6	2,932	high	3,279	2,742	1,089	550	(624)	(1,299)
			low		3,275		1,085		(628)
8,000	3	2,409	high	9,325	8,562	5,410	4,564	2,984	2,056
			low		9,323		6,008		2,982
Total mills	9	5,341							

*/ Net present value assumes sugar prices per hundred weight for the three scenarios as follows:

Scenario	1977-79	1980-82
1	$20.00	$15.00
2	$15.00	$12.00
3	$12.50	$10.29

Note: "High" and "low" are the highest and lowest pollution control annual costsfor the various operating mills in each model mill subcategory.

Table VI- 13. Net present values of model mills with and without BPT and BAT pollution controls in Subcategory V-Puerto Rico under various price scenarios

Model Mill capacity TPD	No. of mills	Annual production cwt/sugar	Range of pollution control costs	Net Present Value */					
				Base 1/	BPT&BAT	Base 2/	BPT&BAT	Base 3/	BPT&BAT
		000		$000					
4,500	5	2,426	high	3,366	2,330	569	(598)	(3,559)	(5,576)
			low		3,600		728		3,354
8,000	3	2,409	high	12,906	10,780	7,928	5,802	3,327	1,201
			low		13,441		8,339		3,625
Total mills	8	4,835							

*/ Net present value assumes sugar prices per hundred weight for the three scenarios as follows:

Scenario	1983-96
1	$15.00
2	$12.50
3	$10.29

Note: "High" and "low" are the highest and lowest pollution control annual costs for the various operating mills in each model mill subcategory.

C. Production Effects

The impact of pollution controls on the production of raw cane sugar was analyzed by the methodology described in Chapter IV. In essence, the various model plants in the three impacted subcategories were subjected to a shut down analysis using the discounted cash flow or net present value method. The cane sugar mills were grouped around the representative model plants, with production, costs and returns for each mill adjusted to the model plant equivalency. Through this procedure, a range of net present values was approximated for each mill and presented under "Financial Effects" in the previous section of this Chapter as Tables VI-7 through VI-13 . These tables show NPV's under various pollution control and price alternatives.

1. Potential Mill Closures

As discussed under "Price Effects" in this chapter, several price scenarios were used to analyze the impact of pollution controls. Potential baseline and pollution control closures under each of three price alternatives are presented in Tables VI-14 through VI-16 for the three impacted areas. Each subcategory will be discussed separately.

Subcategory I-Louisiana--Under price scenarios 1 ($20.00 and $15.00/cwt) and 2 ($15.00 and $12.50/cwt), no baseline closures are expected in Louisiana by 1977 among the eight plants requiring BPT pollution controls. If prices fall to scenario 3 level ($12.50 and $10.29/cwt), as many as six of the eight mills might close under baseline conditions. There is a somewhat smaller likelihood that a mill integrated with a cane farm would close than would a similar sized non-integrated mill. Such potential baseline closures have an estimated annual raw sugar production of 1,258,000 cwt. or 2.3 percent of the 1977 estimated U.S. production. These figures are shown in Table VI- 14 .

BPT pollution control requirements threaten potential closures when price scenario 2 ($15.00 and $12.50/cwt) is reached (Table VI-14). One plant with 151,000 cwt of production (0.3 percent of U.S. production) might close. Moving to scenario 3 ($12.50 and $10.29/cwt), four to seven of the eight mills requiring BPT might close, representing 1,223,000 to 1,743,000 cwt of raw sugar (2.2 to 3.2 percent of U.S. production).

Six of the eight plants requiring BPT controls will also have to install BAT controls by 1983. Under price scenario I-2 ($20.00, $15.00 and $12.50/cwt), no baseline closures are expected. However, under scenarios 1-3 ($20.00 $15.00 and $10.29/cwt), 2-3 ($15.00, $12.50 and $10.29/cwt) and 3-3 ($12.50 $10.29 and $10.29/cwt), four to six mills may close without regard to pollution control, mills with up to 1,577,000 cwt. of production (2.9 percent of U.S. total production). Interestingly enough the slightly more

Table VI- 14. Estimated closures due to BPT pollution control under alternative price levels for cane sugar mills by subcategory

	I-Louisiana Non-integrated	I-Louisiana Integrated	III-Hawaii (Hilo Coast)	V-Puerto Rico	Total 1/	Percent of U. S. total 1/
Price 2 2/						
Baseline						
Number of plants minimum	0	0	0	0	0	
Number of plants maximum	0	0	0	0	0	
Production minimum	0	0	0	0	0	
Production maximum	0	0	0	0	0	
BPT						
Number of plants minimum	0	0	0	0	0	
Number of plants maximum	1	0	0	0	1	
Production minimum	0	0	0	0	0	
Production maximum	151	0	0	0	151	0-0.3
Price 3						
Baseline						
Number of plants minimum	3	0	0	7	7- 10	
Number of plants maximum	6	6	0	7	13	
Production minimum	520	0	0	2,932	2,932-3,452	5.3-6.3
Production maximum	1,258	1,258	0	2,932	4,190	7.6
BPT						
Number of plants minimum	0	1	1	0	1- 2	
Number of plants maximum	4	7	1	0	5- 8	
Production minimum	0	233	732	0	732- 965	1.3-1.8
Production maximum	1,223	1,743	732	0	1,955-2,475	3.6-4.5

1/ Range of numbers represents the differences between integrated and non-integrated mills in Louisiana.

2/ Prices per hundredweight of raw sugar for the various scenarios are as follows:

Scenario	1977-79	1980-82
2	$15.00	$12.50
3	$12.50	$10.29

profitable integrated mills have lower net present values and are more likely to close than non-integrated mills because of the much larger investment base due to the inclusion of land value for the integrated mill-cane farm. In scenario 2-2 ($15.00, $12.50 and $12.50 cwt), only one small mill is a likely baseline closure (151,000 cwt or 0.3 percent of U.S. production). (See Table VI-15).

When BAT requirements are added to the six mills discussed above, possible impacts occur in scenario 1-2 (Table VI-15). One to three mills with 151,000 to 520,000 cwt of production (0.3 to 0.9 percent of U.S. production) might close. Scenario 1-3 might result in four to six closures, or a loss of 23,000 to 1,577,000 cwt of production (1.4 to 2.9 percent of U.S. production). The possible impacts of BAT under scenarios 2-2, 2-3 and 3-3 are also shown in Table VI-15. Under these price scenarios, the number of baseline closures increases and the number due to BAT decreases. Under 2-2, BAT could affect one to three mills with 151,000 to 520,000 cwt of production (same as scenario 1-2). Scenarios 2-3 and 3-3 could cause zero to two mills to close with 824,000 cwt of production (1.5 percent of U.S. production).

There are 21 additional mills requiring BAT controls by 1983 which do not need BPT level controls. In Table VI-16, under price scenarios 0-1 ($15.00/cwt) and 0-2 ($12.50/cwt), there would be no expected baseline closures among these mills. If the price falls to $10.29/cwt by 1983 and remains at that level (scenario 0-3), then 12 to 21 of these mills may close with estimated production of 2,513,000 cwt. (4.6 percent of U.S. production) to 5,697,000 cwt. (10.4 percent of U.S. production). As noted above, integrated operations have lower NPV's and appear more likely candidates for closure because of larger salvage values. Looking only at the non-integrated potential baseline closures, as many as 20 mills with a production of 4,595,000 cwt. might close if price falls to $10.29/cwt by 1977 and remains there or lower. This would represent about 8.4 percent of U.S. production.

Closures among these 21 mills due to BAT alone are also shown in Table VI-16. In scenario 0-2, four mills with 679,000 cwt. of production (1.2 percent of U.S. production) may close due to BAT. Under scenario 0-3, six mills with 2,101,000 cwt. of production (3.8 percent of U.S. production) might close due to BAT.

Subcategory III-Hawaii (Hilo Coast) -- The price alternatives of Subcategory III show no baseline closures.

When BPT is added, only one model mill representing 732,000 cwt. of production or 1.3 percent of U.S. production, appears to be a possible closure. This would occur only under scenario 3 (See Table VI-14). At any higher sugar price, NPV's are positive for this model mill.

Table VI- 15. Estimated closures due to BPT and BAT pollution controls under alternative price levels

	I-Louisiana		III-Hawaii (Hilo Coast)	V-Puerto Rico	Total 1/	Percent of U. S. total 1/
	Non-integrated	Integrated				
Price 1-2 2/						
Baseline						
Number plants minimum	0	0	0	0		
Number plants maximum	0	0	0	0		
Production minimum	0	0	0	0		
Production maximum	0	0	0	0		
BPT and BAT						
Number plants minimum	1	0	0	2	2- 3	
Number plants maximum	3	1	0	5	6- 8	
Production minimum	151	0	0	668	668- 819	1.2-1.5
Production maximum	520	151	0	2,123	2,274-2,643	4.1-4.8
Price 1-3						
Baseline						
Number plants minimum	4	6	0	6	10- 12	
Number plants maximum	4	6	0	6	10- 12	
Production minimum	753	1,577	0	2,555	3,308-4,132	6.0-7.5
Production maximum	753	1,577	0	2,555	3,308-4,132	6.0-7.5
BPT and BAT						
Number plants minimum	2	0	1	0	1- 3	
Number plants maximum	2	0	1	0	1- 3	
Production minimum	824	0	732	0	732-1,556	1.3-2.8
Production maximum	824	0	732	0	732-1,556	1.3-2.8
Price 2-2						
Baseline						
Number plants minimum	1	0	0	0	0- 1	
Number plants maximum	1	1	0	0	1	
Production minimum	151	0	0	0	0- 151	0-0.3
Production maximum	151	151	0	0	151	0.3

Table VI-15 (continued)

	I-Louisiana Non-integrated	I-Louisiana Integrated	III-Hawaii (Hilo Coast)	V-Puerto Rico	Total 1/	Percent of U. S. total 1/
Price 2-2 (continued						
BPT and BAT						
Number plants minimum	3	0	0	2	2- 5	
Number plants maximum	3	1	0	5	6- 9	
Production minimum	520	0	0	668	668-1,188	1.2-2.2
Production maximum	520	151	0	2,123	2,274-2,643	4.3-4.8
Price 2-3						
Baseline						
Number plants minimum	4	6	0	6	10- 12	
Number plants maximum	4	6	0	6	10- 12	
Production minimum	753	1,577	0	2,555	3,308-4,132	6.0-7.5
Production maximum	753	1,577	0	2,555	3,308-4,132	6.0-7.5
BPT and BAT						
Number plants minimum	2	0	1	0	1- 3	
Number plants maximum	2	0	1	0	1- 3	
Production minimum	824	0	732	0	732-1,556	1.3-2.8
Production maximum	824	0	732	0	732-1,556	1.3-2.8
Price 3-3						
Baseline						
Number plants minimum	2	6	1	6	9- 13	
Number plants maximum	2	6	1	6	9- 13	
Production minimum	718	1,577	732	2,555	4,005-4,864	7.3-8.9
Production maximum	718	1,577	732	2,555	4,005-4,864	7.3-8.9
BPT and BAT						
Number plants minimum	2	0	0	0	2	
Number plants maximum	2	0	0	0	2	
Production minimum	824	0	0	0	824	1.5
Production maximum	824	0	0	0	824	1.5

1/ Range of numbers represents the differences between integrated and non-integrated mills in Louisiana

2/ Prices per hundredweight raw sugar for the various scenarios are as follows:

Scenario	1977-79	1980-82	1983 and after
1-2	$20.00	$15.00	$12.50
1-3	$20.00	$15.00	$10.29
2-2	$15.00	$12.50	$12.50
2-3	$15.00	$12.50	$10.29
3-3	$12.50	$10.29	$10.29

Note: Production stated in 000 cwt. of raw sugar.

Table VI-16. Estimated closures due to BAT (only) pollution controls under alternative price levels

	I-Louisiana		III-Hawaii (Hilo Coast)	V-Puerto Rico	Total 1/	Percent of U. S. total 1/
	Non-integrated	Integrated				
Price 0-2 2/						
Baseline						
Number plants minimum	0	0	0	0		
Number of plants maximum	0	0	0	0		
Production minimum	0	0	0	0		
Production maximum	0	0	0	0		
BAT						
Number plants minimum	4	0	0	0	4	
Number of plants maximum	4	0	0	0	4	
Production minimum	679	0	0	0	679	
Production maximum	679	0	0	0	679	1.2
Price 0-3						
Baseline						
Number plants minimum	12	21	0	0	12- 21	
Number plants maximum	12	21	0	0	12- 21	
Production minimum	2,513	5,697	0	0	2,513-5,697	4.6-10.4
Production maximum	2,513	5,697	0	0	2,513-5,697	4.6-10.4
BAT						
Number plants minimum	6	0	0	0	6	
Number plants maximum	6	0	0	0	6	
Production minimum	2,101	0	0	0	2,101	3.8
Production maximum	2,101	0	0	0	2,101	3.8

1/ Range of numbers represents the differences between integrated and non-integrated Louisian mills.

2/ Prices per hundredweight of raw sugar for each of the scenarios are as follows:

Scenario	1983 and after
0-1	$15.00
0-2	$12.50
0-3	$10.29

Note: Production stated in 000 cwt of raw sugar.

Table VI-15 shows the effects of adding BAT to the Hilo Coast model mills. Scenarios 1-3 and 2-3 might cause one mill to close--the same one referred to under BPT above. This mill would be a baseline closure under scenario 3-3.

Subcategory V-Puerto Rico -- Seven of the ten Puerto Rican mills needing BPT controls are possible baseline closure candidates under scenario 3 (Table VI-14), with an estimated production of 2,932,000 cwt. or 5.3 percent of U. S. production.

Imposing BPT requirements on Puerto Rican mills would apparently not cause closures. Price alternative 2 (Table VI-14) shows no likely closures. Under scenario 3, seven of the ten mills are possible baseline closures and, therefore, might close without regard to pollution control. The other three mills should continue to operate even with BPT requirements.

It should be noted that one small mill in Puerto Rico does not fit any of the model mills and that insufficient information is available on which to form a firm judgment. It was assumed that this plant would close under baseline conditions at all price levels.

Nine of the Puerto Rican mills have BAT requirements in addition to BPT. Table VI-15 shows that BAT might cause closure of two to five of these mills (an estimated 668,000 to 2,123,000 cwt of raw sugar, or 1.2 to 3.9 percent of U.S. production) under scenario 1-2 and 2-2. In scenarios 1-3, 2-3 and 3-3, six of the nine mills are potential baseline closures . No closures could be attributed to BAT. Thus, the maximum closures attributable to BAT would be five mills with 3.9 percent of U. S. production.

2. Effects on Industry Growth

The Environmental Protection Agency has not furnished incremental pollution control investment and annual operating costs for new source performance standards (NSPS) for cane sugar mills. Thus, it is not possible to perform a meaningful quantitative impact analysis to determine the effect of NSPS on new mill construction . At the same time, some tentative evaluations may be made based upon observable qualitative and quantitative factors.

Before offering such evaluations, it is necessary to note several variables which will undoubtedly influence decisions to construct new cane sugar milling capacity in the United States. These variables include, but are not limited to, the following:

1. NSPS effluent guidelines and the costs of installing and operating the necessary technology.

2. Price of raw sugar.

3. Growth of cane sugar milling capacity in other countries.

4. Response of beet sugar and corn syrup producers to cane sugar prices.

5. Available land for expanding sugar cane production in the U.S.

For purposes of this analysis, the Effluent Guidelines Division of EPA has estimated that NSPS costs will be equal to or less than BPT plus BAT costs for each category. At the same time, future prices are highly uncertain and must be treated under various price scenarios, as in the previous BPT and BAT analysis. Beyond these two parameters (NSPS costs and the alternative price scenarios), further quantitative analysis is severely limited.

Some general observations about world capacity expansion and beet sugar and corn syrup responses to higher sugar prices were presented in Chapter III, with the conclusion that sugar prices would probably remain above an equilibrium level until after 1980. If this judgment is correct, then prices may remain high enough to encourage new U.S. mill capacity in those geographic regions where sugar cane production can be expanded.

In Hawaii (both Subcategories III and IV), the likelihood of expanding sugar cane acreage is very small. However, there is milling capacity expansion underway in at least three of the four Hilo Coast mills expected to be operating in 1977. This expansion will offset the loss of production resulting from the closure of smaller Hilo Coast mills. Effluent control facilities will reportedly be installed for the expanded capacity, indicating that the mill owners expect the investment in pollution control facilities to be economically feasible.

Louisiana has also experienced the recent closure of smaller mills. No plans for expansion are known at this time, and it is doubtful that Louisiana sugar cane farms would expand very much beyond the 311,000 acres harvested in 1972-73.

Puerto Rico has witnessed a sharp decline in acreage harvested, dropping from 391,000 acres in 1952 to 152,000 acres in 1972. It is reasonable to believe that very high sugar prices could stimulate the redevelopment of some cane farms, but existing milling capacity could be expected to absorb any such increased production.

This leaves the Florida-Texas region (Subcategory II) as the area most likely to construct new cane sugar mills. The most recent construction in the U.S. was a Texas mill, built in 1973. Florida has also expanded capacity during the 1960's and early 1970's. These new mills, larger in size than mills in Louisiana, reportedly meet proposed BPT and BAT pollution control standards and, based on 1973 model plant analysis, appear highly profitable. Therefore, it can be concluded that NSPS costs no greater than BPT plus BAT costs would probably not deter further mill construction in Florida and Texas unless the price of raw sugar falls below ($.10 (1973 dollars).

A rough comparison of BPT plus BAT investment to model plant replacement investment (1973 dollars) appears in Table VI-17. The replacement investment values range generally from $200 to $300 per annual ton of sugar. The BPT plus BAT investment shown in Table VI-17 represents the highest estimated cost on a model mill equivalency basis for any operating mill in each subcategory for which costs were furnished. The percentages of pollution control investment to replacement investment range from 8 percent in Puerto Rico and Louisiana to 16 percent in Hawaii (Hilo Coast). These values are probably overstated in that installing pollution control facilities at the time of new construction would afford some savings in investment as compared to the modification of existing mills.

In summary, NSPS costs not in excess of BPT and BAT costs would not appear to hinder new construction in Florida and Texas. Effects are more doubtful in Louisiana, Hawaii and Puerto Rico, where expanded production does not seem likely but where new or expanded mills might be constructed to replace older, smaller mills. At 1973 prices or lower, NSPS could delay new construction.

D. Employment Effects

Cane sugar plants do not employ a large labor force for the size of their output measured in dollars or tons. Plants generally employ 100 to 150 people. Under the lowest price scenario, it would appear that the maximum number of jobs lost due to mill closure under pollution control would be approximately 1,750 jobs. At the higher price levels, the employment impact would be minor.

The job loss would be concentrated in Louisiana and Puerto Rico. Up to 1250 jobs in Louisiana and 500 jobs in Puerto Rico might be lost. The possibilities for absorption into other sections have not been identified, but with many small mills in Louisiana, the potential for consolidating into larger mills exists, which would create some new jobs. Further, the economic development along the Mississippi River suggests the creation of new jobs within the general area. The potential for mill consolidation in Puerto Rico is apparently very low; consequently, new mill jobs are not likely. Thus, the loss of jobs in sugar cane mills will not materially increase unemployment rates.

Table VI-17. Comparison of maximum BPT plus BAT investment costs with 1973 estimated replacement investment for model plants

Subcategory (TPD capacity)	Estimated Replacement Investment	Maximum BPT + BAT Investment	P.C. Inv. as percent of Replacement Inv.
	----------$000	------------	
I- Louisiana			
2,200	3,000	366	12
3,300	3,800	319	8
5,000	4,900	488	10
III- Hawaii (Hilo Coast)			
1,800	12,000	1,744	15
3,300	17,000	2,743	16
4,800	21,000	3,171	15
V- Puerto Rico			
4,500	6,000	506	8
8,000	8,500	996	12

E. Balance of Payment Effects

The U.S. sugar industry imports about 45 percent of its sugar supply; thus, any loss of U.S. production could increase imports. Whether or not this will occur depends upon the response of the domestic industry.

Corn sweetener production and capacity are being expanded and could offset some if not all of the production decline attributable to pollution controls alone. Too, mills and production are being reorganized as evidenced in Hawaii, and will expand plants to replace smaller, less efficient plants. Whether this would occur in the face of pollution control induced closures has not been determined, but it seems possible that such reorganization would occur without pollution control requirements.

The reorganization of mills and production would appear to be more possible under the scenario of prices remaining above $12.50 per hundredweight. Should prices fall below this level, this prospect does not appear as likely. In response to lower prices near 1973 levels, the production and milling industry would face significant declines in output due to closures; however, closures due to pollution control per se would not be as extensive.

If the maximum amount of lost production due to BPT under the lowest price situation was replaced entirely by imports, the U.S. payments outflow increase would be only about $.5 million. It should be noted that output losses attributable to baseline closures would amount to an additional $1.0 million.

Even under the worst situation, then, pollution control induced increases in trade outflows will not be large relative to U.S. trade. Under higher price situations, the impact on the balance of payments created by pollution control is negligible.

F. Community Impacts

Community impacts will be primarily located in Louisiana and Puerto Rico. The impacts in each area appear to be different.

In Louisiana, the geographic dispersion of sugar cane mills suggests that some production of closed mills could be transferred to other mills. The extent of such transfers may be constrained by ownership patterns (single plant firms) and the availability of milling capacity. Although Louisiana mills, as a whole, normally have some excess capacity, some mill expansion may be necessary to accommodate production transfers. A more precise answer on production transfers would require plant by plant analysis. However, in general, it appears that some of this production could be transferred.

The net reduction in production could lead to some indirect employment impacts on the impact communities. However, of greater importance are those impacts resulting from farm incomes if sugar cane can no longer be grown. At current price levels, the loss of sugar cane as a crop would greatly reduce farm income. However, during the period up to 1973, sugar cane in Louisiana was not a terribly superior crop, as land prices for sugar cane land were reported to be only slightly higher than other agricultural land.

Alternative land uses in Louisiana include soybeans and pasture. These crops would produce a smaller farm income and thus the economic base of the community would be reduced, but not eliminated.

The Puerto Rico situation is believed to be different. Due to the location of mills, the prospect of the remaining mills absorbing lost production does not appear likely. Community impacts are expected both from unemployment and loss of farm income. A loss of sugar cane processing facilities will mean that growers will have to seek alternative crops. A wide range of tropical crops can be grown, but it is expected that these crops will be of lower value and thus a decrease in farm income is expected. These factors suggest that communities dislocations will likely be present in Puerto Rico due to imposition of water pollution controls.

G. Other Impacts

Sugar refiners could be potentially impacted if they are unable to obtain raw sugar supplies; however, it seems probable that imports can be obtained by processors for refining.

VII. LIMITS TO ANALYSIS

A. General Accuracy

Data used were both of primary and secondary nature from industry, contracted government studies, and regularly reported government services. Direct contacts with trade associations and economic analysts were conducted.

Throughout the study an effort was made to evaluate data and other information used and to update these materials wherever possible. Data were reworked so as to make their presentation clearer in light of the purpose of this report and its intended use.

This analysis represents a systematic evaluation of the impact of effluent limitation guidelines on the sugar cane industry, based upon the given data and the step by step methodology described in Chapter IV. However, it should be recognized that the world and U.S. sugar economy is in a state of flux because of very high prices and the prospect of the United States drastically changing its sugar policy. Consequently future conditions and responses in the U.S. industry are quite uncertain. Various price alternatives were analyzed. Different results were obtained depending on the price. The choice of a future price pattern is quite important in determining the impact of pollution controls.

B. Possible Range of Error

Different data series and different sections of the analysis will have different possible ranges of error. Estimated error ranges have an order of magnitude as follows:

	Error Range (%)
1. For number and location of plants	± 1
2. Plant capacities and throughput	± 10
3. Sunk investment	± 20
4. Plant operating costs	± 10
5. Incremental pollution control costs	± 20
6. Future plant numbers and capacity	± 25

Error estimates were not made for prices of sugar, plant closures and production changes. The interrelationship of these factors coupled with the uncertainty regarding future sugar prices are not conducive to error estimation. Projections of price at this juncture could be ± 100 percent in error. Within a price pattern alternative, the estimate of plant closures is believed to be within + 15 percent. It was impossible to estimate actual net production losses in terms of the total sweetener supply. Mill expansion, cane sugar production reorganization, and greater use of corn sweeteners have the potential of absorbing pollution control induced production losses so that the estimated production impact could be 100 percent in error.

C. Critical Assumptions

A number of critical assumptions are present. The major ones are briefly discussed below:

Future Industry Structure - The number and size of cane mills were assumed to be similar to the existing situation, assuming that plants in Hawaii would close and expand as reported. With expectations of higher prices over the next six years, closure of smaller plants and expansion of larger plants may occur in anticipation of the need to be more competitive with world producers during the 1980's and after.

Plant Capacity and Throughput - Capacities and throughput of existing plants were assumed to be as stated in Chapters I and II. Available data on these parameters differed. Also interpretations of these values may have differed between the pollution control cost estimates and production profiles. It was assumed that the intepretations were consistent.

Technology - No productivity gains were assumed during the period of analysis. New technology may result in productivity gains.

Cost Levels - It was assumed that real costs would not increase during the period of analysis from 1973 levels. It may be possible that real wage rates and energy costs will increase. If such increases occur, any productivity gains, through technology, could be offset or even reduced.

Sugar Savings - The benefits of sugar savings in Puerto Rico were taken as given by EPA, adjusted to 1973 sugar prices. No sugar savings were taken for any of the other sub-categories.

Land Costs for Mud Disposal - In Subcategory III (Hawaii-Hilo Coast), land costs for mud disposal represent the income lost from land taken out of production. It was assumed that additional acres could not be brought into production to offset this loss. In Louisiana and Puerto Rico, mills were assumed to have disposal sites so that cane land would not be lost.

Model Plant Financial Profiles - Model plant financial profiles were developed from various published and unpublished sources. These cost estimates may not reflect recent pollution control installations but it was assumed that pollution control costs for the incremental requirements to meet the guidelines were additive to the model plant profiles developed in Chapter II.

Puerto Rico - The financial profiles for Puerto Rico were assumed to be representative. They were based upon the best data available to the contractor. Nonetheless, these data were not consistent. Further, these mills are nationalized and are apparently subsidized. It was assumed that further support would not be made to cover pollution controls in estimating plant closures. However, based on apparent experience, the Commonwealth might choose to provide further support. The net result is that the Puerto Rico analysis is the weakest because of its questionable financial data.

D. Remaining Questions

The major remaining questions concern the levels of future sugar prices and the form of future U. S. sugar policy. Implicit in this are questions regarding world sugar consumption and per capita incomes, the ability and willingness of foreign producers to expand sugar production, and their ability to remain as lower cost producers than the United States. With apparent management limitations and possible wage increases, their cost advantage may be eroded.

Another question of importance is the impact of new source performance standards for cane sugar mills. NSPS investment and annual operating costs have not yet been definitely established by EPA. Only a general, qualitative evaluation of this impact was included in Chapter VI. Until precise data on costs are provided, the impact of NSPS on industry growth must remain questionable.

APPENDIX

Appendix Table 1. Subcategory I--Louisiana sugarcane companies, mill location and daily capacity

Company Name	Mill Location	Capacity[1/] (TPD)
Cajun Sugar Co-op., Inc.	New Iberia	6,000
La Fourche Sugar Co. (Leighton Factory)	Thibodaux	6,000
Sterling Sugars, Inc.	Franklin	6,000
South Coast Corp. (Raceland Factory)	Raceland	5,000
Evan Hall Sugar Co-op., Inc.	McCall	5,000
M. A. Patout & Son, Ltd. (Enterprise Factory)	Jeanerette	5,000
Caldwell Sugars Co-op., Inc.	Thibodaux	4,800
Iberia Sugar Co-op., Inc.	New Iberia	4,250
St. James Sugar Co-op., Inc.	St. James	4,200
Dugas & LeBlanc, Ltd. (Westfield Factory)	Paincourtville	4,200
Glenwood Co-op., Inc.	Napoleonville	4,200
Harry L. Laws & Co., Inc. (Cinclare Central Factory)	Brusly	4,200
Supreme Sugar Co., Inc. (Div. of Archer Daniels Midland Co.)	Supreme	4,000
Southdown Lands, Inc.	Houma	4,000
South Coast Corp. (Oaklawn Fact.)	Franklin	4,000
St. Mary Sugar Co-op., Inc.	Jeanerette	4,000
Lula Factory, Inc. (Savoia)	Belle Rose	3,800
Southdown Lands, Inc. (Armant Factory)	Vacherie	3,500
Levert-St. John, Inc.	St. Martinville	3,500
Southdown Lands, Inc. (Greenwood Factory)	Thibodaux	3,400
Valentine Sugars, Inc.	Lockport	3,300
South Coast Corp. (Terrbonne Factory)	Montegut	3,000
Cora-Texas Mfg. Co., Inc.	White Castle	3,000
Helvetia Sugar Co-op., Inc.	Convent	3,000
Meeker Sugar Co-op., Inc.	Le Compte	3,000
A. Wilbert's Sons Lbr. & Shingle Co. (Myrtle Grove Factory)	Plaquemine	2,800
Billeaud Sugar Co.	Broussard	2,750
Louisa Sugar Co-op., Inc.	Louisa	2,600
Jeanerette Sugar Co. (Co-op.)	Jeanerette	2,500
South Coast Corp. (Georgia Fact.)	Mathews	2,400
Alma Plantation, Ltd.	Lakeland	2,400
Breaux Bridge Sugar Co-op., Inc.	Breaux Bridge	2,400
Smithfield Sugar Cooperative, Inc.	Port Allen	2,400

Appendix Table 1. (Continued)

Company Name	Mill Location	Capacity[1/]
		(TPD)
J. Supple's Sons Planting Co., Ltd. (Catherine Factory)	Bayou Goula	2,000
William T. Burton Industries, Inc. (Cedar-Grove Factory)	White Castle	2,000
Caire & Graugnard (Columbia Factory)	Edgard	2,000
Frisco Cane Co., Inc. (San Francisco Factory)	Reserve	2,000
Columbia Sugar Company	Franklin	2,000
Louisiana State University (Audubon Sugar Factory)	Baton Rouge	360
TOTAL DAILY CAPACITY		134,960

1/ Gross cane in short tons per day.

Figure 1. Locations of cane sugar mills in Louisiana.

Appendix Table 2. Subcategory II--Florida and Texas sugarcane companies, location and daily capacity

Company Name	Mill Location	Capacity 1/ (TPD)
Gulf and Western Food Products Co.	South Bay	12,125
United States Sugar Corporation	Bryant	11,000
United States Sugar Corporation	Clewiston	11,000
Sugar Cane Growers Cooperative of Florida	Belle Glade	10,000
Talisman Sugar Corporation	Belle Glade	10,000
Texas	Harlingen	8,500
Atlantic Sugar Association	Belle Glade	5,730
Osceola Farms Company	Pakokee	5,500
Glades County Sugar Growers Co-op. Assoc.	Moore Haven	4,500
TOTAL DAILY CAPACITY		78,355

1/ Gross cane in short tons per day.

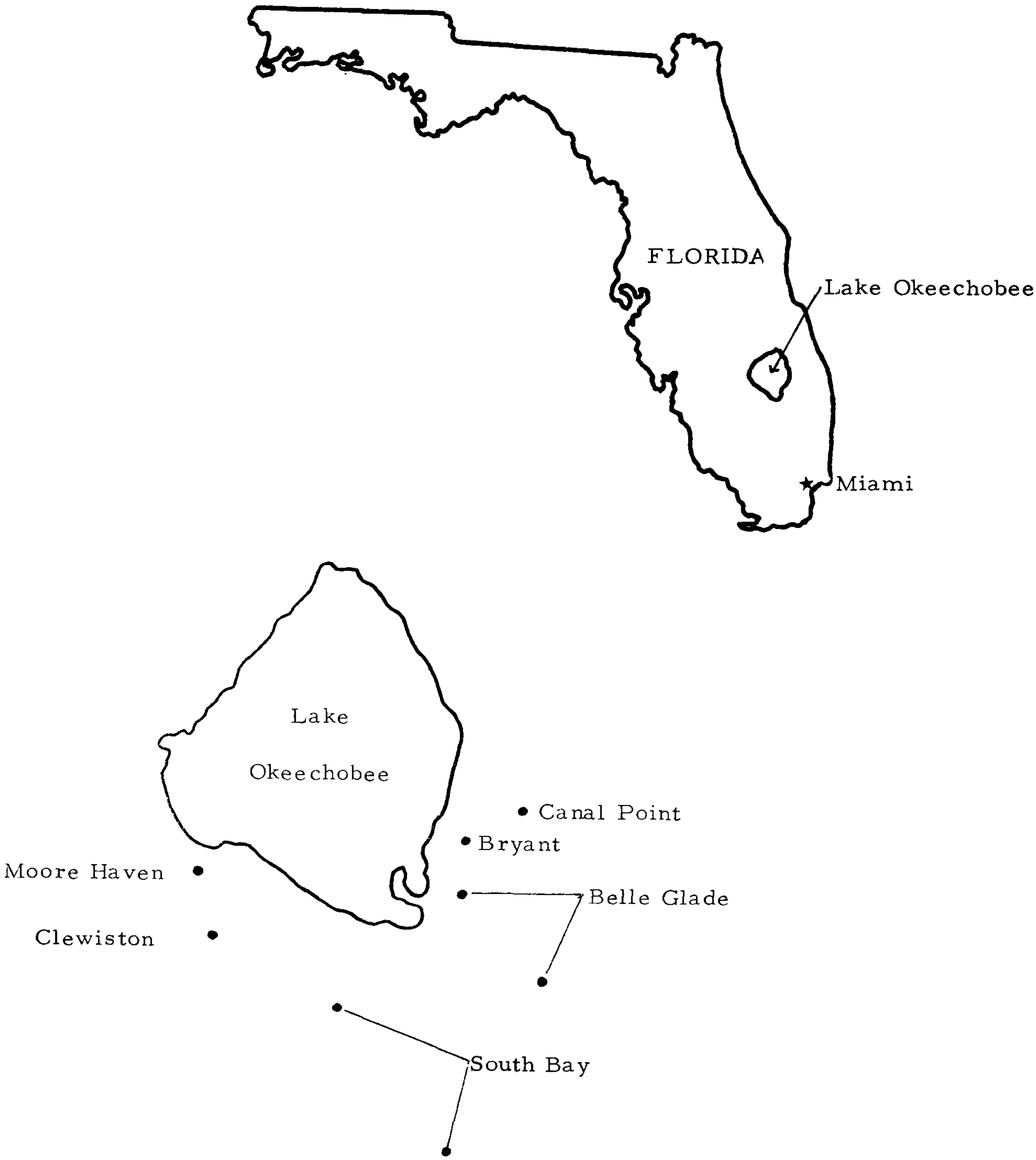


Figure 2. Location of cane sugar mills in Florida.

Appendix Table 3. Subcategory III and IV -- Hawaii sugarcane companies mill, location, and daily capacity

	No.	Company Name	Mill Location	Capacity 1/ (TPD)
	1	Hawaiian Commercial Sugar Co.	Puunene, Maul	6,500
	2	Oahu Sugar Co.	Waipahu, Oahu	5,000
	3	Waialua Sugar Company, Ltd.	Waialua, Oahu	4,600
	4	Puna Sugar Company	Keaau, Hawaii	4,500
	5	Hawaiian Commercial Sugar Co.	Paia, Maui	4,000
	6	Lihue Plantation Company	Lihue, Kauai	3,850
	7	Kekaha Sugar Company, Ltd.	Kekaha, Kauai	3,000
*	8	Laupahoehoe Sugar Company	Ookala, Hawaii	3,000
	9	Kohala Sugar Company	Hawi, Hawaii	2,800 2/
	10	Kau Sugar Company	Pahala, Hawaii	2,800
	11	Pioneer Mill Company, Ltd.	Lahaina, Maui	2,700
*	12	Honokaa Sugar Company	Haina, Hawaii	2,700
	13	Olokele Sugar Company, Ltd.	Kaumakani, Kauai	2,700
	14	Grove Farm Co., Inc.	Koloa, Kauai	2,600
	15	McBryde Sugar Company, Ltd.	Eleele, Kauai	2,000 3/
*	16	Hilo Coast Processing Co.(Co-op)	Wainaku, Hawaii	1,850 3/
	17	Wailuku Sugar Company	Wailuku, Maui	1,800
*	18	Hilo Coast Processing Co.(Co-op)	Pepeekeo, Hawaii	1,800
*	19	Hilo Coast Processing Co.(Co-op)	Papaikou, Hawaii	1,800
*	20	Hilo Coast Processing Co.(Co-op)	Hakalau, Hawaii	1,560 3/
		Total Daily Capacity		61,560

1/ Net cane in short tons per day

2/ Scheduled to close, December, 1975

3/ Scheduled to close, December, 1974

Source: Gilmore Manual -- Louisiana - Florida and Hawaii Sugar Manual Fargo, N.D., 1973 and industry sources

* Subcategory III (Hilo Coast) mills.

Appendix Table 4. Subcategory III and IV - Hawaii sugar cane companies by corporate ownership with mill location and size

I. Alexander & Baldwin, Ltd.		
1. Hawaiian Commercial Sugar Co.	Paia, Maui	4,000
2. Hawaiian Commercial Sugar Co.	Puunene, Maui	6,500
3. McBryde Sugar Co., Ltd.	Eleele, Kauai	2,000
4. Grove Farm Company, Inc.	Koloa, Kauai	2,600
Total		15,100
II. Amfac		
1. Kekaha Sugar Company, Ltd.	Kekaha, Kauai	3,000
2. Oahu Sugar Co.	Wapahu, Oahu	5,000
3. Pioneer Mill Company, Ltd.	Lahana, Maui	2,700
4. Puna Sugar Company	Keaau, Hawaii	4,500
5. Lihue Plantation Company	Lahue, Kauai	3,850
Total		19,050
III. C. Brewer & Company (Hawaiian Sugar Co.)		
1. Olokele Sugar Co., Ltd.	Kaumakani, Kauai	2,700
2. Wailuku Sugar Company	Wailuku, Maui	1,800
3. Kau Sugar Company	Pahala, Hawaii	2,800
Total		7,300
IV. Castle & Cooke, Inc.		
1. Kohala Sugar Company	Hawi, Hawaii	2,800
2. Waialua Sugar Co., Ltd.	Waialua, Oahu	4,600
Total		7,400
* V. Theo H. Davies & Company		
1. Honokaa Mill Company	Haina, Hawaii	2,700
2. Laupahoehoe Sugar Co.	Ookala, Hawaii	3,000
Total		5,700
* VI. Hilo Coast Processing Company (Co-op) 1/	Papaikou, Hawaii	1,800
1. Hilo Coast Processing Company	Papaikou, Hawaii	1,800
2. Hilo Coast Processing Company	Pepeekeo, Hawaii	1,800
3. Hilo Coast Processing Company	Hakalau, Hawaii	1,560
4. Hilo Coast Processing Company	Wainaku, Hawaii	1,800
Total		6,960

1/ 50 percent co-op ownership by Mauna Kea Sugar Co., a plantation, which is a subsidiary of C. Brewer & Co.

* Subcategory III (Hilo Coast) mills.

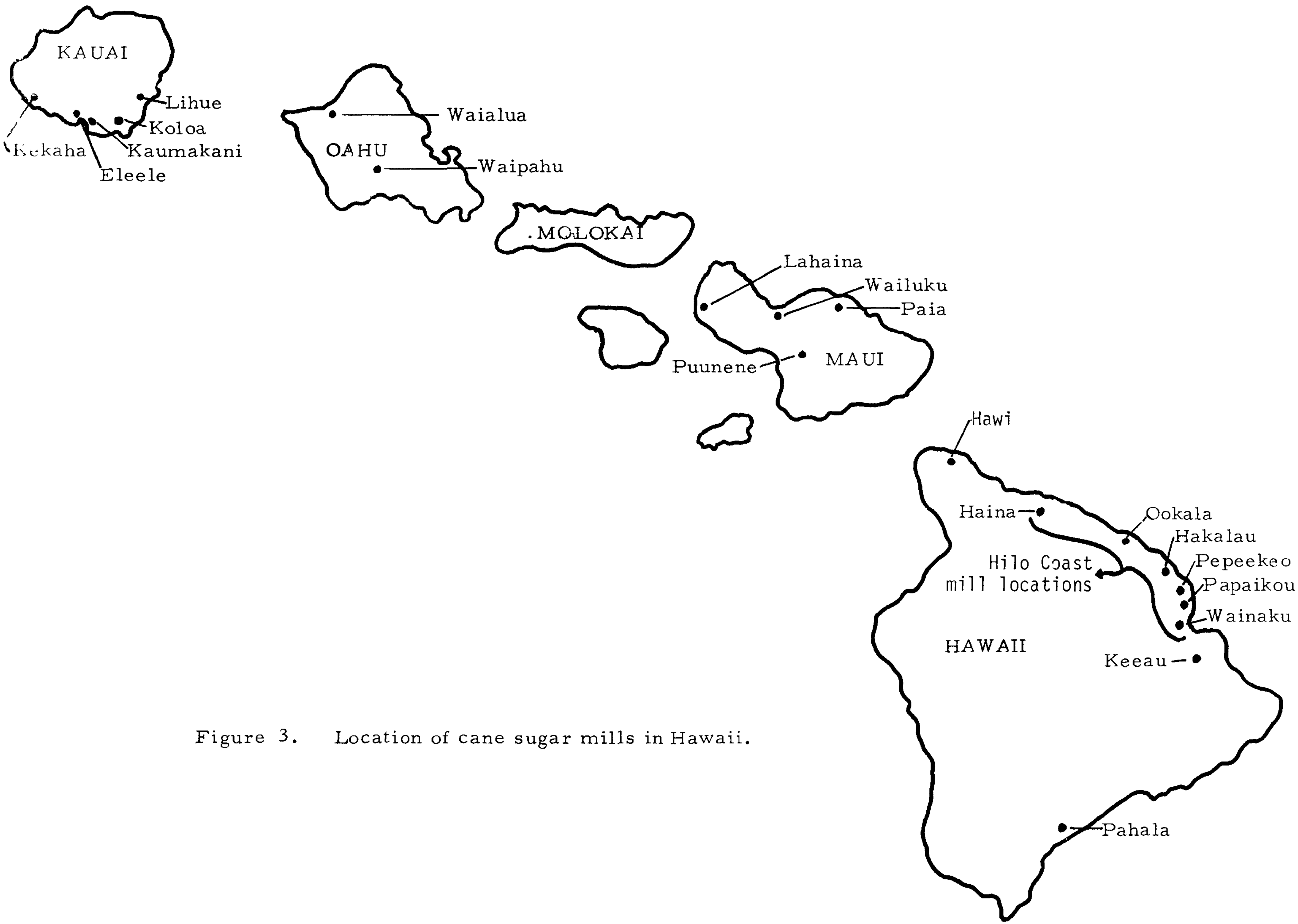


Figure 3. Location of cane sugar mills in Hawaii.

Appendix Table 5. Subcategory V--Puerto Rico sugarcane companies, mill location and daily capacity

Company Name	Mill Location	Capacity 1/
		(TPD)
Central Guanica	Ensenada	8,600
Aquirre Sugar Company	Aguirre	7,500
Central Coloso	Coloso	6,250
Central Mercedita	Mercedita	5,500
Central Cambalache	Arecibo	5,000
Plata Sugar Company	San Sebastian	5,000
Central Roig	Humacao	4,500
Central Eureka	Mayaguez	4,000
Central Igualdad	Mayaguez	4,000
Central Fajardo	Fajardo	3,500
Central San Francisco	Yauco	1,200
TOTAL DAILY CAPACITY		55,050

1/ Gross short tons cane per day.

Source: Industry sources.

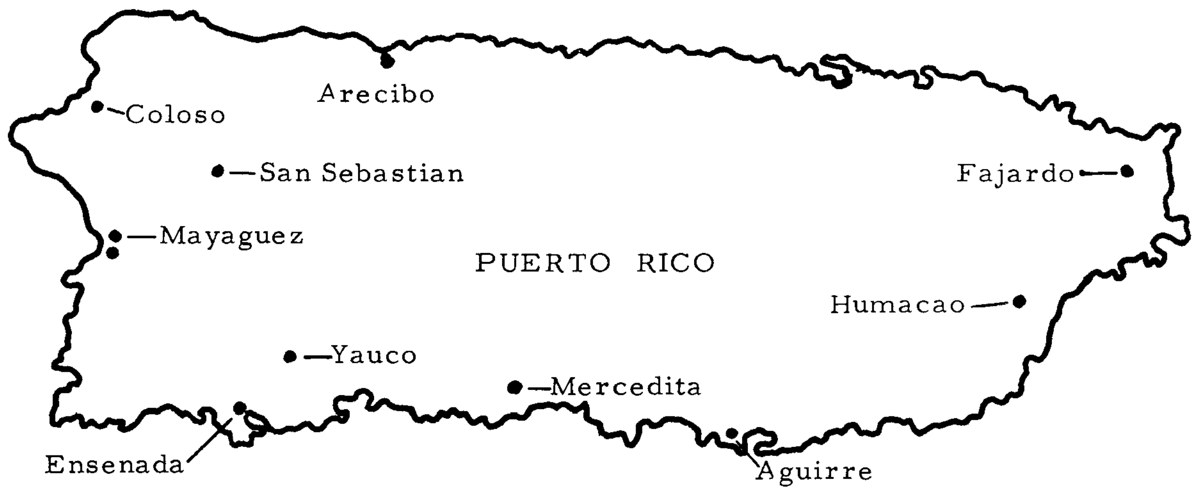


Figure 4. Location of cane sugar mills in Puerto Rico.

Appendix Table 6. Estimated sales, costs and before tax earnings per hundredweight raw sugar for model Louisiana mills, 1973

Capacity Gross Tons Cane/Day	Small 2,200	Medium 3,300	Large 5,000
	------------ $ per cwt raw sugar ------------		
Returns			
Raw sugar	10.29	10.29	10.29
Molasses	1.18	1.18	1.10
Total returns	11.47	11.47	11.39
Direct cost			
Cost of cane	7.81	7.59	7.33
Cost of milling	2.95	2.85	2.70
Total direct costs	10.76	10.44	10.03
Indirect cost	.74	.69	.60
Total operating cost	11.50	11.13	10.63
Depreciation	.16	.22	.26
Interest	.01	.02	.02
Total costs	11.67	11.37	10.91
Before tax profit	9.20)	.10	.48

Appendix Table 7. Estimated sales, costs and before tax earnings per hundredweight raw sugar for model Florida Mills, 1973

	Small	Large
Capacity Gross Tons Cane/Day	6,000	10,000
	---------$ per cwt raw sugar	------------
Returns		
Raw sugar	10.29	10.29
Molasses	.92	.98
Total returns	11.21	11.27
Direct cost		
Cost of cane	6.21	6.04
Cost of milling	2.46	2.13
Total direct costs	8.67	8.17
Indirect cost	.76	.48
Total operating cost	9.43	8.65
Depreciation	.23	.39
Interest	.14	.10
Total costs	9.80	9.14
Before tax profit	1.41	2.13

Appendix Table 8a. Estimated sales, costs and before tax earnings per hundredweight of raw sugar for model mills in Subcategory III-Hawaii (Hilo Coast) 1973

Net TPD	1,800	3,300	4,800
	-------- $ per cwt raw sugar ---------		
Returns			
Raw sugar	9.05	9.05	9.05
Molasses	.46	.46	.48
Processing fees	--	.41	.41
Total returns	9.51	9.92	9.92
Direct cost			
Cost of cane	7.10	6.53	6.53
Cost of milling	1.50	1.68	1.34
Total direct costs	8.60	8.21	7.87
Indirect costs	.55	.90	.90
Total operating cost	9.15	9.11	8.77
Depreciation	.20	.26	.23
Interest	.08	.11	.10
Total costs	9.43	9.48	9.10
Before tax profit	.08	.44	.82

Appendix Table 8b. Estimated sales costs and before tax earnings per hundredweight of raw sugar for model mills in Subcategory IV-Hawaii (Other), 1973

Net TPD	1,800	3,300	4,800
	--------	$ per cwt raw sugar	--------
Returns			
Raw sugar	9.05	9.05	9.05
Molasses	.87	.87	.87
Total returns	9.92	9.92	9.92
Direct costs			
Cost of cane	7.50	7.50	7.50
Cost of milling	1.58	1.16	1.02
Total direct costs	9.08	8.66	8.52
Indirect cost	.57	.51	.45
Total operating cost	9.65	9.17	8.97
Depreciation	.22	.22	.22
Interest	.11	.15	.19
Total costs	9.98	9.54	9.38
Before tax profit	(.06)	.38	.54

Appendix Table 9. Estimated sales, costs and before tax earnings per hundredweight of raw sugar for model mills in Subcategory V-Puerto Rican Mills, 1973

Capacity Gross Tons Cane/Day	Medium 4,500	Large 8,000
	---$ per cwt. raw sugar	-----------
Returns		
Raw sugar	10.29	10.29
Molasses	1.60	1.60
Total returns	11.89	11.89
Direct cost		
Cost of cane	6.35	6.36
Cost of milling	4.30	2.94
Total direct costs	10.65	9.30
Indirect cost	1.01	.78
Total operating cost	11.66	10.08
Depreciation	.21	.22
Interest	.09	.10
Total costs	11.96	10.40
Before tax profit	(.07)	1.49

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15. Supplementary Notes

16. Abstracts The sugarcane milling industry, SIC 2061, is composed of 59 firms operating 79 mills in Louisiana, Florida, Texas, Hawaii and Puerto Rico. Mills demonstrate economies of scale, with the large Florida mills having the highest profit levels. Small mills in other areas appear unprofitable under 1973 prices. Raw sugarcane prices have been relatively stable until 1974, when they reached record levels. Price declines are expected, but a new equilibrium is not expected prior to 1980. The impact of pollution controls was estimated under six price scenarios. An estimated maximum of 4.5 percent of U.S. production might close due to BPT controls and up to 4.8 percent of U.S. production might close due to BPT plus BAT controls. Another 3.8 percent might close due to BAT controls alone. The impact of NSPS is difficult to assess, but at prices above $.10 per pound, little impact is expected. The ultimate impact will depend on future sugar prices, the projection of which is a critical assumption.

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Pollution, water pollution, industrial wastes, sugar, sugarcane, sugarcane mills, economic, economic analysis, discounted cash flow, demand, supply, price, fixed costs, variable costs, community, production, capacity, fixed investment.

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