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# The Sweetener Market in the United States


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## FOREWORD

This study was initiated as a Master's Thesis project under the North Central Regional Research Committee study on the organization and control of the U.S. Food System (NC-117).

The authors are appreciative of the data and assistance provided by members of the sugar processing industry. Numerous personal interviews were made with sugar processor executives to identify characteristics of United States industry. The authors are particularly grateful to the American Crystal Sugar Company for assistance in formulating industry models and transportation rate data.

A special word of appreciation goes to Dr. Donald Scott and Mr. LeRoy Schaffner for their efforts in reviewing the manuscript.

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## Highlights

This study was undertaken to identify the organization and operation of the sugar market in the United States. Per capita consumption of sweeteners has risen approximately 20 percent from 113 pounds in 1970 to 134 pounds in 1976. Caloric and noncaloric sweeteners comprised 126 and 8 pounds in 1976, respectively.

Sugar is the most widely used caloric sweetener. Per capita consumption of sugar was 95 pounds in 1976 followed by corn syrup with 18 pounds. Thirty-five percent of the sugar consumed in the United States in 1976 was produced from domestically grown sugarbeets and 28 percent from domestically grown sugar cane, while the remaining portion was imported. Approximately 60 percent of the refined sugar in the United States was sold to industrial users.

Twelve companies, controlling 56 plants, were involved in refining sugarbeets in the United States in 1976. Thirteen firms controlled 23 plants which refined sugar cane in the United States in 1975.

An analysis of transportation costs indicated no excess sugarbeet plant capacity existed in 1976 in the Upper Midwest sugar producing areas. Excess cane capacity existed on the East, West, and Gulf Coast. Refined beet sugar production is expected to decline slightly by 1985 while sugar cane producing areas are expected to increase production by approximately 15 percent over the same time period.

# THE SWEETENER MARKET IN THE UNITED STATES

by

DONALD E. ANDERSON AND IVEN L. OSE*

As the world's largest sugar importer, United States import demand and production levels have had great effects on world sugar prices, even though the domestic producers were insulated from low world sugar prices. Domestically grown sugar has historically comprised 55 to 60 percent of the sugar consumed in the United States.

This study identifies the consumption of sugar by region and product type, the structure and organization of the sugar industry, and current and future optimum movements of sugar on the basis of freight cost minimization.

## Description of the Sweetener Market in the United States

Sugar grown domestically in the United States has historically exceeded the quantities of sugar imported, the two most recent exceptions being the years 1960 and 1974 (Table 1). Domestically grown sugar has historically comprised 55 to 60 percent of the sugar consumed in the United States. Limited sugar production in the United States and other countries was blamed for the high world sugar prices in 1974 and 1975.[1] Sugar producers in the United States responded to the high prices in 1974 and 1975 with increased production in 1975 and 1976.[2]

The beet sugar share of total United States sugar distribution increased from 23 percent in 1960 to 35 percent in 1976 and the quantity of

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[1]Bohall, Robert, et al., The Sugar Industry's Structure, Pricing, and Performance, Agricultural Economic Report No. 364, United States Department of Agriculture, Economic Research Service, Washington, D.C., March, 1977, p. 4.

[2]United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 3, Washington, D.C., March, 1977, p. 4.

TABLE 1. SUGAR CANE AND BEET: SUPPLY AND UTILIZATION IN THE UNITED STATES, 1960, 1970, and 1976

| Item | 1960 | 1970 | 1976 |
|---|---|---|---|
| | (mil. cwt. refined equivalent) | | |
| Supply | | | |
| Domestic Production | 73 | 110 | 128 |
| Offshore | | | |
| Foreign | 91 | 99 | 84 |
| Territories (primarily Puerto Rico) | 17 | 7 | 4 |
| TOTAL OFFSHORE | 108 | 106 | 88 |
| Beginning Stocks | 37 | 54 | 54 |
| TOTAL SUPPLY[a] | 219 | 269 | 270 |
| Utilization | | | |
| Exports | 1 | 1 | 1 |
| Net Changes in Invisible Stocks | - | 3 | 2 |
| Balancing Items[b] | -1 | 1 | 1 |
| Domestic Disappearance | | | |
| Livestock Feed and Alcohol | c | b | c |
| Military and Civilian | 173 | 209 | 205 |
| TOTAL UTILIZATION | 173 | 216 | 209 |

[a]May not add due to rounding.
[b]Calculated as a residual.
[c]Less than 0.5 million cwt.

SOURCES: United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 2, Washington, D.C., February, 1977, p. 13.

United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Sugar Division, Sugar Statistics and Related Data, Vol. 1 (revised), Statistical Bulletin No. 293, Washington, D.C., March, 1975, p. 1.

beet sugar distributed nearly doubled during that time period. Increases in sugarbeet acreage allocations and basic sugar quotas to the sugarbeet growing areas together with sugar act payments to growers led to the large increases in sugarbeet production.

## United States Sweetener Consumption

Sweeteners in the United States can be divided into two major categories, caloric and noncaloric. The principal caloric sweetener is sugar. The other important caloric sweeteners include corn syrup, dextrose, high fructose corn syrup (HFCS), honey, and the edible syrups of which maple syrup is the most important. The most common noncaloric sweeteners include saccharin and cyclamate. Cyclamate use in food was banned by the Food and Drug Administration in 1970; consequently, saccharin is the primary noncaloric sweetener.

Sugar has historically been the most versatile sweetener as evidenced by its use in many products. It is also the best suited for most household use. During the last several decades some shifts in sweetener use have occurred. Per capita consumption of sugar increased from 97.6 pounds in 1960 to 102.8 pounds in 1972, and then declined to an estimated 95.1 pounds in 1976. Total refined sugar consumption increased from 8.8 million tons in 1960 to 10.1 million tons in 1976. Sugar's share comprised 87 percent of the total caloric sweetener usage in 1960 and declined to 75 percent in 1976. Total caloric sweetener consumption increased from 10.1 million tons in 1960 to an estimated 13.5 million tons in 1976. Most of this increase was in the corn sweetener portion of caloric sweetener.

## Refined Sugar Usage

The increases in sugar prices late in 1974 caused a decline in sugar deliveries during the first three quarters of 1975. Some of the decline in sugar deliveries was attributed to stockpiling on the part of both household and industrial sugar users.[3]

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[3]United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1, No. 3, Washington, D.C., March, 1976, p. 16.

The 1976 sugar deliveries totaled 200,868,131 cwt. Of this total, 60.2 percent was industrial sugar and 24.3 percent was sold in consumer-size packages of less than 50 pounds. The remaining 15.5 percent included government, institutions, sugar dealers, and all other nonindustrial users.[4] The largest industrial user of sugar, the beverage industry, used 43.3 million cwt. in 1976, which represents 21.5 percent of all sugar deliveries and over one-third of all industrial sugar. Bakery, cereal, and allied products accounted for 12.2 percent of the 1976 refined sugar deliveries.

The largest change in sugar usage between 1960 and 1976 occurred in the beverage industry in which refined sugar use increased from 23.0 million cwt. in 1960 to 43.2 million cwt. in 1976 (Table 2). During the same period, the share of total sugar deliveries in consumer-size packages decreased from 34.0 percent to 24.3 percent (Table 3).

Refined sugar in bulk dry form accounted for 13.6 percent of total shipments in 1960 and 32.1 percent in 1976. Liquid sugar sales during the same period increased from 16.4 percent to 21.2 percent of total sugar sales. Packaged granulated sugar (consumer-size packages of less than 50 pounds and industrial and institutional-size packages of 50 pounds and over) declined from 70 percent of total sales in 1960 to 46.8 percent in 1976. Approximately 60 percent of the refined sugar in the United States was sold to industrial users in 1976. Consequently, sugar use is concentrated in those states containing the largest industrial sugar users. Analysis of sugar utilization data revealed that some states received a greater share of total deliveries than their state's share of total United States population. An extreme example of this is the state of Illinois which accounted for 5.27 percent of total United States population[5] in 1974 but received 11.70 percent of total United States refined sugar deliveries (Table 4).

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[4]United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 3, Washington, D.C., March, 1977, p. 4.

[5]United States Department of Commerce, Bureau of the Census, Current Population Reports, Series P-25, Nos. 460, 520, 533, and 534, U.S. Government Printing Office, Washington, D. C.

TABLE 2. SUGAR DELIVERIES BY TYPE OF PRODUCT OR BUSINESS OF BUYER, 1960, 1970, AND 1976

| Product or Business of Buyer | 1960 | | 1970 | | 1976 | |
|---|---|---|---|---|---|---|
| | (000 cwt.) | (%) | (000 cwt.) | (%) | (000 cwt.) | (%) |
| INDUSTRIAL | | | | | | |
| Bakery, Cereal and Allied Products | 20,945 | 12.4 | 29,368 | 13.8 | 24,570 | 12.2 |
| Confectionary and Related Products | 16,077 | 9.6 | 22,124 | 10.4 | 17,332 | 8.6 |
| Ice Cream and Dairy Products | 7,313 | 5.3 | 10,943 | 5.2 | 10,353 | 5.1 |
| Beverages | 22,970 | 13.6 | 47,142 | 22.2 | 43,263 | 21.5 |
| Canned, Bottled, Frozen Foods, Jams, Jellies and Preserves | 15,808 | 9.4 | 18,559 | 8.7 | 13,644 | 6.8 |
| Multiple and All Other Food Uses | 5,938 | 3.5 | 8,510 | 4.0 | 9,793 | 1.0 |
| Nonfood Products | 1,292 | 0.8 | 1,654 | 0.8 | 1,954 | 1.0 |
| Subtotal | 90,352 | 53.6 | 138,301 | 65.1 | 120,910 | 60.2 |
| NONINDUSTRIAL | | | | | | |
| Hotels, Restaurants, Institutions | 1,307 | 0.8 | 1,800 | 0.8 | 1,275 | 0.6 |
| Wholesale Grocers, Jobbers, Sugar Dealers | 50,591 | 30.0 | 43,953 | 20.7 | 40,684 | 20.3 |
| Retail Grocers, Chain Stores, Supermarkets | 24,454 | 14.5 | 26,401 | 12.4 | 25,403 | 12.6 |
| All Other Deliveries Including Deliveries to Government Agencies | 1,755 | 1.1 | 1,967 | 0.9 | 2,595 | 1.3 |
| Unspecified[a] | - | - | - | - | - | - |
| Subtotal | 78,107 | 46.4 | 74,121 | 35.1 | 69,958 | 32.1 |
| TOTAL DELIVERIES | 168,459 | 100.0 | 212,422 | 100.0 | 200,868 | 100.0 |

[a]The Sugar Act of 1948 expired on December 31, 1974, ending the legal obligation of sugar refiners to report to the USDA all sugar deliveries by location and business of buyer. "Unspecified" includes deliveries by refiners unwilling to voluntarily submit specific data on sugar buyers.

SOURCES: United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. II, No. 4, Washington, D.C., April, 1977, p. 15.

United States Department of Agriculture, Agricultural Stablization and Conservation Service, Sugar Statistics and Related Data, Statistical Bulletin No. 293, Washington, D.C., March, 1975, p. 38.

TABLE 3. SUGAR DELIVERIES BY TYPE OF SUGAR OR BUSINESS OF BUYER, 1960, 1970, AND 1976

| Product Form or Business of Buyer | 1960 | | 1970 | | 1976 | |
|---|---|---|---|---|---|---|
| | (000 cwt.) | (%) | (000 cwt.) | (%) | (000 cwt.) | (%) |
| Deliveries in Consumer-Size Packages (less than 50 pounds) | | | | | | |
| Cane Sugar | 48,514 | 28.8 | 40,354 | 19.0 | 39,732 | 19.8 |
| Beet Sugar | 8,813 | 5.2 | 10,529 | 5.0 | 9,058 | 4.5 |
| SUBTOTAL | 57,327 | 34.0 | 50,883 | 24.0 | 48,790 | 24.3 |
| Liquid Sugar | 27,607 | 16.4 | 55,069 | 25.9 | 42,473 | 21.1 |
| Bulk Dry | 22,910 | 13.6 | 59,047 | 27.8 | 64,455 | 32.1 |
| Industrial and Institutional (mostly 100-pound bags) | 60,615 | 36.0 | 47,423 | 22.3 | 45,150 | 22.5 |
| TOTAL DELIVERIES | 168,459 | 100.0 | 212,422 | 100.0 | 200,868 | 100.0 |

SOURCES: United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vo. 2, No. 4, Washington, D.C., April, 1977, p. 15.

United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Sugar Statistics and Related Data, Statistical Bulletin No. 293, Washington, D.C., March, 1975, p. 38.

## Corn and Other Sweeteners

Corn sweeteners have become increasingly important during the past several decades. Regular corn syrup, high fructose corn syrup, and dextrose are derived from refining corn starch. Corn syrup is comprised of maltose, dextrose, and higher sugars. High fructose corn syrup (HFCS) is comprised of 42 percent fructose, 50 percent dextrose, and 8 percent higher sugars.[6] A second generation HFCS became available commercially in 1976 with a fructose content as high as 90 percent. On a

[6]Major, J. N., Jr., President, Old Virginia, Inc., "High Fructose Corn Syrup in Preserves," Corn Annual 1976, Front Royal, Virginia, p. 24.

TABLE 4. HEAVY INDUSTRIAL SUGAR USING STATES, 1974

| State | Percent of U.S. Population | Percent of U.S. Sugar Deliveries |
|---|---|---|
| Illinois | 5.27 | 11.70 |
| California | 9.89 | 10.69 |
| Pennsylvania | 5.60 | 6.53 |
| Ohio | 5.08 | 5.91 |
| Michigan | 4.30 | 4.35 |
| New Jersey | 3.47 | 4.27 |
| Georgia | 2.31 | 3.35 |
| Indiana | 2.52 | 2.55 |
| Missouri | 2.26 | 2.51 |
| Maryland | 1.94 | 2.44 |
| Wisconsin | 2.16 | 2.32 |
| Tennessee | 1.95 | 2.06 |
| Louisiana | 1.78 | 1.92 |
| Delaware | 0.27 | 1.02 |
| Nebraska | 0.73 | 0.92 |
| New Hampshire | 0.38 | 0.41 |

SOURCES: United States Bureau of the Census, Current Population Reports, Series P-25, Nos. 460, 520, 533, and 534.

United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1, No. 2, Washington, D.C., March, 1976, p. 9.

dry basis, regular corn syrup is one-half as sweet as sugar. Dextrose is slightly less sweet than sugar and HFCS is equally as sweet as sugar. The second generation HFCS was rated 20 to 60 percent sweeter than sugar, depending on its application.[7]

Regular corn syrup consumption has increased from 739,000 tons in 1960 to an estimated 1.9 million tons dry basis in 1976. That translates in a doubling of per capita corn syrup consumption of 8.2 pounds per capita in 1960 to an estimated 17.7 pounds in 1976. Dextrose consumption increased from 307,000 tons or 3.4 pounds per capita in 1960 to an estimated 548,000 tons or 5.1 pounds per capita in 1976. HFCS was not commercially available until 1968. Production reached the 125,000-ton level by 1973 and an estimated 750,000 to 800,000 tons in 1976. The change from sugar to HFCS by industrial sweetener users has been occurring

[7]United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1, No. 8, Washington, D.C., September, 1976, p. 22.

more slowly than expected by the corn sweetener industry.[8] Expectations for a one million ton level of HFCS deliveries in 1976 were not reached. Low sugar prices were blamed for this slow change over.[9]

Honey consumption has declined from 105,000 tons or 1.2 pounds per capita in 1960 to 97,000 tons or 0.9 pound per capita in 1976. Over the same period, edible syrup consumption (of which maple syrup is the principal syrup) declined from 73,000 tons (0.8 pound per capita) to 43,000 tons (0.4 pound per capita) (Tables 5 and 6).[10]

Xylitol is a new caloric sweetener produced from xylose, a carbohydrate which is found in wood, corn stalks, peanut shells, and cotton seed hulls. A firm in Switzerland is currently producing xylitol on an experimental basis. Xylitol is rated 20 to 25 percent sweeter than sugar.[11]

Noncaloric sweetener consumption has steadily increased in spite of the ban on cyclamate food use. Saccharin and cyclamate usage are measured on a sugar equivalent basis in the United States Department of Agriculture Sugar and Sweetener Report. Cyclamate is 30 times sweeter than sugar while saccharin is 300 times sweeter. Cyclamate consumption had increased to 2.2 pounds per capita sugar equivalent basis in 1968 before it was banned in 1970. Saccharin consumption increased from 1.9 pounds per capita sugar in 1960 to an estimated eight pounds per capital sugar equivalent basis in 1976.[12] Aspartame, which is 200 times sweeter than sugar, is suitable for table usage, but loses its sweetness in baking.[13]

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[8] United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 2, Washington, D.C., February, 1977, pp. 15-16.

[9] Ibid.

[10] Ibid., p. 28

[11] Chemical Week, "What About Synthetics," November 6, 1974.

[12] United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1, No. 11, Washington, D.C., December, 1976, p. 27.

[13] Changing Times, "Sugar Substitutes: They're Still at Issue," July, 1975.

TABLE 5. PER CAPITA CALORIC AND NONCALORIC SWEETENER CONSUMPTION IN THE UNITED STATES FOR SELECTED YEARS, 1960-1976

| Calendar Year | Refined Sugar | Corn Sweeteners[a] | | | | Minor Caloric[a] | | | Total Caloric | Noncaloric Sweeteners[b] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HFCS | Corn Syrup | Dex-trose | Total | Honey | Edible Syrups | Total | | Sac-charin | Cycla-mate | Total |
| | | | | | | (Pounds) | | | | | | |
| 1960 | 97.6 | - | 8.2 | 3.4 | 11.6 | 1.2 | 0.8 | 2.0 | 111.2 | 1.9 | 0.3 | 2.2 |
| 1965 | 96.8 | - | 11.0 | 4.1 | 15.1 | 1.1 | 0.7 | 1.8 | 11.37 | 4.0 | 1.7 | 5.7 |
| 1970 | 101.9 | - | 14.0 | 4.6 | 18.6 | 1.0 | 0.5 | 1.5 | 122.0 | 6.1 | c | 6.2 |
| 1973 | 101.5 | 1.4 | 16.7 | 4.8 | 22.9 | 0.9 | 0.5 | 1.4 | 125.8 | 5.7 | c | 5.7 |
| 1974 | 96.6 | 2.3 | 17.4 | 4.9 | 24.6 | 0.8 | 0.4 | 1.2 | 122.4 | 7.0 | c | 7.0 |
| 1975[d] | 90.2 | 4.7 | 17.7 | 5.1 | 27.5 | 0.9 | 0.4 | 1.3 | 119.0 | 7.0 | c | 7.0 |
| 1976[d] | 95.1 | 7.1 | 17.7 | 5.1 | 29.9 | 1.0 | 0.4 | 1.4 | 126.4 | 8.0 | c | 8.0 |

[a]Dry basis.
[b]Sugar equivalent basis.
[c]Cyclamate food use was banned by the Food and Drug Administration effective in 1970.
[d]Preliminary or estimate.

SOURCE: United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 2, Washington, D.C., February, 1977, p. 28.

TABLE 6. DISAPPEARANCES FOR FOOD USE OF CALORIC AND NONCALORIC SWEETENERS IN THE UNITED STATES FOR SELECTED YEARS, 1960-1976

| Calendar Year | Refined Sugar | Corn Sweeteners[a] | | | | Minor Caloric[a] | | | Total Caloric | Noncaloric Sweeteners[b] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HFCS | Corn Syrup | Dex-trose | Total | Honey | Edible Syrups | Total | | Sac-charin | Cycla-mate | Total |
| | | | | | | (1,000 tons) | | | | | | |
| 1960 | 8,817 | - | 379 | 307 | 1,046 | 105 | 73 | 178 | 10,041 | 171 | 30 | 201 |
| 1965 | 9,379 | - | 1,068 | 399 | 1,467 | 104 | 72 | 176 | 11,022 | 386 | 165 | 551 |
| 1970 | 10,500 | - | 1,297 | 466 | 1,763 | 97 | 56 | 153 | 12,416 | 633 | c | 633 |
| 1973 | 10,744 | 125 | 1,823 | 504 | 2,452 | 93 | 53 | 146 | 13,342 | 742 | c | 595 |
| 1974 | 10,280 | 250 | 2,085 | 498 | 2,788 | 87 | 47 | 134 | 13,247 | 742 | c | 742 |
| 1975[d] | 9,275 | 500 | 1,886 | 543 | 2,929 | 89 | 45 | 134 | 12,338 | 746 | c | 746 |
| 1976[d] | 10,105 | 800 | 1,903 | 548 | 3,251 | 97 | 43 | 140 | 13,496 | 860 | c | 860 |

[a]Dry basis.
[b]Sugar equivalent basis.
[c]Cyclamate food use was banned by the Food and Drug Administration effective in 1970.
[d]Estimate by author.

SOURCES: Bohall, Robert, et al., The Sugar Industry's Structure, Pricing and Performance, Agricultural Economics Report No. 364, United States Department of Agriculture, Economic Research Service, Washington, D.C., March, 1977.

United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 2, Washington, D.C., February, 1977.

## The Sugarbeet Industry in the United States

Sugarbeet production was separated into seven geographical areas in this study (Figure 1). These areas comprised groups of states having similar growing seasons, average annual rainfall, elevation, competing crops, and irrigation useage. Competing crops in most areas include soybeans, hay, corn, wheat, potatoes, sorghum, and vegetable crops.

In 1976, Area II ranked first in sugarbeet acreage, accounting for 36.9 percent of the nation's 1976 sugarbeet acreage, followed by Area VII with 22.2 percent and Area III with 18.1 percent (Table 7). Area VII had the highest yield in the nation in 1976 with 28.2 tons/acre, followed by Area VI with 24.5 tons/acre. Areas IV and V were tied for third in yield with 20.8 tons/acre. Area VII also led all other areas in production in 1976 with 31.5 percent of the nation's production, followed by Area III with 17.9 percent and Area II with 17.3 percent. Total United States acreage, yield, and production of sugarbeets in 1976 were 1,480,500 acres; 19.9 tons/acre; and 29,427,000 tons; respectively.

## Description of the Sugarbeet Refining Industry in the United States in 1976

Twelve companies were involved in refining sugarbeets in the United States in 1976. The criteria used in determining size were tons of daily beet slicing capacity (TDSC) and average plant size of a firm. Generally, the newer plants were large; therefore, a firm with a low average plant size would tend to have older plants. The location of sugarbeet factories are shown in Figure 2.

Two companies with the greatest daily beet slicing capacity in 1976 were Great Western and American Crystal (Tables 8 and 9). They controlled 39 percent of the nation's daily beet slicing capacity and produced an estimated 34 percent of the beet sugar from the 1975 crop. The six largest firms controlled 87 percent of the nation's total beet slicing capacity and produced 88 percent of the beet sugar from the 1975 crop.

Domestic beet sugar in 1976 accounted for an estimated 35 percent of the nation's sugar consumption (based on USDA estimates); therefore, no beet sugar refining firm could be said to control a significant portion of the total cane and beet sugar market with the possible exception

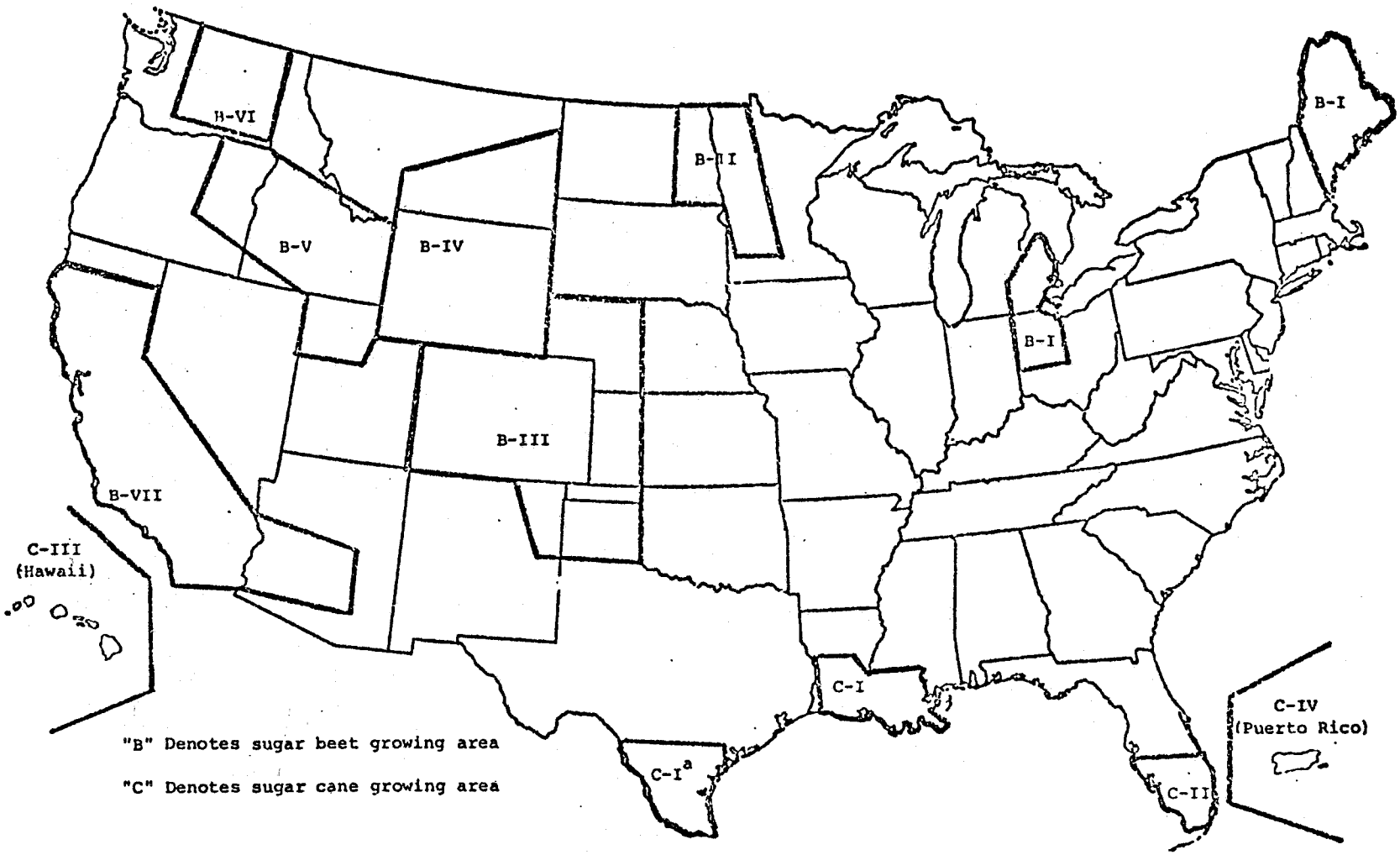


Figure 1. Sugarbeet and Sugar Cane Producing Areas of the United States and Puerto Rico, 1976

TABLE 7. SUGARBEET ACREAGE HARVESTED, YIELD, AND PRODUCTION IN THE UNITED STATES, 1960, 1970, AND 1976

| State | Acreage Harvested | | | Yield Per Acre | | | Production | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1960 | 1970 | 1976 | 1960 | 1970 | 1976 | 1960 | 1970 | 1976 |
| | (000 acres) | | | (tons) | | | (000 tons) | | |
| Area I | | | | | | | | | |
| Maine | - | - | 7.0 | - | 8.6 | | - | - | 60.0 |
| Michigan | 67.9 | 89.9 | 91.4 | 13.9 | 21.3 | 16.8 | 943.0 | 1,913.0 | 1,536.0 |
| Ohio | 22.4 | 39.1 | 36.5 | 14.6 | 18.8 | 16.9 | 328.0 | 735.0 | 1.536.0 |
| Other Eastern | 7.5 | - | - | 11.2 | - | - | 84.0 | - | - |
| Total[a] | 97.8 | 129.0 | 134.9 | 13.9 | 20.5 | 16.4 | 1,355.0 | 2,648.0 | 2,213.0 |
| Percent of U.S. Total | 10.2 | 9.4 | 9.1 | 80.3 | 110.8 | 82.4 | 8.2 | 10.5 | 7.5 |
| Area II | | | | | | | | | |
| Minnesota | 80.8 | 150.5 | 248.0 | 12.6 | 12.0 | 12.2 | 1,018.0 | 1,811.0 | 3,026.0 |
| North Dakota | 42.5 | 93.3 | 150.0 | 13.3 | 11.5 | 13.8 | 564.0 | 1,070.0 | 2,070.0 |
| Iowa | 1.4 | 1.7 | - | 12.8 | 13.7 | - | 18.0 | 23.0 | - |
| South Dakota | 6.2 | - | - | 12.1 | - | - | 75.0 | - | - |
| Total[a] | 130.9 | 245.5 | 398.0 | 12.8 | 11.8 | 12.8 | 1,675.0 | 2,904.0 | 5,096.0 |
| Percent of U.S. Total | 13.6 | 18.0 | 36.9 | 74.0 | 63.8 | 64.3 | 10.1 | 11.5 | 17.3 |
| Area III | | | | | | | | | |
| Colorado | 155.1 | 145.2 | 121.0 | 17.8 | 16.4 | 19.1 | 2,761.0 | 2,383.0 | 2,303.0 |
| Kansas | 9.0 | 43.8 | 38.0 | 17.1 | 16.1 | 19.7 | 154.0 | 706.0 | 749.0 |
| Nebraska | 68.7 | 78.7 | 84.5 | 17.8 | 17.4 | 20.0 | 1,226.0 | 1,365.0 | 1,690.0 |
| New Mexico | 0.6 | 2.4 | 0.9 | 11.0 | 16.5 | 22.2 | 7.0 | 39.0 | 20.0 |
| Texas | 1.7 | 28.8 | 23.6 | 18.8 | 20.0 | 21.6 | 33.0 | 575.0 | 510.0 |
| Total[a] | 235.1 | 298.9 | 268.0 | 17.8 | 17.0 | 19.7 | 4,181.0 | 5,068.0 | 5,272.0 |
| Percent of U.S. Total | 24.4 | 21.9 | 18.1 | 102.8 | 91.9 | 99.0 | 25.2 | 20.0 | 17.9 |
| Area IV | | | | | | | | | |
| Montana | 60.6 | 56.9 | 46.1 | 13.9 | 16.2 | 21.0 | 841.0 | 921.0 | 968.0 |
| Wyoming | 41.5 | 59.0 | 56.4 | 15.3 | 16.2 | 20.7 | 634.0 | 955.0 | 1,167.0 |
| Total[a] | 102.0 | 115.9 | 102.5 | 14.5 | 16.2 | 20.8 | 1,475.0 | 1,876.0 | 2,135.0 |
| Percent of U.S. Total | 10.6 | 8.5 | 6.9 | 83.8 | 87.6 | 104.5 | 8.9 | 7.4 | 7.3 |
| Area V | | | | | | | | | |
| Oregon | 20.3 | 20.2 | 14.2 | 23.1 | 21.0 | 25.1 | 470.0 | 424.0 | 365.0 |
| Idaho | 94.9 | 168.9 | 139.4 | 18.3 | 18.4 | 20.7 | 1,740.0 | 3,104.0 | 2,879.0 |
| Utah | 31.6 | 29.1 | 18.0 | 17.0 | 16.4 | 17.7 | 536.0 | 479.0 | 319.0 |
| Total[a] | 146.8 | 218.1 | 171.6 | 18.7 | 18.4 | 20.8 | 2,746.0 | 4,007.0 | 3,563.0 |
| Percent of U.S. Total | 15.3 | 16.0 | 11.6 | 108.1 | 99.5 | 104.5 | 16.5 | 15.8 | 12.1 |
| Area VI | | | | | | | | | |
| Washington | 37.5 | 61.6 | 76.5 | 20.8 | 19.4 | 24.5 | 781.0 | 1,196.0 | 1,874.0 |
| Percent of U.S. Total | 3.9 | 4.5 | 5.2 | 120.2 | 104.9 | 123.1 | 4.7 | 4.7 | 6.4 |
| Area VII | | | | | | | | | |
| Arizona | - | 12.0 | 17.0 | - | 19.0 | 23.0 | - | 227.0 | 391.0 |
| California | 211.4 | 286.1 | 312.0 | 20.8 | 25.8 | 28.5 | 4,397.0 | 7,397.0 | 8,892.0 |
| Nevada | 0.5 | - | - | 14.4 | - | - | 8.0 | - | - |
| Total[a] | 211.9 | 298.1 | 329.0 | 20.8 | 25.6 | 28.2 | 4,405.0 | 7,620.0 | 9,283.0 |
| Percent of U.S. Total | 22.0 | 21.8 | 22.2 | 120.2 | 138.2 | 141.7 | 26.5 | 30.1 | 31.5 |
| United States Total[a] | 962.1 | 1,367.2 | 1,480.5 | 17.3 | 18.5 | 19.9 | 16,618.0 | 25,320.0 | 29,427.0 |
| Percent of U.S. Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

[a] Yield per acre is an average.

SOURCE: United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 2, Washington, D.C., February, 1977, p. 23.

United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Sugar Statistics and Related Data, Vol. II (Revised), Statistical Bulletin No. 244, Washington, D.C., May, 1975, pp. 21-23.

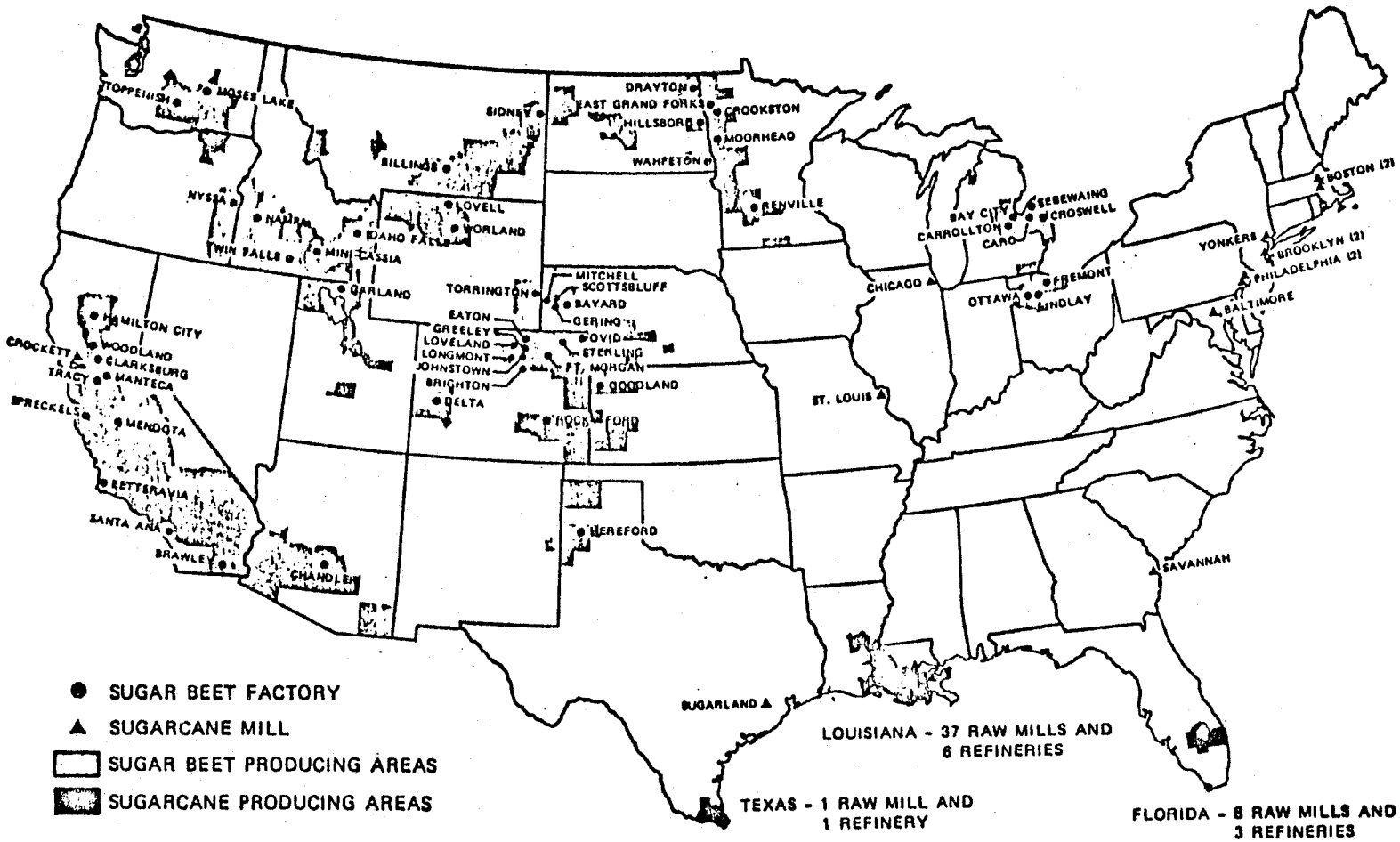


Figure 2. Location of Sugar Crop Production, Beet Sugar Factories, Cane Sugar Mills, and Cane Sugar Refineries in the United States, 1975

SOURCE: Bohall, Robert, et al., The Sugar Industry's Structure, Pricing, and Performance, United States Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 364.

TABLE 8. NUMBER OF PLANTS PER FIRM, DAILY SLICING CAPACITY, AVERAGE DAILY SLICING CAPACITY PER PLANT, LOCATION OF PLANTS AND FIRM OFFICE, AND NUMBER OF PLANTS AMONG THE TEN LARGEST SUGAR BEET REFINING PLANTS IN THE UNITED STATES, 1976

| Size Rank | Company Name | Number of Plants | Total TDSC | Percent of Total | Average TDSC Per Plant | Location | | Number of Plants Among Ten Largest |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Company Office | Plants | |
| 1 | Great Western Sugar Company | 17 | 45,750 | 21.1 | 2,691 | Denver, Co | CO, KS, MT, NE, WY | 0 |
| 2 | American Crystal Sugar Company[a] | 8 | 39,200 | 18.1 | 4,900 | Moorhead, MN | MN, ND | 3 |
| 3 | Holly Sugar Corporation | 9 | 33,000 | 15.3 | 3,667 | Colorado Springs, CO | CA, CO, MT, TX, WY | 2 |
| 4 | Amalgamated Sugar Company | 4 | 26,525 | 12.3 | 6,631 | Ogden, UT | ID, OR | 3 |
| 5 | Spreckels Sugar Division Amstar Corporation | 5 | 21,700 | 10.0 | 4,340 | San Francisco, CA | CA, AZ | 1 |
| 6 | U & I, Incorporated | 4 | 21,600 | 10.0 | 5,400 | Salt Lake City, UT | UT, ID, WA | 1 |
| 7 | Michigan Sugar Company | 4 | 8,950 | 4.1 | 2,237 | Saginaw, MI | MI | 0 |
| 8 | Union Sugar Division Consolidated Foods Corporation | 1 | 5,000 | 2.3 | - | San Francisco, CA | CA | 0 |
| 9 | Minn-Dak Farmers' Cooperative | 1 | 5,000 | 2.3 | - | Wahpeton, ND | ND | 0 |
| 10 | Monitor Sugar Company | 1 | 4,000 | 1.8 | - | Bay City, MI | MI | 0 |
| 11 | Triple A Sugar Company | 1 | 4,000 | 1.8 | - | Easton, ME | ME | 0 |
| 12 | Buckeye Sugars, Incorporated | 1 | 1,600 | 0.7 | | Ottowa, OH | OH | 0 |
| | TOTAL United States | 56 | 216,325 | 100.0 | | | | 10 |

[a]Included in American Crystal capacity is the 6,500 TDSC plant at Renville, Minnesota, which belongs to the Southern Minnesota Beet Sugar Cooperative but operated by American Crystal.

SOURCES: United States Beet Sugar Association, American Beet Sugar Companies, 1975-76 Directory.

Bloomquist, Aldrich, American Crystal Sugar Company; Swartz, Donald, Spreckels Sugar Division, Amstar Corporation; Greaves, Stanley, Pine Tree Sugarbeet Cooperative, Presque Isle, Maine.

TABLE 9. ACREAGE CONTRACTED, SUGAR PRODUCED, AND PERCENTAGE OF TOTAL 1975 BEET SUGAR CROP PRODUCED BY SUGARBEET COMPANIES IN THE UNITED STATES

| Average Plant Capacity Rank | Company Name | Acreage Contracted (Crop Year) 1975 | 1976 | Current Optimum[a] | Sugar Production (Crop Year) 1975 | Est. 1976 | Percent of 1975 Beet Sugar |
|---|---|---|---|---|---|---|---|
| | | | | | (million cwt.) | | |
| 6 | Great Western | 342,000 | 298,500 | 300,000 | 13.6 | 14.1[b] | 18.9 |
| 3 | American Crystal[c] | 347,158 | 398,128 | 407,500 | 10.9 | 12.9 | 15.1 |
| 5 | Holly | 200,000[d] | 200,000[d] | 200,000[d] | 10.7 | 11.7[b] | 14.9 |
| 1 | Amalgamated | 150,000 | 127,000 | 150,000 | 7.0[d] | 7.0[d] | 9.7 |
| 4 | Spreckels | 180,000 | 165,000 | 180,000 | 13.0 | 11.0 | 18.1 |
| 2 | U & I, Incorporated | 160,000 | 162,000 | 160,000 | 8.0[d] | 8.0[d] | 11.1 |
| 7 | Michigan Sugar Company | 63,000[d] | 63,000[d] | 63,000[d] | 3.0[d] | 3.0[d] | 4.2 |
| - | Union Sugar | 42,000[d] | 42,000[d] | 42,000[d] | 3.0[d] | 3.0[d] | 4.2 |
| - | Minn-Dak | 52,000 | 52,000 | 52,000 | 1.4[d] | 1.4[d] | 1.9 |
| - | Monitor | 25,000 | 25,000 | 30,000 | 1.0[d] | 1.0[d] | 1.4 |
| - | Triple A | 0 | 10,000 | 35,000 | 0.0 | 0.3[b] | 0.0 |
| - | Buckeye | 8,200[e] | 8,000[e] | 10,000[e] | 0.4[e] | 0.4[e] | 0.6 |
| | TOTAL United States[f] | 1,569,900 | 1,541,600 | 1,629,500 | 72.0 | 73.8 | 100.0 |

[a]Company officials indicated this was the level of acreage which would best utilize the capacity of all plants owned by the company.
[b]Production estimates by Iven Ose based on 12.5 percent recoverable sugar content of sugarbeets, acreage as provided by the company officials, and yield average of the state in which the plant is located.
[c]Included in American Crystal data is the information on the Southern Minnesota Beet Sugar Cooperative plant at Renville, Minnesota.
[d]Company official was unwilling to give specific figures so figure is approximate annual acreage and production according to the company official.
[e]Estimates by Iven Ose.
[f]Does not necessarily agree with the Sugar and Sweetener Report, United States Department of Agricultural data because many companies were willing to give only rough estimates of acreage contracted and sugar production.

SOURCES: Wherry, Robert, The Great Western Sugar Company
Krabbenhoft, Richard, American Crystal Sugar Company
Chenburg, Marlin, Holly Sugar Corporation
Lipman, Allan, The Amalgamated Sugar Company
Swartz, Donald, Spreckels Sugar Division, Amstar Corporation
Wallentine, Keith, U & I, Incorporated
Flegenheimer, Ernest, Michigan Sugar Company
Carlson, Milton, Union Sugar Division, Consolidated Foods Corporation
Shannon, Jerry, Minn-Dak Farmers' Cooperative
Greaves, Stanley, Pine Tree Sugarbeet Cooperative

of Amstar Corporation which refines both cane and beet sugar. Great Western and American Crystal produced approximately 12 percent of the sugar consumed in the United States in 1976.

## The Cane Sugar Industry in the United States and Puerto Rico

Sugar cane is produced in Texas, Louisiana, Florida, Hawaii, and Puerto Rico. Domestically produced cane sugar provided approximately 29 percent of the sugar consumed in the United States in 1960. This share decreased to approximately 28 percent of the sugar consumed in 1976.[14] Domestically grown sugar cane is initially processed at a local sugar mill. Raw sugar is produced at the mill and shipped to a cane sugar refinery where it is refined for use in food. Raw sugar is 93.46 percent pure; that is, 93.46 pounds of refined sugar is produced from 100 pounds of raw cane sugar.[15]

Most cane sugar refineries are located near ports in the northeastern United States and the New Orleans area. Large cane refineries are also located at Crockett, California; Sugar Land, Texas; and Savannah, Georgia. Close proximity to ports and large population centers provide refiners with readily accessible supplies and nearby markets.

### Sugar Cane Production and Milling

The sugar cane producing areas were divided into four general areas. Area I includes the south central United States, Area II includes Florida, Area III includes Hawaii, and Area IV includes Puerto Rico (Tables 10 and 11). References to "domestically grown" sugar cane include all four sugar cane growing areas, whereas; "United States-grown" refers only to Areas I, II, and II, since Puerto Rico is considered a "domestic source" for sugar in U.S.D.A. sugar statistics publications.

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[14] United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Washington, D.C., Vol. 2, No. 2, February, 1977, p. 24, Vol. 2, No. 3, March, 1977, pp. 10-11.

[15] United States Department of Agriculture, Agricultural Stabilization Service, Sugar Statistics and Related Data, Statistical Bulletin No. 293, Washington, D.C., March, 1975.

TABLE 10. SUGAR CANE ACREAGE, YIELD, SUGAR CANE PRODUCED, AND RAW CANE SUGAR PRODUCTION IN THE UNITED STATES AND PUERTO RICO, 1960, 1970, AND 1976

| State and Area | Acreage Harvested | | | Yield Per Acre | | | Sugar Cane Production | | | Raw Cane Sugar Production | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1960 | 1970 | 1976 | 1960 | 1970 | 1976 | 1960 | 1970 | 1976 | 1960 | 1970 | 1976 |
| | (000 acres) | | | (tons) | | | (000 tons) | | | (000 tons) | | |
| Area I | | | | | | | | | | | | |
| Texas | -- | -- | 35.9 | -- | -- | 37.7 | -- | -- | 1,354.0 | -- | -- | 131.0 |
| Louisiana | 279.4 | 285.4 | 312.0 | 21.9 | 26.1 | 25.0 | 6,111.0 | 7,441.0 | 7,800.0 | 471.0 | 603.0 | 650.0 |
| Total | 279.4 | 285.4 | 347.9 | 21.9 | 26.1 | 62.7 | 6,111.0 | 7,441.0 | 9,154.0 | 471.0 | 603.0 | 781.0 |
| Percent of Total Domestic | 36.7 | 39.0 | 41.3 | 61.5 | 67.1 | 72.7 | 22.6 | 26.2 | 30.0 | 17.6 | 22.0 | 25.7 |
| Area II | | | | | | | | | | | | |
| Florida | 50.7 | 178.5 | 269.5 | 31.8 | 33.4 | 32.9 | 1,611.0 | 5,955.0 | 8,862.0 | 158.0 | 649.0 | 900.0 |
| Percent of Total Domestic | 6.7 | 24.4 | 32.0 | 89.3 | 85.9 | 90.0 | 5.9 | 20.9 | 29.1 | 5.9 | 23.7 | 29.6 |
| Area III | | | | | | | | | | | | |
| Hawaii | 103.6 | 113.8 | 104.8 | 83.2 | 91.9 | 85.0 | 8,613.0 | 10,457.0 | 8,891.0 | 936.0 | 1,162.0 | 1,050.0 |
| Percent of Total Domestic | 13.6 | 15.6 | 12.4 | 233.7 | 136.2 | 234.8 | 31.8 | 36.8 | 29.1 | 35.0 | 42.4 | 34.5 |
| United States Total | 433.7 | 577.7 | 722.0 | 37.7 | 41.3 | 37.3 | 16,355.0 | 23,853.0 | 26,907.0 | 1,565.0 | 2,414.0 | 2,731.0 |
| Percent of Total Domestic | 56.9 | 79.0 | 85.6 | 105.9 | 106.2 | 103.0 | 60.3 | 88.9 | 88.1 | 58.5 | 88.2 | 89.8 |
| Area IV | | | | | | | | | | | | |
| Puerto Rico | 328.1 | 153.4 | 121.3 | 32.8 | 29.9 | 29.9 | 10,754.0 | 4,582.0 | 3,630.0 | 1,110.0 | 324.0 | 310.0 |
| Percent of Total Domestic | 43.1 | 21.0 | 14.4 | 92.1 | 76.9 | 82.6 | 39.7 | 16.1 | 11.9 | 41.5 | 11.8 | 10.2 |
| Domestic Total | 761.8 | 731.1 | 843.3 | 34.6 | 38.9 | 36.2 | 27,089.0 | 28,435.0 | 30,357.0 | 2,675.0 | 2,738.0 | 3,041.0 |
| Percent of Total Domestic | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Puerto Rican-grown sugar receipts in the United States, raw sugar plus direct consumption sugar, raw sugar equivalent (calendar year) | | | | | | | | | | 896.0 | 352.0 | 205.0 |
| Percent of Total Domestic Crop | | | | | | | | | | 33.5 | 12.9 | 6.7 |

SOURCES: United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 2, Washington, D.C., February, 1977.

United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Sugar Statistics and Related Data, Statistical Bulletin No. 293, March, 1975, and Statistical Bulletin No. 244, May, 1975, Washington, D.C.

TABLE 11. SIZE AND LOCATION OF SUGAR CANE MILLERS IN THE UNITED STATES AND PUERTO RICO, 1973

| State/Ownership | City | Daily Grinding Capacity (tons) |
|---|---|---|
| AREA I | | |
| Texas | | |
| Rio Grande Valley Sugar Growers, Inc. | Santa Rosa | 8,000 |
| Louisiana | | |
| Alma Plantation, Ltd. | Lakeland | 2,400 |
| Billeraud Sugar Co. | Broussard | 2,750 |
| Breaux Bridge Sugar Co-op., Inc. | Breaux Bridge | 2,400 |
| Wm. T. Burton Industries, Inc. | White Castle | 1,868 |
| Cario and Graugnard | Edgard | 1,900 |
| Cajun Sugar Co-op., Inc. | New Iberia | 6,000 |
| Caldwill Sugars Co-op. | Thibodaux | 5,000 |
| Columbia Sugar Company | Franklin | 1,800 |
| Cora-Texa Mfg. Co., Inc. | White Castle | 3,000 |
| Dugast LeBlane, Ltd. | Paihcourtville | 4,500 |
| Evan Hall Sugar Co-op., Inc. | McCall | 5,500 |
| Frisco Cane Co., Inc. | Reserve | 2,000 |
| Glenwood Co-op., Inc. | Napoleonville | 4,500 |
| Helvetia Sugar Co-op., Inc. | Convent | 3,000 |
| Iberia Sugar Co-op., Inc. | New Iberia | 4,250 |
| LaFourche Sugar Co. | Thibodauy | 6,300 |
| Harry L. Laws and Co., Inc. | Brusly | 4,200 |
| Levert St. John, Inc. | St. Martinville | 3,500 |
| Louisa Sugar Co-op., Inc. | Louisa | 2,600 |
| Meeker Sugar Co-op., Inc. | LeCompte | 3,000 |
| M.A. Patout and Son, Ltd. | Jeanerette | 4,250 |
| St. James Sugar Co-op., Inc. | St. James | 4,200 |
| St. Mary Sugar Co-op., Inc. | Jeanerette | 4,000 |
| Savoie Industries, Inc.-Lula | Belle Rose | 3,800 |
| Smithfield Sugar Co-op., Inc. | Port Allen | 2,400 |
| South Coast Corp.-Oaklawn | Franklin | 4,500 |
| Georgia | Mathews | 2,500 |
| Tearebonne | Montegut | 3,000 |
| Raceland | Raceland | 5,000 |
| Southdown Lands, Inc.-Southdown | Houma | 3,800 |
| Greenwood | Thibodauy | 3,600 |
| Armant | Vacherie | 3,400 |
| Sterling Sugars, Inc. | Franklin | 6,000 |
| J. Supples and Son Pltg.-Catherin | Bayou Goula | 2,000 |
| Supreme Sugar Co., Inc. | Supreme | 4,000 |
| Valentine Sugars, Inc. | Lockport | 3,300 |
| A. Wilbert's Son Lbr. and Sh. Co. | Plaguemine | 2,800 |
| Duhen Bourgeois Sugar Co. | Jeanerette | 3,000 |
| TOTAL Louisiana | | 136,018 |
| Average Mill Size--Louisiana | | 3,647 |
| AREA II | | |
| Florida | | |
| Atlantic Sugar Association | Belle Glade | 6,000 |
| Glades County Sugar Growers Corp. Assn. | Moore Haven | 5,000 |
| Gulf and Western Food Products Co. | South Bay | 10,000 |
| Osceola Farms Company | Canal Point | 7,500 |
| Sugar Cane Growers Co-op. of Florida | Belle Glade | 13,000 |
| United States Sugar Corp. | Clewiston | 10,000 |
| | Bryant | 10,000 |
| Talisman Sugar Corporation | South Bay | 8,000 |
| TOTAL Florida | | 69,500 |
| Average Mill Size--Florida | | |

- continued -

TABLE 11. SIZE AND LOCATION OF SUGAR CANE MILLERS IN THE UNITED STATES AND PUERTO RICO, 1973

(continued)

| State/Ownership | City | Daily Grinding Capacity |
|---|---|---|
| | | (tons) |
| AREA III | | |
| Hawaii | | |
| Amfac., Inc. | Kekaha | 3,000 |
| | Lilue | 3,850 |
| | Waipahu | 3,200 |
| | Keaau | 4,500 |
| | Lahaina | 2,700 |
| C. Brewer and Co., Ltd. | Pahala | 2,800 |
| | Pepeekeo | 6,960 |
| | Kaumakini | 2,695 |
| | Wailuku | 1,800 |
| Alexander and Baldwin, Inc. | Puunene | 10,500 |
| | Eleele | 2,000 |
| Castle and Cooke, Inc. | Hawi | 2,800 |
| | Waialua | 4,600 |
| Theo. K. Davis and Co. | Paauilo | 2,000 |
| | Papaaloa | 3,300 |
| | Haiwa | 2,700 |
| Bishop Trust Co., Ltd. | Makaweli | N/A |
| Grove Farm Co., Inc. | Puhi | 2,600 |
| TOTAL Hawaii | | 62,005 |
| Average Mill Size--Hawaii | | 3,647 |
| AREA IV | | |
| Puerto Rico | | |
| Aguirre | Aguirre | 7,500 |
| Cambalache | Arecibo | 5,000 |
| Coloso | Coloso | 6,250 |
| Cortada | Santa Isabel | 2,400 |
| Eureka | Mayaguez | 4,000 |
| Fajardo | Fajardo | 3,500 |
| Guanica | Ensenada | 8,600 |
| Igualdad | Mayaguez | 4,000 |
| Lafayette | Arroyo | 3,600 |
| Mercedita | Mercedita | 5,500 |
| Plata | San Sebastian | 5,000 |
| Roig | Humacao | 4,500 |
| San Francisco | Yauco | 1,200 |
| TOTAL Puerto Rico | | 61,050 |
| Average Mill Size--Puerto Rico | | 4,696 |

SOURCE: Jesse, Edward V. and Glen A. Zepp, Sugar Policy Options for the United States, Agricultural Economic Report No. 351, United States Department of Agriculture, Economic Research Service, Washington, D.C., February, 1977, pp. 30-31.

Cooperatives are becoming increasingly important in the raw cane milling industry. Four cooperative mills have been added to the ten already in Louisiana since 1960. Three sugar cooperatives were organized in Florida, and one each in Texas and Hawaii, since 1960. Thirty-one percent of all mills in those states in 1973 were cooperatives, accounting for 29 percent of the raw sugar production.[16] Thirteen percent of the mills in Texas, Florida, and Hawaii in 1960 were cooperatively owned and produced only 8 percent of the sugar. The producers' desire for a marketing outlet for cane and the lack of adequate returns to retain or attract private capital to the cane milling industry are possible reasons for the trend toward cooperative operation and ownership of cane mills.

United States Cane Sugar Refining Industry

A major difference between the sugar cane refining industry and the sugarbeet refining industry is that the beet refinery takes in a bulky raw farm product and produces refined sugar; whereas the cane refinery takes in an intermediate product, raw sugar, and produces refined sugar. The cane mill, located near sugar cane production, reduces the bulk of sugar cane to raw sugar which has nearly the same bulk as refined sugar. Transportation of raw sugar is less costly than that of refined sugar. Raw sugar can be transported like grain, whereas refined sugar must be transported under sanitary conditions in special rail cars or trucks. Consequently, savings can be realized when shipping raw sugar from the production point to the cane sugar refinery which is located near the point of consumption.[17] The sugarbeet refineries on the other hand must ship the refined sugar to the point of consumption which is often distant from the refinery.

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[16]United States Department of Agriculture, Economic Research Service, The Sugar Industry's Structure, Pricing and Performance, Agricultural Economic Report No. 364, Washington, D.C., March, 1977, p. 11.

[17]United States Department of Agriculture, Economic Research Service, Farmer Cooperative Service, Staff Report on Sugar Industry Structure and Pricing, Washington, D.C., January, 1976, p. 21.

Actual quantities of sugar produced by individual sugar refineries is generally unavailable in published form. Capacity information is available, however. Cane sugar refineries are rated on the basis of tons of raw sugar per day. The United States total cane sugar refining capacity was 31,870 tons per day in 1975 (Table 12). When multiplied by 270 operating days per year, this resulted in 8,604,900 ton annual capacity raw equivalent of cane sugar production. Refined cane sugar delivered in the United States in 1976 was 6,938,191 tons raw sugar equivalent.[18] This would indicate that United States cane refineries operated at approximately 81 percent of capacity in 1976.

Puerto Rican cane sugar refineries have an annual production capacity of approximately 500,000 tons, but supply only 150,000 tons for local consumption, leaving over two-thirds of Puerto Rican sugar refining capacity idle. Only 15,000 tons of refined sugar in 1975 and 7,000 tons in 1976 were shipped from Puerto Rico to the United States as "direct consumption sugar." The remaining 87,000 tons in 1975 and 198,000 tons in 1976 were shipped to the United States as raw sugar.[19] Direct consumption sugar from Puerto Rico in the past has accounted for a negligible share of the total sugar consumed in the United States.

## Cane Sugar Industry Concentration and Organization

The cane sugar refining industry is quite concentrated, both in location and share of the market. Thirteen firms were engaged in cane refining in 1976. The four largest firms controlled 63.3 percent of the refining capacity in the United States while the ten largest firms controlled 94 percent of the refining capacity.

The cane refining industry is concentrated regionally. Nearly three-fourths of the United States cane sugar refining capacity is located in the northeast and the south central. The remainder of the cane refining capacity is located in Georgia, Florida, California, Hawaii, Missouri, and Illinois. The northeast contained 42.7 percent of the refining capacity with all refineries located in port cities in the states of New York, Massachusetts, Pennsylvania, and Maryland in 1976 (Table 13). Refineries located in Texas and Louisiana accounted for 31.4 percent of the United States cane sugar refining capacity.

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[18] United States Department of Agriculture, Economic Research Service, op. cit., p. 11.

[19] Ibid., p. 10.

TABLE 12. SIZE, RANK, AND LOCATION OF CANE SUGAR REFINING FIRMS AND REFINERIES IN THE UNITED STATES AND PUERTO RICO, 1975

| Firm Capacity Rank | Firm | Location | Capacity (Tons/Day) | Percent of U.S. Capacity |
|---|---|---|---|---|
| 1 | Amstar Corporation | Brooklyn, NY | 2,100 | 6.6 |
| | | Boston, MA | 1,000 | 3.1 |
| | | Baltimore, MD | 2,600 | 8.2 |
| | | Chalmette, LA | 3,250 | 10.2 |
| | | Philadelphia, PA | 2,100 | 6.6 |
| | TOTAL Amstar | | 11,050 | 34.7 |
| 2 | California & Hawaiian Sugar Company | Crockett, CA | 3,500 | 11.0 |
| | | Aiea, HI | 190 | 0.6 |
| | TOTAL CA and HI | | 3,690 | 11.6 |
| 3 | SuCrest Corporation | Brooklyn, NY | 820 | 2.6 |
| | | Chicago, IL | 850 | 2.7 |
| | | Charleston, MA | 1,200 | 3.8 |
| | TOTAL SuCrest | | 2,870 | 9.0 |
| 4 | Savannah Foods and Industries | Port Wentworth, GA | 2,200 | 6.9 |
| | | Clewiston, FL | 350 | 1.1 |
| | TOTAL Savannah | | 2,550 | 8.0 |
| 5 | Borden | | | |
| | Colonial Sugar Co. | Gramercy, LA | 1,500 | 4.7 |
| | NA Sugar Industries | Belle Glade, FL | 390 | 1.2 |
| | IndusSugars, Inc. | St. Louis, MO | 300 | 0.9 |
| | TOTAL Borden | | 2,190 | 6.9 |
| 6 | National Sugar Refinery | Philadelphia, PA | 2,000 | 6.3 |
| 7 | CPC International, Inc. | Yonkers, NY | 1,800 | 5.6 |
| 8 | Godchaux-Henderson Sugar Company | Reserve, LA | 1,700 | 5.3 |
| 9 | Imperial Sugar Company | Sugar Land, TX | 1,500 | 4.7 |
| 10 | Jim Walter Company South Coast Corp. | Mathews, LA | 700 | 2.2 |
| 11 | Archer Daniles Midland Supreme Sugar Co., Inc. | Supreme, LA | 700 | 2.2 |
| 12 | Zapata-Norness Southdown Sugar, Inc. | Houma, LA | 660 | 2.1 |
| 13 | Glades County Sugar Grower Co-op. Assn. | Moore Haven, FL | 460 | 1.4 |
| | TOTAL United States | | 31,870 | 100.0 |

| Firm Capacity Rank | Firm | Location | Capacity (Tons/Day) | Percent of Puerto Rican Capacity |
|---|---|---|---|---|
| 1 | Puerto Rico Land Adm. | Igualdad, P.R. | 700 | 34.7 |
| 2 | Puerto Rico Land Adm. | Mercedita, P.R. | 600 | 29.7 |
| 3 | Puerto Rico Land Adm. | Humacao, P.R. | 400 | 19.8 |
| 4 | Puerto Rico Land Adm. | Guanica, P.R. | 220 | 10.9 |
| 5 | Ponce Candy | Ponce, P.R. | 100 | 5.0 |
| | TOTAL Puerto Rico | | 2,020 | 100.0 |

SOURCE: David, Milton L., et al., Economic Analysis of Effluent Guidelines: Cane Sugar Refining, Development Planning and Research Associate, Inc., Manhattan, Kansas, November, 1975.

TABLE 13. SIZE AND LOCATION BY REGION OF CANE SUGAR REFINING AND REFINERIES IN THE UNITED STATES, 1976

| Region | Firm | Location | Capacity (tons/day) | Percent of U.S. Capacity |
|---|---|---|---|---|
| NE | Amstar | Brooklyn, NY | 2,100 | 6.6 |
| | Amstar | Boston, MA | 1,000 | 3.1 |
| | Amstar | Baltimore, MD | 2,600 | 8.2 |
| | Amstar | Philadelphia, PA | 2,100 | 6.6 |
| | SuCrest | Brooklyn, NY | 820 | 2.6 |
| | SuCrest | Charleston, MA | 1,200 | 3.8 |
| | National Sugar Ref. | Philadelphia, PA | 2,000 | 6.3 |
| | CPC International | Yonkers, NY | 1,800 | 5.6 |
| | TOTAL Northeast | | 13,620 | 42.7 |
| SE | Savannah Foods & Ind. | Port Wentworth, GA | 2,200 | 6.9 |
| | Savannah Foods & Ind. | Clewiston, FL | 350 | 1.1 |
| | Borden | Belle Glade, FL | 390 | 1.2 |
| | Glades County | Moore Haven, FL | 460 | 1.4 |
| | TOTAL Southeast | | 3,400 | 10.7 |
| S. Central | Amstar | Chalmette, LA | 3,250 | 10.2 |
| | Borden | Gramercy, LA | 1,500 | 4.7 |
| | Godchaux-Henderson | Reserve, LA | 1,700 | 5.3 |
| | Imperial Sugar | Sugar Lane, TX | 1,500 | 4.7 |
| | Jim Walter | Mathews, LA | 700 | 2.2 |
| | Archer Daniels | Supreme, LA | 700 | 2.2 |
| | Zapata-Norness | Houma, LA | 660 | 2.1 |
| | TOTAL South Central | | 10,010 | 31.4 |
| Midwest | SuCrest | Chicago, IL | 850 | 2.7 |
| | Borden | St. Louis, MO | 300 | 0.9 |
| | TOTAL Midwest | | 1,150 | 3.6 |
| SW | C & H | Crockett, CA | 3,500 | 11.0 |
| | C & H | Aiea, HI | 190 | 0.6 |
| | TOTAL Southwest | | 3,690 | 11.6 |
| | TOTAL United States | | 31,870 | 100.0 |

SOURCE: David, Milton L., et al., Economic Analysis of Effluent Guidelines: Cane Sugar Refining, Development Planning and Research Associates, Inc., Manhattan, Kansas, November, 1975.

Generally, the refineries were operated completely separate from the raw cane mills. The four smallest cane refining firms in addition to C & H were integrated with raw cane mills.[20] These five firms controlled 19.5 percent of the cane refining capacity in the United States. C & H accounted for over one-half of the cane refining capacity integrated with raw cane mills.

Concentration of the Sugar Industry In the United States

Nearly one-half of all sugar was delivered by the four largest sugar producers in 1974. Sugar is one of the more concentrated agricultural industries.[21] The top ten producers of sugar delivered nearly three-fourths of all the refined sugar in 1974. There has been little change in the top ten firms' share of total deliveries since 1960 (Table 14).

Cane sugar refineries distributed an average of five to eight times as much sugar per refinery as beet processors.[22] The 1974 average distribution per cane sugar refinery was seven million cwt., while the average for beet processors was 1.1 million cwt.

Most sugar refiners were not engaged in nonsweetener food production. Some exceptions to this rule were Southdown, Holly, and Amstar.[23] The H.L. Hunt firm, owner of Great Western, was engaged primarily in nonsweetener food production.[24]

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[20]Bohall, Robert, et al., The Sugar Industry's Structure, Pricing, and Performance, United States Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 364, Washington, D.C., March, 1977, p. 13.

[21]Ibid., pp. 9-13

[22]United States Department of Agriculture, Economic Research Service, Staff Report on Sugar Industry Structure and Pricing, Washington, D.C., January, 1976, p. 20.

[23]Ibid., p. 20

[24]Bloomquist, Aldrich, op. cit.

TABLE 14. RANKING OF UNITED STATES CANE AND BEET REFINERS BY PERCENTAGE OF SUGAR DISTRIBUTED FOR UNITED STATES CONSUMPTION, 1960, 1965, 1970, 1974, AND 1975

| Company Rankings According to 1975 Share of U.S. Market | 1960 | 1965 | 1970 | 1974 | 1975 |
|---|---|---|---|---|---|
| | | | (percent) | | |
| Top 4 | 52.5 | 48.1 | 43.6 | 48.9 | 48.0 |
| Top 5 to 10 | 21.1 | 24.9 | 26.5 | 25.7 | 28.0 |
| Top 10 | 73.6 | 73.0 | 70.1 | 74.6 | 76.0 |
| Top 11 to 18 | 15.1 | 20.2 | 21.8 | 18.3 | 21.4 |
| Top 18 | 88.7 | 93.3 | 91.9 | 92.9 | 97.4 |
| All Other | 11.3 | 6.8 | 8.1 | 7.1 | 2.6 |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

SOURCE: Bohall, Robert, et al., The Sugar Industry's Structure, Pricing, and Performance, United States Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 364, Washington, D.C., March, 1977, p. 8.

## ANALYSIS OF THE FLOW OF REFINED SUGAR TO UNITED STATES MARKETS

A transportation model was used to determine optimum flows of refined sugar between producing and consuming areas of the United States. Optimum flows of refined sugar were determined using 1975-76 crop production and 1976 consumption. Areas of the United States containing unused or inadequate refinery capacity based on the results of the transportation model were identified.

A description of how the data on the beet sugar supply areas were used in the transportation model is presented followed by similar information of cane sugar supply areas. Next, a summary of refined sugar consuming areas and an explanation of their delineation is presented. Two alternative pricing systems for sugar, simple freight cost and basing point pricing (the system in use at the time of this writing), are then described.

Future levels of production in each beet and cane sugar supply area in the United States and Puerto Rico are discussed along with projections for 1985 for each area. Several scenarios involving United

States government sugar policy and future world sugar prices are developed to project future levels of HFCS and sugar use. Optimum refinery locations for the future and the prospects for the Red River Valley also are analyzed.

## Sources of Refined Beet Sugar

Beet sugar sources were located in each of the seven sugarbeet producing areas. One city was selected in each area as the shipping point for all sugar produced in that area. The shipping point was selected on the basis of location and size among all the beet processing plants in the area (Figure 3). Quantities of sugarbeets produced from the 1975-76 crop in each of the beet growing areas were used to determine supply.[25] The basis used for determining the quantities of sugar available was the sugarbeet tonnage produced in each state, times the sugar recovery rate, times the conversion factor of 0.9346 for converting raw sugar to refined equivalent. Production in each state within an area was summed to determine the total quantity of sugar available from each area (Table 15).

As an example, Moorhead, Minnesota, was chosen as the shipping point for sugar produced in Minnesota and North Dakota. The tonnage of sugarbeets in 1975 was 4,603,000 tons.[26] The recovery average of sugar (raw equivalent) from sugarbeets was 13.6 percent.[27] Example: (4,603,000 tons of sugarbeets) (0.136 recovery rate) (0.9346 conversion factor, raw equivalent to refined equivalent) (20 cwt. per ton) = 11.70 million cwt. of refined sugar.

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[25]"All campaigns which begin not earlier than May of one year and not later than April of the following year are included in the same crop year." The data used was for the 1975 crop year which includes all cane grinding and beet slicing campaigns that began after May 1, 1975, and before April 30, 1976. "1975-76 crop" is synonomous to "1975 crop year." Source: United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Situation, No. 1, Washington, D.C., August, 1975, p. 6.

[26]United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1, No. 11, Washington, D.C., December, 1976, p. 8.

[27]United States Department of Agriculture, Economic Research Service, op. cit., p. 9.

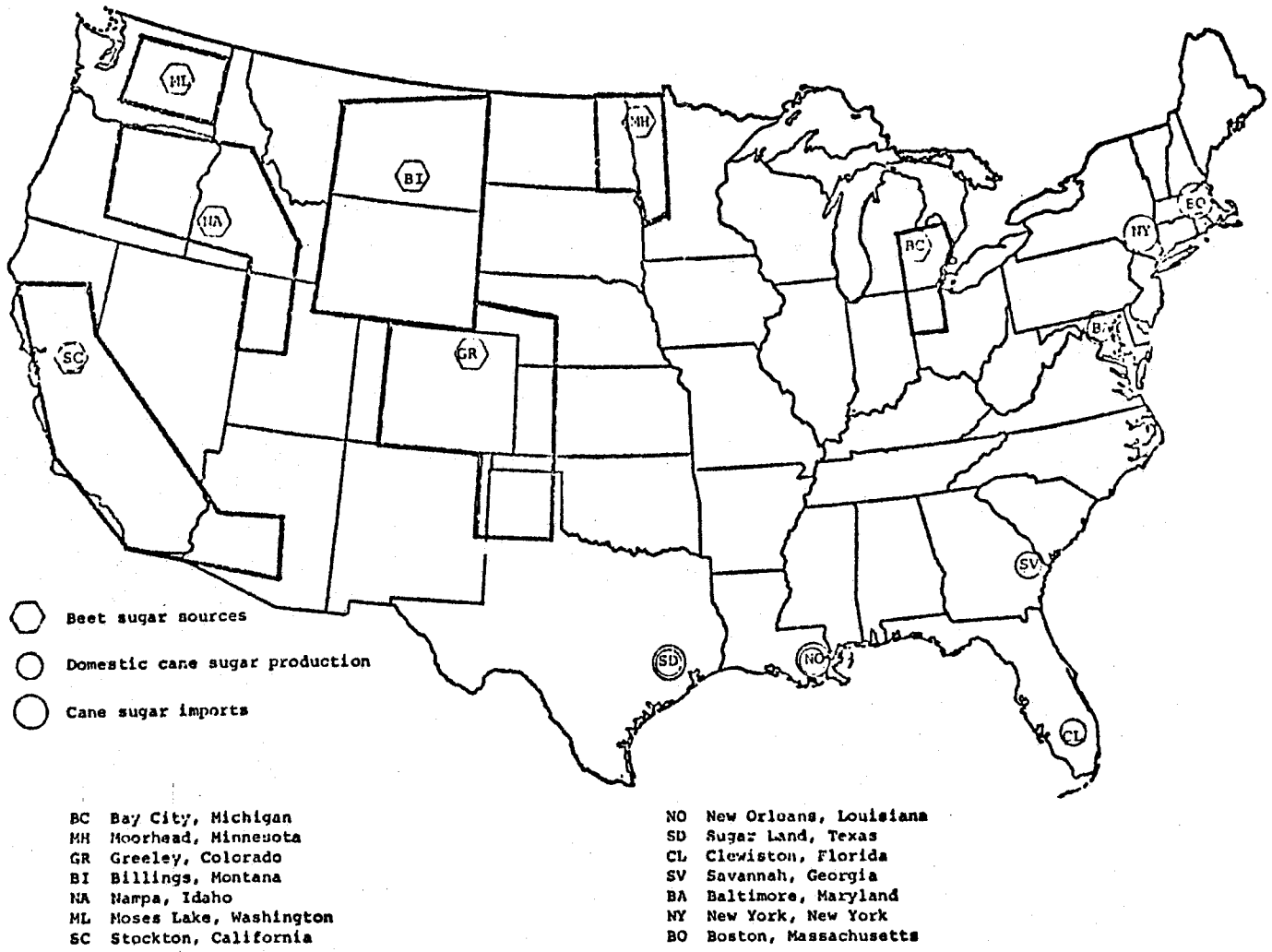


Figure 3. Sugarbeet Growing Areas and Shipping Points of Refined Sugar Used in the Transportation Model

TABLE 15. SHIPPING POINTS OF REFINED BEET SUGAR USED IN THE TRANSPORATATION MODEL, 1975-76 CROP

| Shipping Point | States Included In Area | 1975-76 Sugar Beet Production | Refined Sugar Production[a] |
|---|---|---|---|
| | | (000 tons) | (million cwt.) |
| Bay City, MI | MI, OH | 2,532 | 6.44 |
| Moorhead, MN | MN, ND | 4,603 | 11.70 |
| Greeley, CO | CO, KS, NE, NM, TX | 5,559 | 14.13 |
| Billings, MT | MT, WY | 1,889 | 4.80 |
| Nampa, ID | ID, OR, UT | 3,721 | 9.46 |
| Moses Lake, WA | WA | 2,142 | 5.45 |
| Stockton, CA | CA, AZ | 9,256 | 23.53 |
| UNITED STATES TOTAL | | 29,702 | 75.51 |

[a]Sugar production for the individual areas is based on the United States average recovery rate of 13.6 percent for beet sugar (raw value) for 1975; consequently actual quantities of sugar produced in each area may be slightly higher or lower. Refined sugar production is found by multiplying beet tonnage times 0.136 (the recovery rate of sugar, raw equivalent, from sugarbeets) times 0.9346 (the conversion factor, tons refined per ton raw sugar) times 20 (cwt. per ton).

SOURCE: United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1, No. 11, Washington, D.C., December, 1976, pp. 8-9.

## Sources of Refined Cane Sugar

The shipping points of cane sugar were selected refinery locations. For the purpose of the transportation analysis, refiners located close together in a specific region were assumed to ship all their sugar from the same location. The largest cane sugar refiners were located near seaports and large population centers in order to facilitate the transportation of imported raw sugar to the refinery and refined sugar to markets. Some of the smaller refineries were located in or near the cane growing areas of the United States.

Refinery capacity was determined on the basis of a 270 day work-year.[28] The procedure used to determine annual refined sugar capacity was as follows: daily capacity (Tons of raw sugar per work-day) times

[28]Information received from Nicholas Kominus in a personal telephone interview with Iven Ose on January 12, 1977.

270 (work-days per year) times 0.9346 (tons of refined sugar per ton of raw sugar) times 20 (cwt. per ton) = annual capacity (cwt. refined sugar per year). For example, the Savannah, Georgia, refinery had a raw capacity of 2,200 tons of raw sugar per day. Refined capacity of 11.10 million cwt. annually was determined as follows: 2,200 tons/day[29] X 270 days/year[30] X 0.9346 tons refined/ton raw[31] X 20 cwt./ton = 11.10 million cwt. per year.

The cane refineries are primarily located in four general areas; the Northeast, Southeast, South Central, and Southwest. The Northeast contains more refinery capacity than any other area. Several shipping points were identified within these areas (Table 16). The 1976 capacity for refined cane sugar was used because the consumption figures used were 1976 data and the 1975-76 beet sugar crop was assumed to be available for 1976 consumption only.

The three shipping points selected in the Northeast were Boston, New York, and Baltimore. New York was used as a shipping point for the refineries located in the New York and Philadelphia areas. The total capacity of the New York shipping point was 44.51 million cwt. (refined equivalent) of sugar per year. Several refineries in south central Florida were assumed to ship all their sugar from Clewiston, Florida. New Orleans was used as a shipping point for the six refineries in Louisiana and the two small refineries in St. Louis and Chicago. The New Orleans shipping capacity for the transportation model was 48.74 million cwt. The remaining shipping points include Savannah, Georgia; Sugar Land, Texas; and Crockett, California (Stockton, California) for a total of eight cane sugar sources. The refined cane sugar capacity in the model was 160.82 million cwt., a quantity equivalent to 80 percent of the total refined sugar deliveries in the United States.

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[29] David, Milton L., et al., Economic Analysis of Effluent Guidelines; Cane Sugar Refining, Development Planning and Research Associates, Inc., Manhattan, Kansas, November, 1975, pp. I-10-11.

[30] Kominus, Nicholas, op. cit.

[31] United States Department of Agriculture, Agricultural Stabilization and Conservation Service, op. cit., p. 75.

TABLE 16. SHIPPING POINTS AND PRODUCTION CAPACITY OF REFINED CANE SUGAR USED IN THE TRANSPORTATION MODEL, 1976

| Shipping Point | Raw Plant Locations | Capacity* Raw Sugar | Capacity* Refined Sugar | Basing Point |
|---|---|---|---|---|
| New York, NY | Brooklyn, NY | 2,100 | 10.50 | New York, NY |
| | Philadelphia, PA | 2,100 | 10.60 | |
| | Brooklyn, NY | 320 | 4.14 | |
| | Philadelphia, PA | 2,000 | 10.09 | |
| | Yonkers, NY | 1,800 | 9.08 | |
| | TOTAL | 8,820 | 44.51 | |
| Boston, MA | Boston, MA | 1,000 | 5.05 | Boston, MA |
| | Charleston, MA | 1,200 | 6.06 | |
| | TOTAL | 2,200 | 11.10 | |
| Baltimore, MD | Baltimore, MD | 2,600 | 13.12 | Baltimore, MD |
| Savannah, GA | Savannah, GA | 2,200 | 11.10 | Savannah, GA |
| Clewiston, FL | Clewiston, FL | 350 | 1.77 | Savannah, GA |
| | Belle Glade, FL | 390 | 1.97 | |
| | Moore Haven, FL | 460 | 2.32 | |
| | TOTAL | 1,200 | 6.06 | |
| New Orleans, LA | Houma, LA | 660 | 3.33 | New Orleans, LA |
| | Supreme, LA | 700 | 3.53 | |
| | Gramercy, LA | 1,500 | 7.57 | |
| | Mathews, LA | 700 | 3.53 | |
| | Reserve, LA | 1,700 | 8.58 | |
| | Chalmette, LA | 3,250 | 16.40 | |
| | Chicago, IL | 350 | 4.29 | |
| | St. Louis, MO | 300 | 1.51 | |
| | TOTAL | 9,660 | 48.74 | |
| Sugar Land, TX | Sugar Land, TX | 1,500 | 7.57 | Sugar Land, TX |
| Stockton, CA | Crockett, CA | 3,500 | 17.66 | San Francisco, CA |
| | Aiea, HI | 190 | .96 | |
| | TOTAL | 3,690 | 18.62 | |
| | UNITED STATES TOTAL | 31,870 | 160.82 | |

*Found by multiplying Daily Capacity (tons/day)[1] times 270[2] (operating days/year times 0.9346[3] (conversion factor, tons refined per ton raw) times 20 (cwt. per ton) = cwt./year.

SOURCE: [1]David, Milton L., et at., Economic Analysis of Effluent Guidelines: Cane Sugar Refining, Development Planning and Research Associates, Inc., Manhattan, Kansas, November, 1975.

[2]Operating days per year information received from Mr. Nicholas Kominus, Director of Information for the United States Cane Refiners' Association.

[3]United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Sugar Statistics and Related Data, Statistical Bulletin No. 244, May, 1975, p. 70.

## Sugar Consuming Areas and Delivery Points

The United States was divided into 16 consuming regions with a delivery point in each region for sugar shipments (Figure 4). The sugar for each state was assumed to be delivered to the delivery point for the region in which the state was located. For example, the sugar delivered to Minneapolis, Minnesota, would satisfy the requirements in Minnesota, North Dakota, and South Dakota.

Each area included several states with a large population center near the geographical center. A major city at the approximate geographical center was then used as the delivery point. The areas in the east were smaller, but usually received more sugar than western areas because of higher population densities. Also, eastern areas were drawn smaller to give more specific results on sugar movements from west to east; that is, to determine how far east sugar would move from western sugar suppliers.

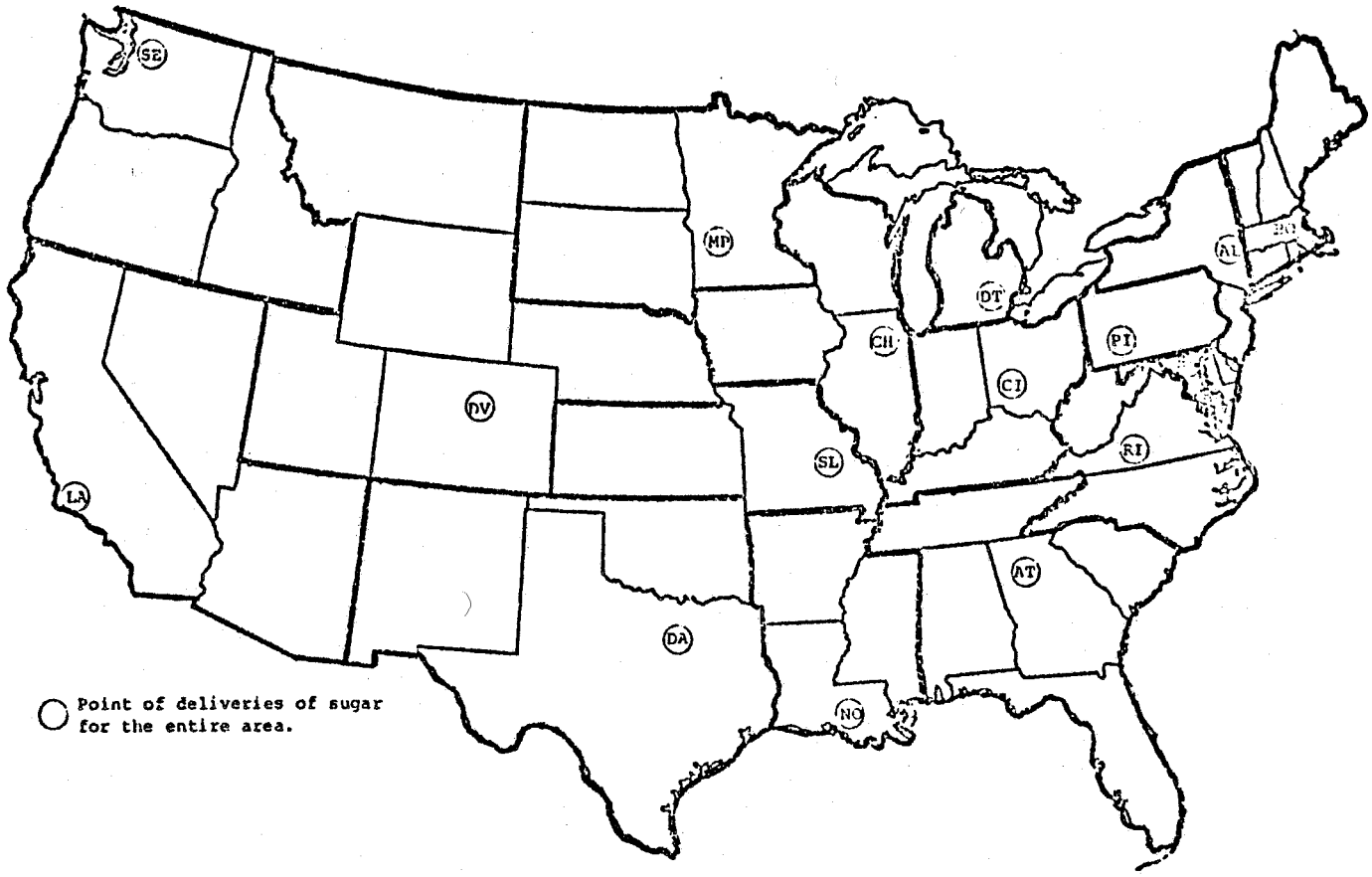
## Freight and Pricing Systems

A transportation model was used to determine the optimum movements of sugar under two systems, the simple freight-cost system and the basing point pricing system. Most commodities are shipped using the simple freight cost system where either the buyer or seller pays the freight and the price is F.O.B. the buyer or seller. The basing point pricing system, which is more complex, was in use by the sugar industry at the time of this writing.

### Simple Freight Cost Pricing

The simple freight cost system assumed the price of sugar throughout the United States was the same, F.O.B. the sugar refineries. Sugar cost to the buyer was sugar price plus freight. For example, sugar produced in Moorhead, Minnesota, would be shipped to Minneapolis, Minnesota, at a cost of $.40 per cwt. (Table 17). If sugar were shipped from Greeley, Colorado, to Minneapolis, the transportation cost would be $1.11 per cwt. In other words, Moorhead enjoyed an advantage over Greeley in shipping to Minneapolis.

The mathematical model used in this study is a specialized technique of linear programming called the transportation method. The linear




BO Boston--MA, ME, NH, VT, CT, RI
AL Albany--NY, NJ
PI Pittsburgh--PA
BA Baltimore--MD
Washington--DC, DE
RI Richmond--VA, WV, NC
AT Atlanta--GA, AL, FL, SC, TN
CI Cincinnati--OH, IN, KY
DT Detroit--MI

CH Chicago--IL, IA, WI
MP Minneapolis--MN, ND, SD
SL St. Louis--MO, KS
NO New Orleans--LA, AK, MS
DA Dallas--TX, OK, NM
DV Denver--CO, NE, MT, UT, WY
SE Seattle--WA, OR, ID, AK
LA Los Angeles--CA, AZ, NV

Figure 4. Delivery Locations and Regions for Refined Sugar Used in the Transportation Model

TABLE 17. FREIGHT RATE MATRIX USED IN THE TRANSPORTATION MODEL

| Destinations | Source | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stockton CA | New Orleans LA | Sugar Land TX | Clewiston TX | Savannah GA | Baltimore MD | New City NY | Boston MA |
| | (dollars per cwt.) | | | | | | | | | | | | | |
| Boston, MA | 1.44 | 2.53 | 2.63 | 2.63 | 2.86 | 2.95 | 3.03 | 2.38 | a | a | 3.78 | 0.89 | 0.62 | 0.00 |
| Albany, NY | 1.23 | 2.48 | 2.52 | 2.56 | 2.77 | 2.86 | 3.00 | 2.34 | a | a | 3.58 | 0.70 | 0.49 | 0.52 |
| Pittsburgh, PA | 0.78 | 2.20 | 2.05 | 2.10 | 2.11 | 2.28 | 2.49 | 1.44 | a | a | 1.57 | 0.64 | 0.67 | 0.77 |
| Baltimore, MD | 1.37 | 2.45 | 2.51 | 2.50 | 2.58 | 2.83 | 2.99 | 2.27 | a | 1.73 | 2.87 | 0.00 | 0.59 | 0.87 |
| Richmond, VA | 1.47 | 2.48 | 2.52 | 2.56 | 2.86 | 2.86 | 3.00 | a | a | 1.31 | 0.71 | 0.52 | 0.73 | 1.22 |
| Atlanta, GA | a | a | a | a | a | a | a | 0.79 | a | 0.83 | 0.46 | a | a | a |
| Cincinnati, OH | 0.66 | 1.51 | 1.65 | 1.73 | 1.83 | 2.10 | 2.16 | 0.82 | a | a | a | 1.16 | 1.15 | 1.17 |
| Detroit, MI | 0.50 | 1.54 | 1.74 | 1.87 | 1.88 | 2.18 | 2.20 | 1.48 | a | a | a | 1.10 | 1.15 | 1.15 |
| Chicago, IL | 0.89 | 0.88 | 1.10 | 1.17 | 1.25 | 1.37 | 1.44 | 1.00 | 1.41 | 1.17 | 3.65 | 1.12 | 1.29 | 1.15 |
| Minneapolis, MN | a | 0.40 | 1.11 | 1.19 | 1.37 | 1.37 | 1.31 | 1.31 | a | a | a | a | a | a |
| St. Louis, MO | 1.65 | 1.13 | 1.10 | 1.19 | 1.28 | 1.37 | 1.44 | 0.93 | 1.36 | 1.30 | 1.47 | a | a | a |
| New Orleans, LA | a | a | a | a | a | a | a | 0.00 | a | a | a | a | a | a |
| Dallas, TX | a | 1.23 | 1.03 | a | 1.46 | 1.46 | 1.41 | 1.23 | 0.58 | a | a | a | a | a |
| Denver, CO | a | a | 0.50 | a | a | a | 1.77 | a | a | a | a | a | a | a |
| Seattle, WA | a | a | a | a | 1.00 | 0.50 | 1.25 | a | a | a | a | a | a | a |
| Los Angeles, CA | a | a | a | a | a | a | 0.80 | a | a | a | a | a | a | a |

[a]Industry sources indicated these were irrational movements for sugar and rates were unavailable.

SOURCE: Mr. Ken Scar, American Crystal Sugar Company; Mr. James Lumbkin, Seaboard Coastline Railroad; and Mr. A.L. Wolfe, Chessie System Railroad.

programming model was used to determine the optimum flows of refined sugar from sources to destinations in such a manner as to minimize total transportation costs within the constraints imposed by source capacities and destination requirements. This model was designed with the assumption that all costs other than freight costs are equal to all origins and that product movement decisions are made only on the basis of least cost. The restraints used were the 1975-76 beet sugar crop from the sugarbeet producing areas, and the refinery capacity of each of the cane sugar supply points. Stockton, California, was a source for both refined cane and beet sugar. In that case the total of the beet sugar crop plus the cane refinery capacity was used as the upper limit of sugar available from that point. The rates used were the lowest railroad rates (usually 170,000 to 190,000 pound lot minimum) available between each source-destination pair.

## The Basing Point Pricing System

The pricing system used to price sugar in the United States is the basing point pricing system. The United States was divided into seven marketing regions. Each region had a specific price for refined sugar, although the price may have been the same in several regions. The seven regions used were the Northeast, Southeast, Gulf, Chicago-West, Southwest, Lower Pacific, and Northwest Intermountain (Figure 5).

Basing points were established by the industry as port cities with large cane refineries.[32] A basing point zone can be defined as a group of destinations for sugar for which the freight from the basing point in that zone to each of the destinations in the zone is less than the freight from a basing point outside the zone (Figure 6). Often a destination in a marketing area uses a basing point in another marketing area (Table 18). For example, much of the Chicago-West marketing area uses New Orleans as its basing point while the Pacific Intermountain Northwest uses San Francisco as its basing point.

The procedure used for determining the price to be paid for sugar by a buyer at a delivery point was the marketing area refined sugar price

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[32]Garrot, William N., "Developments in Refined Sugar Pricing," United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Washington, D.C., Sugar Reports No. 230, July, 1971, p. 10.


Figure 5. Marketing Regions for Refined Sugar in the United States, 1970

SOURCE: Garrott, William M., "Developments in Refined Sugar Pricing," United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Washington, D.C., Sugar Reports, No. 230, July, 1971, p. 10.


Figure 6. Basing Point Zones for Sugar

SOURCE: Garrott, William M., "Developments in Refined Sugar Pricing," United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Washington D.C., Sugar Reports, No. 230, July, 1971, p. 11.

TABLE 18. BASING POINT ZONES, BASING POINTS, DELIVERY POINTS AND THEIR BASING POINTS, AND THE FREIGHT FROM BASING POINTS TO DELIVERY POINTS, PRIOR TO OCTOBER, 1976

| Marketing Regions | Basing Point(s) for Region[a] | Delivery Points Within Basing Point Zone | Basing Point for Delivery Point[a] | "Freight Prepay" (Freight From Basing Point) to Delivery Point[b]) |
|---|---|---|---|---|
| | | | | ($/cwt. refined sugar) |
| Northeast | Boston | Boston | Boston | 0.00 |
| | New York | Albany | New York | 0.49 |
| | Philadelphia | Pittsburgh | Baltimore | 0.64 |
| | Baltimore | Baltimore | Baltimore | 0.00 |
| | | Richmond | Baltimore | 0.52 |
| | | Cincinnati | New Orleans | 0.82 |
| Southeast | Savannah | Atlanta | Savannah | 0.46 |
| Gulf | New Orleans | New Orleans | New Orleans | 0.00 |
| Chicago-West | New Orleans | St. Louis | New Orleans | 0.93 |
| | | Chicago | New Orleans | 1.00 |
| | | Minneapolis | New Orleans | 1.31 |
| | | Detroit | Baltimore | 1.10 |
| | | Denver | San Francisco | 1.77 |
| Southwest | Sugar Land | Dallas | Sugar Land | 0.58 |
| Lower Pacific | Crockett | Los Angeles | Crockett | 0.80 |
| Northwest Intermountain | Crockett | Seattle | Crockett | 1.25 |

[a]SOURCE: Bohall, Robert, et al., The Sugar Industry's Structure, Pricing and Performance, United States Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 364, Washington, D.C., March, 1977, pp. 21 and 38.

[b]Freight rates received from Ken Scar, American Crystal Sugar Company; James Lumbkin, Seaboard Coastline Railroad; and A.L. Wolfe, Chessie System Railroad.

plus the value of the "freight prepay" from the basing point to the delivery point (Table 19). The refiner pays the actual freight from the refinery to the buyer. A "freight pick-up" is money made on the prepay. If the freight from the basing point to the delivery point is greater than the actual shipping cost from the refinery to the delivery point (buyer) the seller (refiner) makes a gain (freight pick-up) on the freight due to the basing point system. The system is best illustrated by several examples.

Situation 1: Moorhead, Minnesota, sugar refiner sells sugar to a buyer in Minneapolis, Minnesota.

Question: What price and what freight cost will be incurred?

Background: Minneapolis is in the Chicago-West marketing area and New Orleans is the basing point for Minneapolis. The freight for refined sugar, Moorhead to Minneapolis, is $.40 per cwt. The freight from New Orleans to Minneapolis is $1.31 per cwt. Assume the Chicago-West price of sugar is $15.00 per cwt.

Solution: Minneapolis buyer pays the Moorhead refiner $15.00 per cwt. plus $1.31 per cwt. basing point freight (prepay) or $16.31 total per cwt. The Moorhead seller pays the Moorhead to Minneapolis freight of $.40 per cwt. The Moorhead refiner nets $15.91 per cwt. after paying the Moorhead to Minneapolis freight. The $.85 per cwt. made in excess of the Chicago-West price is called a "freight pick-up" (Table 27).

Sometimes there is a freight loss incurred when the buyer is distant from the seller.

Situation 2: Moorhead refiner sells sugar to a Detroit, Michigan, buyer.

Question: What price will be paid and what freight cost will be incurred?

Background: Moorhead to Detroit freight is $1.54 per cwt. Detroit's basing point is Baltimore. Baltimore to Detroit freight is $1.10 per cwt. Detroit is in the Northeast marketing area. Assume the Northeast refined sugar price is $15.00 per cwt.

Solution: Detroit buyer pays $15.00 per cwt. plus the Baltimore to Detroit freight (prepay) of $1.10 for a total of $16.10 per cwt. Moorhead refiner pays $1.54 per cwt. for the Moorhead to Detroit freight. Moorhead refiner's net return per cwt. is $16.10, -$1.54 or $14.56 per cwt.

TABLE 19. BASING POINT RETURNS TO REFINERS OF SUGAR AFTER PAYING 1976 FREIGHT COSTS AND COLLECTING PREPAYS, ASSUMING $15 PER CWT. PRICE FOR REFINED SUGAR IN ALL MARKETING REGIONS

| Destinations | Source (returns to shippers) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stockton CA | New Orleans LA | Sugar Land TX | Clewiston FL | Savannah GA | Baltimore MD | New York City NY | Boston MA | Sugar Price Plus Prepay For Destination |
| | (dollars per cwt.) | | | | | | | | | | | | | | |
| Boston, MA | 13.56 | 12.47 | 12.37 | 12.37 | 12.14 | 12.05 | 11.97 | 12.62 | a | a | 11.32 | 14.11 | 14.11 | 15.00 | 15.00 |
| Albany, NY | 14.26 | 13.01 | 12.97 | 12.93 | 12.72 | 12.63 | 12.49 | 13.15 | a | a | 11.91 | 14.79 | 15.00 | 14.97 | 15.49 |
| Pittsburgh, PA | 14.86 | 13.44 | 13.59 | 13.54 | 13.53 | 13.36 | 13.15 | 14.20 | a | a | 14.07 | 15.00 | 13.97 | 14.87 | 15.64 |
| Baltimore, MD | 13.63 | 12.55 | 12.49 | 12.50 | 12.42 | 12.17 | 12.01 | 12.73 | a | 13.27 | 12.13 | 15.00 | 14.41 | 14.13 | 15.00 |
| Richmond, VA | 14.05 | 13.04 | 13.00 | 12.96 | 12.66 | 12.66 | 12.52 | a | a | 14.21 | 14.81 | 15.00 | 14.79 | 14.30 | 15.52 |
| Atlanta, GA | a | a | a | a | a | a | a | 14.67 | a | 14.63 | 15.00 | a | a | a | 15.46 |
| Cincinnati, OH | 15.16 | 14.31 | 14.17 | 14.09 | 13.99 | 13.72 | 13.66 | 15.00 | a | a | a | 14.66 | 14.67 | 14.65 | 15.82 |
| Detroit, MI | 15.60 | 14.56 | 14.36 | 14.23 | 14.22 | 13.92 | 13.90 | 14.62 | a | a | a | 15.00 | 14.95 | 14.95 | 16.10 |
| Chicago, IL | 15.11 | 15.12 | 14.90 | 14.83 | 14.75 | 14.63 | 14.56 | 15.00 | 14.59 | 14.83 | 12.35 | 14.88 | 14.71 | 14.85 | 16.00 |
| Minneapolis,MN | a | 15.91 | 15.20 | 15.12 | 14.94 | 14.94 | 14.87 | 15.00 | a | a | a | a | a | a | 16.31 |
| St. Louis, MO | 14.28 | 14.80 | 14.83 | 14.74 | 14.65 | 14.56 | 14.49 | 15.00 | 14.57 | 14.63 | 14.46 | a | a | a | 15.93 |
| New Orleans,LA | a | a | a | a | a | a | a | 15.00 | a | a | a | a | a | a | 15.00 |
| Dallas, TX | a | 14.35 | 14.55 | a | 14.12 | 14.12 | 14.17 | 14.35 | 15.00 | a | a | a | a | a | 15.58 |
| Denver, CO | a | a | 16.25 | a | a | a | 15.00 | a | a | a | a | a | a | a | 16.77 |
| Seattle, WA | a | a | a | a | 15.25 | 15.00 | a | a | a | a | a | a | a | a | 16.25 |
| Los Angeles,CA | a | a | a | a | a | a | 15.00 | a | a | a | a | a | a | a | 15.80 |

[a]Industry sources indicated these were irrational movements for sugar and rates were unavailable.

SOURCE: Mr. Ken Scar, American Crystal Sugar Company; Mr. James Lumbkin, Seaboard Coastline Railroad; and Mr. A.L. Wolfe, Chessie System Railroad.

If a refiner sold refined sugar to a buyer at a basing point, the refiner would pay the entire cost of the shipping since there would be no prepay.[33]

The above examples indicate how the data presented in Tables 17, 18, and 19 were derived. The prepay column of Table 18 was added to the assumed price of $15.00 per cwt. for the derivation of the "Sugar price plus prepay..." column of Table 19. The sugar price plus prepay for a given destination minus the simple freight rate from the source to the destination equals the "Return to shippers...". The sugar price at a given destination is the same no matter which refiner the sugar is purchased from. Since no gain could be made by buyers selecting a particular refiner, the criterion used for finding optimum sugar flows was the flows which maximized refiners' returns using the basing point pricing system.

## Optimum Flows of Sugar, 1975-76 Marketing Year

The model determined the optimum movements of sugar from producer to buyer using the freight cost minimizing criteria for the simple freight pricing system and refiner revenue maximizing criteria for the basing point pricing system. The limit imposed upon each sugarbeet refiner was an estimate of the actual quantity of sugar produced from the 1975-76 crop in the refiner's area. For example, 11.70 million cwt. of sugar was produced from the sugarbeet crop grown in Minnesota and North Dakota in 1975 (Table 20). The assumption made was that sugar will move along the least cost freight routes until the refinery capacity of sugar crop is used up. Cane refineries were assumed to be limited by 1976 annual capacity. These assumptions left some beet sugar unsold. In reality the refiners that were disadvantageously located with respect to markets would cut prices in order to compete with sugar suppliers more advantageously located.

The solutions to the model were the same for both the simple freight-cost minimizing criteria and the refiner revenue maximizing criteria of the basing point pricing system. The entire production of 9.46 million cwt. of refined sugar from the Utah-Idaho-Oregon sugarbeet producing

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[33] Ibid, p. 10.

area was not sold (Table 20). The Montana-Wyoming sugarbeet growing area had just under one million cwt. of refined sugar unsold. Refiners in these areas would in reality cut their prices in order to compete for sugar sales in markets more distant from their producing areas. Unused refinery capacity of 19 million cwt. and 3 million cwt. was evident in California and New York, respectively. Minnesota-North Dakota sugar producers shipped 8.18 million cwt. to Chicago and 3.52 million cwt. to the Minneapolis delivery area in the model. Colorado-Nebraska-Kansas-Texas beet sugar producers shipped 3.95 million cwt. of refined sugar to Chicago, 5.02 million cwt. to Texas, and 5.16 million cwt. to Denver, Colorado. New Orleans utilized all its refinery capacity by shipping a total of 48.74 million cwt. of sugar to Atlanta, Georgia; Cincinnati, Ohio; Chicago, Illinois; St. Louis, Missouri; and local New Orleans buyers. Sugar Land, Texas, southern Florida, and Savannah, Georgia, refiners utilized all their capacity by shipping to refined sugar buyers in delivery areas in which they were located. Northeastern cane refiners shipped nearly all their refined sugar to markets in the Northeast with the exception of 2.28 million cwt. shipped to Detroit, Michigan, and 3.37 million cwt. to Chicago, Illinois.

## Sensitivity of Minnesota-North Dakota Originating Refined Sugar Shipments to Freight Rate Changes in Short-Run

Sensitivity analysis was employed in this study to analyze the effects of freight rate changes on refined sugar shipments originating in Moorhead, Minnesota. This analysis indicated the range over which freight rates from Moorhead, Minnesota, could vary while all other rates were held constant, and still maintain the level of shipments attained in the least freight cost solution. Sensitivity analysis provided an indication of the rate decrease required to stimulate a flow and the volume that would be shipped in those instances where no refined sugar shipments occurred in the least freight cost solution. Sensitivity analysis provided an indication of the magnitude of the rate increase required before Moorhead shipments would be reduced or leave the solution for refined sugar shipments occurring in the least freight cost solution. It also provided an indication of the rate decrease required to increase the flow of refined sugar and the increase in volume expected.

TABLE 20. OPTIMUM FLOWS OF SUGAR IN THE UNITED STATES, 1975 CROP YEAR, 1976 CONSUMPTION ESTIMATES, 1976 REFINERY CAPACITY

| Destinations | Source (unlimited capacity assumption) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stockton CA | New Orleans LA | Sugar Land TX | Clewiston FL | Savannah GA | Baltimore MD | New York City NY | Boston MA | Total Consumption |
| | (million cwt.) | | | | | | | | | | | | | | |
| Boston, MA | | | | | | | | | | | | | | 7.73 | 7.73 |
| Albany, NY | | | | | | | | | | | | | 22.87 | | 22.87 |
| Pittsburgh, PA | | | | | | | | | | | | | 13.30 | | 13.30 |
| Baltimore, MD | | | | | | | | | | | | 7.52 | | | 7.52 |
| Richmond, VA | | | | | | | | | | | | 5.60 | 2.65 | | 8.25 |
| Atlanta, GA | | | | | | | | 5.10 | | 6.06 | 11.10 | | | | 22.26 |
| Cincinnati, OH | | | | | | | | 19.78 | | | | | | | 19.78 |
| Detroit, MI | 6.44 | | | | | | | | | | | | 2.28 | | 8.72 |
| Chicago, IL | | 8.18 | 3.95 | 4.05 | | | | 10.46 | | | | | | 3.37 | 30.01 |
| Minneapolis,MN | | 3.52 | | | | | | | | | | | | | 3.52 |
| St. Louis, MO | | | | | | | | 6.93 | | | | | | | 6.93 |
| New Orleans,LA | | | | | | | | 6.47 | | | | | | | 6.47 |
| Dallas, TX | | | 5.02 | | | | | | 7.57 | | | | | | 12.59 |
| Denver, CO | | | 5.16 | | | | | | | | | | | | 5.16 |
| Seattle, WA | | | | | | 5.06 | | | | | | | | | 5.06 |
| Los Angeles,CA | | | | | | | 23.18 | | | | | | | | 23.18 |
| U.S. Total | 6.44 | 11.70 | 14.13 | 4.05 | 0.00 | 5.06 | 23.18 | 48.74 | 7.57 | 6.06 | 11.10 | 13.12 | 41.10 | 11.10 | 203.32 |
| Unused Capacity | 0.00 | 0.00 | 0.00 | 0.73 | 9.46 | 0.39 | 18.97 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.41 | 0.00 | 32.98 |
| Capacity | 6.44 | 11.70 | 14.13 | 4.80 | 9.46 | 5.45 | 42.15 | 48.74 | 7.57 | 6.06 | 11.10 | 13.12 | 44.51 | 11.10 | 236.30 |

The change in freight rates needed to change the least cost solution was quite high for all destinations (Table 21). Reductions of $2 or more per cwt. would be required to stimulate shipments to any of the consuming areas along the Atlantic Coast. Reductions in freight rates of $.30 or more would be required to gain access to the Detroit, Cincinnati, St. Louis, and Dallas consuming areas. A 50 percent reduction in freight rates from Moorhead to Chicago would be required for additional movements along that route. Sensitivity analysis showed that freight rates would have to increase by $.30 to $.40 per cwt. before Moorhead shipments to the Minneapolis and Chicago consuming areas would be changed.

TABLE 21. THE EFFECT OF CHANGES IN FREIGHT RATES ON REFINED SUGAR SHIPMENTS FROM MOORHEAD, MINNESOTA, 1976

| Moorhead Minnesota, to | Present Rate | Required Rate To Increase Shipment (Anything Less than) | Volume to be Gained | Upper Limit on Rate in Order to Continue to Supply Refined Sugar |
|---|---|---|---|---|
| | ($/cwt.) | ($/cwt.) | (million cwt.) | ($/cwt.) |
| Boston, MA | 2.53 | .00[a] | .00 | b |
| Albany, NY | 2.48 | .20 | .75 | b |
| Pittsburgh, PA | 2.20 | .38 | .75 | b |
| Baltimore, MD | 2.45 | .00[a] | .00 | b |
| Richmond, VA | 2.48 | .44 | .75 | b |
| Atlanta, GA | c | .67 | 5.10 | b |
| Cincinnati, OH | 1.51 | .70 | 8.18 | b |
| Detroit, MI | 1.54 | .86 | .75 | b |
| Chicago, IL | .88 | .39 | 3.52 | 1.16 |
| Minneapolis, MN | .40 | d | d | .88 |
| St. Louis, MO | 1.13 | .81 | 6.93 | b |
| New Orleans, LA | c | .00[a] | .00 | b |
| Dallas, TX | 1.23 | .81 | 5.02 | b |
| Denver, CO | c | .28 | 5.16 | b |
| Seattle, WA | c | .21 | .75 | b |
| Los Angeles, CA | c | .51 | .75 | b |

[a]The rate required to stimulate shipments is less than 0.
[b]No shipments occur in the least-cost solution.
[c]Industry sources indicated these were irrational movements for sugar and rates were unavailable.
[d]Shipments supply total needs of delivery point.

## Optimum Locations for Refined Sugar Production in the United States Using an Unlimited Supply Model

The most advantageously located sugar producing points with respect to markets were found by assuming each refined sugar source had an unlimited capacity for sugar production. The model then allocated the sugar to each delivery point from the least cost shipping point. The demand for sugar at each delivery point was based on actual 1976 refined sugar deliveries. The solution had several producing areas shipping no sugar at all (Table 22). These included the Idaho-Oregon-Utah area, the Montana-Wyoming area, and the southern Florida cane sugar refineries. Sugar movements were the same under the simple freight-cost minimizing criteria of sugar movements and the refiner revenue maximizing criteria for sugar movements under the basing point pricing system.

Sugar producers in Minnesota and North Dakota were the most advantageously located for shipping sugar to the Minneapolis, Minnesota, and Chicago, Illinois, delivery areas. The estimated 1975 crop in Minnesota and North Dakota was 11.70 million cwt. of refined sugar; the model solution had 35.8 million cwt. of refined sugar being marketed from this area. Sugar producers in Minnesota and North Dakota were the least freight cost shippers into the Minneapolis and Chicago markets; although, the Bay City, Michigan, to Chicago freight is only $.01 greater per cwt. than the Moorhead to Chicago rate. Since there are nearly equal marketing costs between these two producing areas, the competitive advantage for the Chicago market would be determined by farm production and processing costs.

The model indicated 28.5 million cwt. of sugar would be marketed in the Cincinnati and Detroit delivery areas from Michigan and Ohio sugar producers. This area would produce four and one-half times the actual 1975-76 crop under the optimum flow solution.

Sugar production from Colorado, Nebraska, Kansas, and Texas was limited to consumption designated for delivery to the Denver delivery area. Consumption in the Denver delivery area in 1976 was estimated at 5.16 million cwt. The estimated actual production of sugar from Area III was 14.1 million cwt. in 1975. In other words the model indicates a 63 percent decrease in sugar production in this area under the optimum

TABLE 22. OPTIMUM FLOWS OF SUGAR IN THE UNITED STATES, ASSUMING UNLIMITED REFINERY CAPACITY, 1976 CONSUMPTION

| Destinations | Source (unlimited capacity assumption) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stockton CA | New Orleans LA | Sugar Land TX | Clewiston FL | Savannah GA | Baltimore MD | New City York NY | Boston MA | Total Consumption |
| | (million cwt.) | | | | | | | | | | | | | | |
| Boston, MA | | | | | | | | | | | | | | 7.73 | 7.73 |
| Albany, NY | | | | | | | | | | | | | 22.87 | | 22.87 |
| Pittsburgh,PA | | | | | | | | | | | | 13.30 | | | 13.30 |
| Baltimore, MD | | | | | | | | | | | | 7.52 | | | 7.52 |
| Richmond, VA | | | | | | | | | | | | 8.25 | | | 8.25 |
| Atlanta, GA | | | | | | | | | | | 22.26 | | | | 22.60 |
| Cincinnati,OH | 19.78 | | | | | | | | | | | | | | 19.78 |
| Detroit, MI | 8.72 | | | | | | | | | | | | | | 8.72 |
| Chicago, IL | | 30.01 | | | | | | | | | | | | | 30.01 |
| Minneapolis,MN | | 3.52 | | | | | | | | | | | | | 3.52 |
| St. Louis, MO | | | | | | | | 6.93 | | | | | | | 6.93 |
| New Orleans,LA | | | | | | | | 6.47 | | | | | | | 6.47 |
| Dallas, TX | | | | | | | | | 12.59 | | | | | | 12.59 |
| Denver, CO | | | 5.16 | | | | | | | | | | | | 5.16 |
| Seattle, WA | | | | | | 5.06 | | | | | | | | | 5.06 |
| Los Angeles,CA | | | | | | | 23.18 | | | | | | | | 23.18 |
| U.S. TOTAL | 28.50 | 33.53 | 5.16 | 0.00 | 0.00 | 5.06 | 23.18 | 13.40 | 12.59 | 0.00 | 22.26 | 29.07 | 22.87 | 7.73 | 203.32 |
| Actual Crop or Capacity | 6.44 | 11.70 | 14.13 | 4.80 | 9.46 | 5.45 | 42.15 | 48.74 | 7.57 | 6.06 | 11.10 | 13.12 | 44.51 | 11.10 | Total U.S. Capacity 236.33* |

*Limited by 1975 sugarbeet crop and cane sugar refinery capacity.

flow solution. Oregon, Idaho, Utah, Montana, and Wyoming sugar producers were at a disadvantage by comparison to all other producers for shipping to the major markets. The model indicates that these areas would produce no sugar if transfer costs were minimized.

Washington production was limited to sugar consumed in the delivery area served by Seattle which resulted in a 7 percent decrease from 1975-76 sugar crop levels when solving for least freight cost movements.

Arizona and California sugar production was limited by the model to the amount of sugar consumed in the California-Arizona-Nevada delivery area. The model indicated production of 23.3 million cwt. of sugar in the California-Arizona area which was approximately equal to the actual 1975-76 beet sugar crop of 23.5 million cwt. A 45 percent reduction in total cane refinery capacity plus beet sugar crop would result in Arizona and California. Survival of cane sugar production versus beet sugar production would depend on which had the greatest production and processing cost advantages.

The model called for cane sugar production levels greater than current capacity at some sources and less than current capacity at other sources. The model indicated freight minimizing sugar production levels at twice the current annual refined sugar producing capacity in Sugar Land, Texas; Savannah, Georgia; and Baltimore, Maryland. These locations would have produced 64 million cwt. of sugar for nearby buyers with unlimited capacity.

## Domestic Sugar Supply Projections for 1985

Projections for 1985 domestic sugar supply were made for the sugarbeet and sugar cane growing areas of the United States. The history of sugar production of each of the seven sugarbeet growing areas and four sugar cane growing areas was analyzed, and studies carried out by other researchers on the subject of future domestic sugar supply were consulted in making the projections. The basic assumption underlying the projections was that the United States government would adopt a long-term sugar policy which would uphold the price of sugar at a profitable level in the future.

The basis for making these projections lie in two general areas, the first being trend analysis. Acreages for each sugar growing area for the period 1966 to 1977 for sugarbeets and 1966 to 1976 for sugar

cane were analyzed (Tables 23 and 24). A trend line was estimated which represented the relationship between acreage and time in each area. A standard statistical technique was used to determine trends and make projections. After trends for each area were estimated, other factors were examined, such as land limitations.

The objective of this analysis was to determine the future flows of sugar assuming a continuation of recent historic trends in sugar production by areas, and to determine which sugar producing areas are located the most advantageously with respect to markets. Domestic sugar supply projections were used to determine the optimum flows for 1985 consumption levels assuming several different scenarios concerning United States government sugar policy and world sugar prices.

A five-year average of sugar produced per acre of sugarbeets was used to convert sugarbeet acreage projections to total sugar production projections for each area. A similar average was used for sugar cane areas except that cane acreage harvested for sugar and seed was used as the basis on which to project sugar production. Planted cane acreage could not be used because cane is a perennial crop.

The projected United States acreage of sugarbeets was not expected to change greatly from 1976 levels, but the total quantity of sugar produced would decline slightly from 1976 levels due to the change in location of acreage. Areas III, IV, and V in the West were projected to decline in acreage by 1985 while the lowest yielding area, Area II, has a significant increase in acreage projected. This redistribution of acreage from higher yielding areas to Minnesota and North Dakota caused a slight decline in projected sugar production from the 1976 level.

Sugar cane acreage and cane sugar production in the United States was projected to increase moderately on the basis of trends established between 1966 and 1976. The 1985 Florida acreage would comprise 47 percent of the total United States cane acreage harvested, up from 40 percent in 1976. The Hawaiian share of acreage harvested would decline from 13.5 percent to 11.0 percent according to the projections. Total cane sugar production would increase from 53.2 million cwt. (refined equivalent) in 1976 to 60.3 million cwt. in 1985, with 85 percent of the increase coming from increases in Florida production.

TABLE 23. SUGARBEET ACREAGE PLANTED AND ESTIMATES OF REFINED SUGAR PRODUCTION, 1966-1977, AND 1985 PROJECTIONS

| Area | States Included | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977[a] | 1985 | Sugar Per Acre[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (cwt.) | | | | | | | | |
| I | OH, MI, ME | | | | | | | | | | | | | | |
| | Acreage Planted (000) | 122.0 | 122.0 | 156.0 | 155.0 | 134.0 | 133.0 | 138.0 | 120.0 | 116.0 | 134.0 | 142.0 | 146.0 | 138.0 | 39.78 |
| | Refined Sugar Production (million cwt.) | 4.6 | 4.3 | 5.5 | 5.5 | 5.4 | 4.9 | 4.2 | 4.7 | 4.7 | 6.4 | 5.9 | 5.8 | 5.5 | |
| II | MN, ND, IA | | | | | | | | | | | | | | |
| | Acreage Planted (000) | 194.0 | 210.0 | 254.0 | 264.0 | 252.0 | 193.0 | 192.0 | 212.0 | 333.0 | 363.0 | 411.0 | 422.0 | 525.0 | 32.35 |
| | Refined Sugar Production (million cwt.) | 6.4 | 6.2 | 8.6 | 7.4 | 6.8 | 7.2 | 6.5 | 8.2 | 9.1 | 11.7 | 12.2 | 13.7 | 17.0 | |
| III | CO, KS, NE, NM, TX | | | | | | | | | | | | | | |
| | Acreage Planted (000) | 274.0 | 266.0 | 341.0 | 402.0 | 323.0 | 302.0 | 311.0 | 261.0 | 270.0 | 345.0 | 277.0 | 249.0 | 255.0 | 42.27 |
| | Refined Sugar Production (million cwt.) | 12.0 | 11.2 | 13.8 | 12.8 | 11.9 | 12.3 | 13.6 | 10.3 | 11.4 | 14.1 | 12.5 | 10.5 | 10.8 | |
| IV | MT, WY | | | | | | | | | | | | | | |
| | Acreage Planted (000) | 113.0 | 113.0 | 132.0 | 148.0 | 119.0 | 115.0 | 105.0 | 101.0 | 100.0 | 107.0 | 104.0 | 101.0 | 41.0 | 46.03 |
| | Refined Sugar Production (million cwt.) | 4.7 | 5.1 | 5.3 | 4.9 | 4.4 | 5.2 | 5.0 | 4.4 | 4.5 | 4.8 | 5.1 | 4.7 | 3.8 | |
| V | ID, OR, UT | | | | | | | | | | | | | | |
| | Acreage Planted (000) | 100.0 | 204.0 | 249.0 | 268.0 | 229.0 | 218.0 | 230.0 | 193.0 | 123.0 | 210.0 | 179.0 | 145.0 | 117.0 | 47.18 |
| | Refined Sugar Production (million cwt.) | 8.2 | 9.5 | 11.1 | 11.3 | 10.5 | 10.4 | 10.0 | 9.3 | 5.9 | 9.5 | 8.5 | 6.8 | 5.5 | |
| VI | WA | | | | | | | | | | | | | | |
| | Acreage Planted (000) | 56.0 | 50.0 | 61.0 | 66.0 | 67.0 | 81.0 | 94.0 | 97.0 | 65.0 | 84.0 | 79.0 | 76.0 | 108.0 | 61.36 |
| | Refined Sugar Production (million cwt.) | 3.3 | 2.6 | 3.6 | 4.2 | 3.2 | 5.0 | 5.6 | 6.2 | 3.8 | 5.5 | 4.8 | 4.7 | 6.6 | |
| VII | CA, AZ | | | | | | | | | | | | | | |
| | Acreage Planted (000) | 289.0 | 246.0 | 316.0 | 376.0 | 306.0 | 348.0 | 355.0 | 292.0 | 245.0 | 349.0 | 336.0 | 284.0 | 325.0 | 63.76 |
| | Refined Sugar Production (million cwt.) | 14.0 | 11.3 | 17.4 | 19.1 | 20.0 | 20.0 | 22.2 | 16.9 | 15.3 | 23.5 | 22.4 | 10.1 | 20.8 | |
| | U.S. TOTAL | | | | | | | | | | | | | | |
| | Acreage Planted (000) | 1,240.0 | 1,210.0 | 1,509.0 | 1,670.0 | 1,431.0 | 1,309.0 | 1,424.0 | 1,780.0 | 1,252.0 | 1,501.0 | 1,527.0 | 1,423.0 | 1,551.0 | 46.45 |
| | Refined Sugar Production (million cwt.) | 53.2 | 50.4 | 62.2 | 63.0 | 62.0 | 65.6 | 68.0 | 59.8 | 54.6 | 75.5 | 71.3 | 66.1 | 70.0 | |

[a]Based on January 1, 1977, planting intentions.
[b]Based on 1972 to 1976 United States beet sugar recovery rates and individual state yields.

SOURCES: United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Sugar Statistics and Related Data, Statistical Bulletin No. 244, revised, Washington, D.C., May, 1975, pp. 19, 23, and 24.

United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1., No. 4, Washington, D.C., May, 1976, p. 9.

Ibid., Vol. 2, No. 2, February, 1977, p. 23.

Ibid., Vol. 2, No. 3, March, 1977, p. 4.

TABLE 24. SUGAR CANE ACREAGE HARVESTED AND ESTIMATES OF SUGAR PRODUCTION (REFINED EQUIVALENT), 1966-1976 AND 1985 PROJECTIONS

| Area | States Included | | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1985[a] | Sugar Per Acre (cwt. refined equivalent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | LA, TX | | | | | | | | | | | | | | |
| | Acreage Harvested (000) | LA | 312.0 | 315.0 | 300.0 | 265.0 | 284.0 | 326.0 | 334.0 | 341.0 | 331.0 | 329.0 | 325.0 | 340.0 | 35.27 |
| | | TX | -- | -- | -- | -- | -- | -- | -- | 19.0 | 29.0 | 36.0 | 36.0 | 40.0 | 66.81 |
| | | | 312.0 | 315.0 | 300.0 | 265.0 | 284.0 | 326.0 | 334.0 | 360.0 | 360.0 | 365.0 | 361.0 | 380.0 | |
| | Total Area I Sugar Production Refined Equivalent (million cwt.) | LA | 11.3 | 14.9 | 13.3 | 10.8 | 12.1 | 11.4 | 13.2 | 11.1 | 11.1 | 12.0 | 11.2 | 12.0 | |
| | | TX | -- | -- | -- | -- | -- | -- | -- | .7 | 1.4 | 2.3 | 2.4 | 2.7 | |
| | TOTAL Area I[b] | | 11.3 | 14.9 | 13.3 | 10.8 | 12.1 | 11.4 | 13.2 | 11.8 | 12.5 | 14.3 | 13.6 | 14.7 | |
| II | FL | | | | | | | | | | | | | | |
| | Acreage Harvested (000) | | 197.0 | 196.0 | 187.0 | 160.0 | 179.0 | 200.0 | 250.0 | 267.0 | 273.0 | 298.0 | 314.0 | 424.0 | 63.22 |
| | Sugar Production Refined Equivalent (million cwt.) | | 12.1 | 12.3 | 10.1 | 9.9 | 12.1 | 11.9 | 17.9 | 15.3 | 15.0 | 19.3 | 20.6 | 26.8 | |
| III | HI | | | | | | | | | | | | | | |
| | Acreage Harvested (000) | | 111.0 | 112.0 | 114.0 | 113.0 | 114.0 | 116.0 | 109.0 | 108.0 | 101.0 | 112.0 | 105.0 | 100.0 | 189.36 |
| | Sugar Production Refined Equivalent (million cwt.) | | 23.0 | 22.3 | 23.0 | 22.1 | 21.7 | 23.0 | 20.9 | 21.1 | 19.5 | 20.7 | 19.0 | 18.9 | |
| | U.S. TOTAL Cane Acreage (000)[b] | | 620.0 | 623.0 | 600.0 | 530.0 | 578.0 | 642.0 | 693.0 | 715.0 | 734.0 | 744.0 | 780.0 | 903.0 | |
| | Sugar Production Refined Equivalent (million cwt.)[b] | | 46.5 | 50.5 | 46.5 | 42.8 | 45.9 | 46.3 | 52.0 | 48.2 | 47.0 | 54.8 | 53.3 | 60.3 | |
| IV | Puerto Rico | | | | | | | | | | | | | | |
| | Acreage Harvested (000) | | 263.0 | 237.0 | 180.0 | 189.0 | 153.0 | 152.0 | 132.0 | 122.0 | 122.0 | 132.0 | 121.0 | 100.0 | 44.67 |
| | Sugar Production Refined Equivalent (million cwt.) | | 15.3 | 12.1 | 9.0 | 8.6 | 6.1 | 5.6 | 4.7 | 5.4 | 5.4 | 5.6 | 5.8 | 4.7 | |

[a]Projection based on 1966 to 1976 trend and articles by Glenn A. Zepp in the Sugar and Sweetener Report, May, 1976, and February, 1977.
[b]May not add due to rounding.

SOURCES: United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Sugar Statistics and Related Data, Statistical Bulletin No. 244, Washington, D.C., revised May, 1975, pp. 52, 55, 62, 63, 70, 71, 77, and 78.

United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1, No. 11, Washington, D.C., December, 1976, p. 9.

## Projections of Sugar-High Fructose Corn Syrup Consumption

Sugar plus high fructose corn syrup (HFCS) consumption has remained at a fairly constant level over the past several years. Per capita consumption of sugar plus HFCS was between 100 and 104 pounds in six of eight years from 1969 through 1976 (Table 25). In 1974 and 1975, per capita consumption of sugar plus HFCS was below 100 pounds. In those two years sugar prices were at very high levels which caused consumers to decrease sugar consumption. It is expected that per capita consumption of HFCS plus sugar will remain at a fairly constant level to 1985.

It was assumed that per capita consumption of sugar plus HFCS would remain at 102 pounds per capita through 1985. The United States population in 1985 is projected to be 239,329,000 people.[34] Total consumption of sugar plus HFCS would, therefore, reach 244,120,000 cwt. in 1985.

As indicated earlier, the underlying assumption for the supply projections was that the government would adopt a sugar policy that would insure the profitability of domestic sugar production. The policy could take one of two possible directions. The government could subsidize sugar cane and sugarbeet growers, or restrict imports through either a variable tariff or a quota system.

The desired result of the restricted import policy would be a United States sugar price at a level which would maintain domestic sugar production at historical levels. Such a policy would insure that sugar production would remain above the break-even level of costs and returns for sugar growers. An additional result, however, is that an umbrella for prices of all substitute sweeteners would be created by the inflated sugar prices. This price umbrella would most likely allow substantial penetration of HFCS into the industrial sugar market.[35]

The future growth of HFCS use is uncertain, partially because of the recent volatility of the sugar market. Projections by industry personnel of HFCS production range from 40 to 70 million cwt. by 1980. This study assumed a 30 percent HFCS level in the HFCS-sugar mix for the restricted import policy option in 1985.

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[34] United States Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, Washington, D.C., 1976, p. 15.

[35] Jesse, Edward V., and Glenn A. Zepp, Sugar Policy Options for the United States, Agricultural Economic Report No. 351, United States Department of Agriculture, Economic Research Service, Washington, D.C., February, 1977, p. 26.

TABLE 25. PER CAPITA CONSUMPTION OF HIGH FRUCTOSE CORN SYRUP AND SUGAR IN THE UNITED STATES, 1969-1976, WITH PROJECTIONS TO 1985

| Year | HFCS | Sugar | HFCS Plus Sugar |
|---|---|---|---|
| 1969 | | 100.7 | 100.7 |
| 1970 | | 101.9 | 101.9 |
| 1971 | | 102.4 | 102.4 |
| 1972 | 0.9 | 102.8 | 103.3 |
| 1973 | 1.4 | 101.5 | 102.9 |
| 1974 | 2.3 | 96.6 | 98.9 |
| 1975 | 4.7 | 90.2 | 94.9 |
| 1976 | 7.1 | 95.1 | 102.2 |
| 1985[a] | 10.2 | 91.8 | 102.0 |
| 1985[b] | 30.6 | 71.4 | 102.0 |

[a]Projections for sugar and HFCS consumption made by Iven Ose, assuming a government sugar policy of grower subsidies and low world raw sugar prices to 1985.
[b]Projections for sugar and HFCS consumption made by Iven Ose, assuming a government sugar policy of sugar import restrictions.

SOURCE: Consumption data 1976 and before, United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 2, No. 2, Washington, D.C., February, 1977, p. 28.

An alternative to restricting imports is a grower subsidy policy that would insure returns to growers and maintain domestic sugar production at least at historical levels. Low grower prices received for sugarbeets and cane would be supplemented by government payments to growers. This policy would not provide an "umbrella" for HFCS prices. Consequently, in the event of low United States and world sugar prices HFCS production would remain in low levels. This study assumed 1985 HFCS use at 10 percent of total HFCS plus sugar total usage under the grower subsidy policy.

Total refined sugar deliveries in 1976 were 203.32 million cwt. Approximately 800,000 tons, or 16 million cwt., of HFCS were produced.[36] Total consumption of HFCS and sugar in 1976 was approximately 220 million cwt. and the 1985 total is projected to be 244 million cwt. The sugar

[36]United States Department of Agriculture, Economic Research Service, Sugar and Sweetener, op. cit., p. 15.

policy restricting imports was estimated to result in approximately 171 million cwt. of sugar and 73 million cwt. of HFCS consumed in 1985. The grower subsidy policy was estimated to result in approximately 220 million cwt. of sugar and 24 million cwt. of HFCS consumption in 1985 (Table 26). These estimates provided the basis for analyzing production and marketing patterns of sugar in 1985.

## 1985 Sugar Movements in the United States

The transportation model was used to determine the optimum flows of sugar in 1985 under selected government policy options using the projected supplies of domestic sugar and 1976 refining capacity for imported raw sugars. The transportation model was used to identify the least cost source of sugar supply to meet 1985 consumption requirements.

Consumption in each area in 1985 was based on the 1974-75 patterns of refined sugar deliveries. Each area's percentage of total United States deliveries of refined sugar in 1974 and 1975 was assumed to remain constant to 1985. For example, the average percentage of total United States refined sugar deliveries for 1974 and 1975 to Minnesota, North Dakota, and South Dakota was 1.73 percent. The 1976 and 1985 percentages of total United States refined sugar deliveries were assumed to be the same. The formula for finding the quantity of sugar delivered to Minnesota, North Dakota, and South Dakota in 1985 under the low HFCS assumption would be: (0.0173)* (219.70 million cwt.)** = (3.80 million cwt.).***

### Tariff on Imported Sugar

A tariff of 0.625 of a cent per pound on imported sugar was in effect in the United States until September, 1976, when the tariff was tripled to 1.875 cents per pound.[37] This action was taken to raise domestic sugar prices

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*Share of total United States deliveries shipped to Minnesota, North Dakota, and South Dakota.

**Total United States sugar deliveries under grower subsidy policy, 1985.

***Quantity of sugar projected to be consumed in Minnesota, North Dakota, and South Dakota in 1985 under the grower subsidy policy. See Table 26.

[37] United States Department of Agriculture, Economic Research Service, Sugar and Sweetener Report, Vol. 1, No. 9, Washington, D.C., October, 1976. p. 5.

TABLE 26. SUGAR DELIVERIES BY DELIVERY AREA, 1970, 1974, 1975, 1976 ESTIMATES AND 1985 PROJECTIONS

| Delivery Point | States Included | Sugar Deliveries 1970 | 1974 | 1975 | 1976 | Projections 1985* Sugar + HFCS 1985 | 90% Sugar 1985[a] | 70% Sugar 1985[b] |
|---|---|---|---|---|---|---|---|---|
| | | (million cwt.) | | | | (million cwt.) | | |
| Boston | MA, NH, VT, CT, RI, MA | 8.36 | 8.06 | 6.81 | 7.73 | 9.28 | 8.35 | 6.49 |
| Albany | NY, NJ | 27.05 | 24.37 | 19.66 | 22.87 | 27.46 | 24.72 | 19.22 |
| Pittsburg | PA | 13.95 | 13.76 | 11.74 | 13.30 | 15.97 | 14.37 | 11.18 |
| Baltimore | MD, DC, DE | 7.88 | 7.69 | 6.76 | 7.52 | 9.03 | 8.13 | 6.32 |
| Richmond | NC, VA, WV | 8.28 | 8.32 | 7.48 | 8.25 | 9.91 | 8.92 | 6.94 |
| Atlanta | AL, FL, GA, SC, TN | 21.22 | 22.17 | 20.45 | 22.26 | 26.73 | 24.06 | 18.71 |
| Cincinnati | IN, OH, KY | 19.60 | 20.24 | 17.71 | 19.78 | 23.75 | 21.38 | 16.63 |
| Detroit | MI | 8.21 | 9.18 | 7.58 | 8.72 | 10.47 | 9.43 | 7.33 |
| Chicago | IL, IA, WI | 32.91 | 32.19 | 25.62 | 30.01 | 36.03 | 32.43 | 25.22 |
| Minneapolis | MN, ND, SD | 3.86 | 3.81 | 2.94 | 3.52 | 4.22 | 3.80 | 2.96 |
| St. Louis | MO, KS | 7.11 | 7.12 | 6.19 | 6.93 | 8.32 | 7.49 | 5.83 |
| New Orleans | AK, LA, MS | 6.82 | 6.65 | 5.77 | 6.47 | 7.76 | 6.99 | 5.43 |
| Dallas | TX, OK, NM | 12.50 | 12.45 | 11.64 | 12.59 | 15.11 | 13.60 | 10.58 |
| Denver | CO, NE, MT, UT, WY | 4.96 | 5.39 | 4.50 | 5.16 | 6.20 | 5.58 | 4.34 |
| Seattle | AK, ID, OR, WA | 5.68 | 5.75 | 4.00 | 5.06 | 6.08 | 5.47 | 4.25 |
| Los Angeles | CA, AZ, NV | 24.29 | 23.72 | 20.70 | 23.18 | 27.83 | 25.05 | 19.48 |
| U.S. TOTAL | | 212.67 | 210.88 | 185.50 | 203.32 | 244.12 | 219.70 | 170.88 |

*Assumes 102.0 pounds per capita of sugar plus HFCS. United States population in 1985 is to be 239,329,000 people. From U.S. Department of Commerce, Statistical Abstract, 1976.

[a]Grower Subsidy Policy-Low World Sugar Prices
[b]Import Restricting Policy

SOURCE: United States Department of Agriculture, Economic Research Service, Sugar Reports, February, 1971, 1975, March, 1976 and 1977.

and to reduce capital loses for domestic sugar producers. The 1.875 cents per pound is termed the "snap-back" tariff and is regarded as a temporary measure.[38]

This study assumed that the tariff on imported raw sugar of 0.625 of a cent per pound would remain on a permanent basis. Dividing by 0.9346, the conversion factor of raw equivalent to refined equivalent, the tariff becomes 0.6687¢ per pound which is rounded to 0.67¢ per pound, or $0.67 per cwt. of refined sugar.

The tariff of $0.67 per cwt. was added to the freight rates of sugar coming from imported sugar sources. For example, all refined sugar originating in New York was assumed to be imported. The tariff of $0.67 per cwt. was added to the New York to Albany freight rate of $0.49 to arrive at $1.16 per cwt. (Table 27). The new "returns to refiners matrix" (Table 28) was calculated in the same manner as the matrix in Table 19, using the revised simple freight rate matrix. The result of adding the tariff to the freight rate was to increase the cost of moving imported sugar to all United States markets.

Hawaiian sugar was allocated to the Texas, Louisiana, and California refineries as domestic capacity before determining the optimum flow solution. The allocation of Hawaiian sugar was based on the projected need for refined sugar in the consuming areas and the actual movements of Hawaiian raw sugar to United States mainland ports in recent years.

## Refined Sugar Movements in 1985 Under a Sugar Import Restricting Policy

The transportation model was used to solve for the minimun freight cost movements of the 171 million cwt. of refined sugar that would be utilized in 1985 under a sugar import restricting policy. The solution was the same using the least freight cost criteria for sugar movements and the refiner revenue maximizing criteria for the basing point pricing system.

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[38] Jesse, Edward V., and Glenn A. Zepp, Sugar Policy Options, op. cit., p. 23.

TABLE 27. FREIGHT RATE MATRIX USED IN THE TRANSPORTATION MODEL FOR 1985 SUGAR MOVEMENTS INCLUDES $0.67 PER CWT. TARIFF IN FREIGHT RATES FOR IMPORTED SUGAR

| Destinations | Source | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stockton CA (DOM)[a] | New Orleans LA (DOM) | Sugar Land TX (DOM) | Clewiston FL (DOM) | Savannah GA (DOM) | Baltimore MD (DOM) | New Orleans LA (IMP)[b] | Sugar Land TX (IMP) | Baltimore MD (IMP) | New York City NY (IMP) | Boston MA (IMP) |
| | (dollars per cwt.) | | | | | | | | | | | | | | | | |
| Boston,MA | 1.44 | 2.53 | 2.63 | 2.63 | 2.86 | 2.95 | 3.03 | 2.38 | c | c | 3.78 | 0.89 | 3.05 | c | 1.56 | 1.29 | 0.67 |
| Albany,NY | 1.23 | 2.48 | 2.52 | 2.56 | 2.77 | 2.86 | 3.00 | 2.34 | c | c | 3.58 | 0.70 | 3.01 | c | 1.37 | 1.16 | 1.19 |
| Pittsburgh,PA | 0.78 | 2.20 | 2.05 | 2.10 | 2.11 | 2.28 | 2.49 | 1.44 | c | c | 1.57 | 0.64 | 2.11 | c | 1.31 | 1.34 | 1.44 |
| Baltimore,MD | 1.37 | 2.45 | 2.51 | 2.50 | 2.58 | 2.83 | 2.99 | 2.27 | c | 1.73 | 2.87 | 0.00 | 2.94 | c | 0.67 | 1.26 | 1.54 |
| Richmond,VA | 1.47 | 2.48 | 2.52 | 2.56 | 2.86 | 2.86 | 3.00 | c | c | 1.31 | 0.71 | 0.52 | c | c | 1.19 | 1.40 | 1.89 |
| Atlanta,GA | c | c | c | c | c | c | c | 0.79 | c | 0.83 | 0.46 | c | 1.46 | c | c | c | c |
| Cincinnati,OH | 0.66 | 1.51 | 1.65 | 1.73 | 1.83 | 2.10 | 2.16 | 0.82 | c | c | c | 1.16 | 1.49 | c | 1.83 | 1.82 | 1.84 |
| Detroit,MI | 0.50 | 1.54 | 1.74 | 1.87 | 1.88 | 2.18 | 2.20 | 1.48 | c | c | c | 1.10 | 2.15 | c | 1.77 | 1.82 | 1.82 |
| Chicago,IL | 0.89 | 0.88 | 1.10 | 1.17 | 1.25 | 1.37 | 1.44 | 1.00 | 1.41 | 1.17 | 2.65 | 1.12 | 1.67 | 2.08 | 1.79 | 1.96 | 1.82 |
| Minneapolis,MN | c | 0.40 | 1.11 | 1.19 | 1.37 | 1.37 | 1.44 | 1.31 | c | c | c | c | 1.98 | c | c | c | c |
| St. Louis,MO | 1.65 | 1.13 | 1.10 | 1.19 | 1.28 | 1.37 | 1.44 | 0.93 | 1.36 | 1.30 | 1.47 | c | 1.60 | 2.03 | c | c | c |
| New Orleans,LA | c | c | c | c | c | c | c | 0.00 | c | c | c | c | 0.67 | c | c | c | c |
| Dallas,TX | c | 1.23 | 1.03 | c | 1.46 | 1.46 | 1.41 | 1.23 | 0.58 | c | c | c | 1.90 | 1.25 | c | c | c |
| Denver,CO | c | c | 0.50 | c | c | c | 1.77 | c | c | c | c | c | c | c | c | c | c |
| Seattle,WA | c | c | c | c | 1.00 | 0.50 | 1.25 | c | c | c | c | c | c | c | c | c | c |
| Los Angeles,CA | c | c | c | c | c | c | 0.80 | c | c | c | c | c | c | c | c | c | c |

[a]"(DOM)" indicates domestically (United States) grown sugar, no tariff added to freight rate.
[b]"(IMP)" indicates imported sugar, $0.67 per cwt. import tariff added to freight rate.
[c]Industry sources indicated these were irrational movements for sugar, and rates were unavailable.

SOURCE: Mr. Ken Scar, American Crystal Sugar Company; Mr. James Lumbkin, Seaboard Coastline Railroad; and Mr. A.L. Wolfe, Chessie System Railroad.

TABLE 28. BASING POINT RETURNS TO SHIPPERS AFTER PAYING 1976 FREIGHT COSTS PLUS $0.67 TARIFF ON IMPORTED SUGAR AND COLLECTING PREPAYS, ASSUMING $15.00 PER CWT. FOR REFINED SUGAR IN ALL MARKETING REGIONS

| Destinations | Source | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stock-ton CA (DOM)[a] | New Orleans LA (DOM) | Sugar Land TX (DOM) | Clewis-ton FL (DOM) | Savannah GA (DOM) | Balti-more MD (DOM) | New Orleans LA (IMP)[b] | Sugar Land TX (IMP) | Balti-more MD (IMP) | New York City NY (IMP) | Boston MA (IMP) |
| | (dollars per cwt.) | | | | | | | | | | | | | | | | |
| Boston, MA | 13.56 | 12.47 | 12.37 | 12.37 | 12.14 | 12.05 | 11.97 | 12.62 | c | c | 11.22 | 14.11 | 11.95 | c | 13.44 | 13.71 | 14.33 |
| Albany, NY | 14.26 | 13.01 | 12.97 | 12.93 | 12.72 | 12.63 | 12.49 | 13.15 | c | c | 11.91 | 14.79 | 12.48 | c | 14.12 | 14.33 | 14.30 |
| Pittsburgh, PA | 14.86 | 13.44 | 13.59 | 13.54 | 13.53 | 13.36 | 13.15 | 14.20 | c | c | 14.07 | 15.00 | 13.53 | c | 14.33 | 14.30 | 14.20 |
| Baltimore, MD | 13.63 | 12.55 | 12.49 | 12.50 | 12.42 | 12.17 | 12.01 | 12.73 | c | 13.27 | 12.13 | 15.00 | 12.06 | c | 14.33 | 13.74 | 13.46 |
| Richmond, VA | 14.05 | 13.04 | 13.00 | 12.96 | 12.66 | 12.66 | 12.52 | c | c | 14.21 | 14.81 | 15.00 | c | c | 14.33 | 14.12 | 13.63 |
| Atlanta, GA | c | c | c | c | c | c | c | 14.67 | c | 14.63 | 15.00 | c | 14.00 | c | c | c | c |
| Cincinnati, OH | 15.16 | 14.31 | 14.17 | 14.09 | 13.99 | 13.72 | 13.66 | 15.00 | c | c | c | 14.66 | 14.33 | c | 13.99 | 14.00 | 13.98 |
| Detroit, MI | 15.60 | 14.56 | 14.36 | 14.23 | 14.22 | 13.92 | 13.90 | 14.62 | c | c | c | 15.00 | 13.95 | c | 14.33 | 14.28 | 14.28 |
| Chicago, IL | 15.11 | 15.12 | 14.90 | 14.83 | 14.75 | 14.63 | 14.56 | 15.00 | 14.59 | 14.83 | 12.35 | 14.88 | 14.33 | 13.92 | 14.21 | 14.04 | 14.18 |
| Minneapolis,MN | c | 15.91 | 15.20 | 15.12 | 14.94 | 14.94 | 14.87 | 15.00 | c | c | c | c | 14.33 | c | c | c | c |
| St. Louis, MO | 14.28 | 14.80 | 14.83 | 14.74 | 14.65 | 14.56 | 14.49 | 15.00 | 14.57 | 14.63 | 14.46 | c | 14.33 | 13.90 | c | c | c |
| New Orleans,LA | c | c | c | c | c | c | c | 15.00 | c | c | c | c | 14.33 | c | c | c | c |
| Dallas, TX | c | 14.35 | 14.55 | c | 14.12 | 14.12 | 14.17 | 14.35 | 15.00 | c | c | c | 13.68 | 14.33 | c | c | c |
| Denver, CO | c | c | 16.27 | c | c | c | 15.00 | c | c | c | c | c | c | c | c | c | c |
| Seattle, WA | c | c | c | c | 15.25 | 15.75 | 15.00 | c | c | c | c | c | c | c | c | c | c |
| Los Angeles,CA | c | c | c | c | c | c | 15.00 | c | c | c | c | c | c | c | c | c | c |

[a]"(DOM)" indicates domestically (United States) grown sugar, no tariff added to freight rate.
[b]"(IMP)" indicates imported sugar, $0.67 per cwt. import tariff added to freight rate.
[c]Industry sources indicated these were irrational movements for sugar, and rates were unavailable.

SOURCE: Mr. Ken Scar, American Crystal Sugar Company; Mr. James Lumbkin, Seaboard Coastline Railroad; and Mr. A.L. Wolfe, Chessie System Railroad.

Unused capacity was evident at five of the 14 sugar sources and five of the 17 sources when imported sugar is considered separately (Table 29). The beet sugar sources having excess production were the Washington and California-Arizona areas.

California-Arizona production was limited to consumption in the California-Arizona-Nevada delivery area. Unused beet sugar production in Washington was 0.83 million cwt., while in California-Arizona it was 1.27 million cwt. On the basis of projections made in this study, both areas produced more sugar than would be consumed in their closest delivery areas.

Other beet sugar movements included 5.47 million cwt. from Bay City, Michigan, to Detorit, Michigan. Moorhead, Minnesota, shipments included 2.96 million cwt. to Minneapolis, Minnesota, and 14.04 million cwt. to Chicago, Illinois, which comprised over one-half the refined sugar movements into Chicago. Greeley, Colorado, shipped 330,000 cwt. to Chicago, Illinois; 4.34 million cwt. to Denver, Colorado; and just over three million cwt. each to St. Louis, Missouri, and Dallas, Texas. Billings, Montana, and Nampa, Idaho, shipped their entire projected 1985 production of 3.75 and 5.54 million cwt. of sugar, respectively, to Chicago, Illinois. The entire 1985 projected production of Areas I through V, which included all the beet sugar producing areas east of and including Oregon, Idaho, and Utah, was utilized. Only the projected 1985 production of Washington and California-Arizona exceeded the refined sugar movements called for by the model.

Unused cane refining capacity occurred at Crockett, California, (Stockton, California, source) Louisiana, New York, and Boston. No cane sugar would be produced in California in 1985 according to the results of the transportation model. In 1976 approximately one-half of the sugar received at mainland ports from Hawaii was refined in California and one-half in Texas and Louisiana.[39] Hawaiian raw sugar was allocated to the Sugar Land, Texas, and Louisiana refineries for this analysis. All domestically produced cane sugar capacity was used since the Hawaiian raw sugar production was allocated to Texas and Louisiana. Nearly one-half of the New Orleans capacity was not utilized in the 1985 optimum solution (22.41 million cwt. of the 48.74 million cwt. of annual refined sugar capacity was unused). The unused portion of Louisiana refining capacity was that portion that would be imported. Unused

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[39] Information received from Glenn A. Zepp, United States Department of Agriculture, Economic Research Service, in a personal telephone interview with Iven Ose on March 8, 1977.

TABLE 29. OPTIMUM FLOWS OF SUGAR IN THE UNITED STATES IN 1985 UNDER THE SUGAR IMPORT RESTRICTING GOVERNMENT POLICY

| Destinations | Source (unlimited capacity assumption) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stockton CA (DOM)[a] | New Orleans LA[b] (DOM) | Sugar Land TX[c] (DOM) | Clewiston FL (DOM) | Savannah GA (DOM) | Balti-more MD (DOM) | New Orleans LA[b] (IMP)[d] | Sugar Land TX[c] (IMP) | Balti-more MD (IMP) | New York City NY (IMP) | Boston MA (IMP) | Total Consumption |
| | (million cwt.) | | | | | | | | | | | | | | | | | |
| Boston, MA | | | | | | | | | | | | | | | | | 6.49 | 6.49 |
| Albany, NY | | | | | | | | | | | | | | | | 19.22 | | 19.22 |
| Pittsburgh, PA | | | | | | | | | | | | | | | | 11.18 | | 11.18 |
| Baltimore, MD | | | | | | | | | | | | 2.48 | | | 3.48 | | | 6.32 |
| Richmond, VA | | | | | | | | | | | | 6.80 | | | | 0.14 | | 6.94 |
| Atlanta, GA | | | | | | | | 1.55 | | 6.06 | 11.10 | | | | | | | 18.71 |
| Cincinnati, OH | | | | | | | | 16.63 | | | | | | | | | | 16.63 |
| Detroit, MI | 5.47 | | | | | | | | | | | | | | | | 1.86 | 7.33 |
| Chicago, IL | | 14.04 | 0.33 | 3.75 | 5.54 | 1.56 | | | | | | | | | | | | 25.22 |
| Minneapolis, MN | | 2.96 | | | | | | | | | | | | | | | | 2.96 |
| St. Louis, MO | | | 3.11 | | | | | 2.72 | | | | | | | | | | 5.83 |
| New Orleans, LA | | | | | | | | 5.43 | | | | | | | | | | 5.43 |
| Dallas, TX | | | 3.01 | | | | | | 7.17 | | | | | 0.40 | | | | 10.58 |
| Denver, CO | | | 4.34 | | | | | | | | | | | | | | | 4.34 |
| Seattle, WA | | | | | | 4.25 | | | | | | | | | | | | 4.25 |
| Los Angeles, CA | | | | | | | 19.48 | | | | | | | | | | | 19.48 |
| U.S. TOTAL | 5.47 | 17.00 | 10.79 | 3.75 | 5.54 | 5.81 | 19.48 | 26.33 | 7.17 | 6.06 | 11.10 | 9.64 | 0.00 | 0.40 | 3.48 | 30.54 | 8.35 | 170.88 |
| Unused Capacity | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.83 | 19.89[e] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 22.41 | 0.00 | 0.00 | 13.79 | 2.75 | 59.88 |

[a] "(DOM)" indicates domestically (United States) grown sugar.
[b] Assumes 11.99 million cwt. of refined sugar available from Louisiana and 14.34 million cwt. available from Hawaii as domestic sugar which leaves a capacity of 22.41 million cwt. for imported sugar from the Louisiana refining point.
[c] Assumes 2.67 million cwt. available from Texas millers and 4.50 million cwt. from Hawaii as domestic sugar which leaves a capacity of 400,000 cwt. for imported sugar from the Sugar Land, Texas, refining point.
[d] "(IMP)" indicates imported sugar.
[e] Refined beet sugar accounted for 20.75 million cwt.; therefore projected deliveries to California leave 1.27 million cwt. of beet sugar unsold and the cane refining capacity at Crockett, California, unutilized.

capacity in New York was 13.79 million cwt. out of total annual capacity of 44.51 million cwt. Unused capacity in Boston was 2.75 million cwt. out of a total of 11.10 million cwt. annually. Sugar Land, Texas, and Baltimore, Maryland, were the only importing sources not showing unutilized capacity.

### Sensitivity of Minnesota-North Dakota Originating Shipments to Freight Rate Changes, 1985

Changes in the least freight cost refined sugar movements from Moorhead would require large reductions in freight rates for all destinations (Table 30). Freight reductions of at least 60 percent would be required to stimulate shipments to the consuming areas along the Atlantic. Freight reductions of $0.21 to $0.74 per cwt. would be required on shipments originating in Moorhead to gain access to markets in Detroit, Cincinnati, St. Louis, and Dallas. Freight rates from Moorhead to Minneapolis and Chicago could double before the solution to the transportation model would change. Moorhead to Chicago movements of refined sugar could not be increased without cutting rates on that route by over one-half. Sensitivity analysis of freight rate changes indicated considerable stability in shipments of refined sugar from Moorhead.

### Refined Sugar Movements in 1985 Under a Grower Subsidy Policy and Low World Sugar Prices

The refined sugar movements in 1985 under a grower subsidy policy and low world sugar prices left much less unused refinery capacity than the movements under a policy of restricting sugar imports because of the low level of penetration of HFCS into the sugar market. Consequently, the sugar needs of each consuming area were increased substantially under this policy.

The sugar industry model solved for the minimum freight cost in the simple freight minimizing run. Maximum returns to refiners was solved using basing point pricing. Refined sugar movements from the production areas to the consumption areas were identical, although the make-up (imported versus domestic) of the New Orleans to Cincinnati and the New Orleans to St. Louis shipments were slightly different (Tables 31 and 32).

All refined beet sugar capacity was utilized in the solution to this model. Movements included 5.47 million cwt. from Bay City, Michigan, to Detroit, Michigan. Moorhead, Minnesota, shipments included 3.80 million cwt. to Minneapolis, Minnesota, and 13.20 million cwt. to Chicago, Illinois.

TABLE 30. THE EFFECT OF CHANGES IN FREIGHT RATES ON REFINED SUGAR SHIPMENTS FROM MOORHEAD, MINNESOTA, 1985

| Moorhead, MN to | Present Rate | Required Rate to Increase Shipment (Anything Less Than) | Volume to be Gained | Upper Limit on Rate in Order to Continue to Supply Refined Sugar |
|---|---|---|---|---|
| | ($/cwt.) | ($/cwt.) | (million cwt.) | ($/cwt.) |
| Boston, MA | 2.53 | 0.18 | 0.83 | a |
| Albany, NY | 2.48 | 0.67 | 0.83 | a |
| Pittsburgh, PA | 2.20 | 0.85 | 0.83 | a |
| Baltimore, MD | 2.45 | 0.39 | 0.14 | a |
| Richmond, VA | 2.48 | 0.91 | 0.14 | a |
| Atlanta, GA | b | 0.74 | 1.55 | a |
| Cincinnati, OH | 1.50 | 0.77 | 3.11 | a |
| Detroit, MI | 1.54 | 1.33 | 0.83 | a |
| Chicago, IL | 0.88 | 0.40 | 1.56 | 1.08 |
| Minneapolis, MN | 0.40 | c | 0 | 0.87 |
| St. Louis, MO | 1.13 | 0.88 | 3.11 | a |
| New Orleans, LA | b | d | 0 | a |
| Dallas, TX | 1.23 | 0.81 | 3.01 | a |
| Denver, CO | b | 0.28 | 4.34 | a |
| Seattle, WA | b | 0.01 | 4.25 | a |
| Los Angeles, CA | b | 0.31 | 0.83 | a |

[a]No shipments occur in the least-cost solution.
[b]Industry sources indicated these were irrational movements for sugar and rates were unavailable.
[c]Shipments supply total needs of delivery point.
[d]The rate required to stimulate shipments is less than 0.

Chicago received the entire production of refined sugar from the Billings, Montana, and Nampa, Idaho, refiners in addition to 60,000 cwt. from Moses Lake, Washington, and 9.88 million cwt. from the California refiners. Moses Lake, Washington, refiners also shipped 1.11 million cwt. to St. Louis, Missouri, and 5.47 million cwt. to Seattle, Washington. California refiners shipped 820,000 cwt. of refined sugar to Dallas, Texas, and 25.05 million cwt. to local California-Arizona-Nevada buyers leaving only 3.67 million cwt. of unused refinery capacity in California. The 35.75 million cwt. of refined sugar from California refiners is comprised of 20.75 million cwt. of beet sugar and 15.00 million cwt. of Hawaiian-grown sugar. The remaining 3.83 million cwt. of sugar from the 1985 Hawaiian crop was allocated to Sugar Land, Texas (3.00 million cwt.), and New Orleans, Louisiana (830,000 cwt.), refiners as domestic capacity. This solution left 3.67 million cwt. of California refiner capacity unused.

TABLE 31. OPTIMUM FLOWS OF SUGAR IN THE UNITED STATES IN 1985 UNDER THE SUGAR GROWER SUBSIDY POLICY, SIMPLE FREIGHT COST MINIMIZING CRITERIA

| Destinations | Source (unlimited capacity assumption) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stockton CA[a] (DOM)[b] | New Orleans LA[c] (DOM) | Sugar Land - TX[d] (DOM) | Clewiston FL (DOM) | Savannah GA (DOM) | Balti-more MD (DOM) | New Orleans LA[c] (IMP)[e] | Sugar-Land TX[d] (IMP) | Balti-more MD (IMP) | New York City NY (IMP) |
| | (million cwt.) | | | | | | | | | | | | | | | |
| Boston, MA | | | | | | | | | | | | | | | | |
| Albany, NY | | | | | | | | | | | | | | | | 24.37 |
| Pittsburgh, PA | | | | | | | | | | | | | | | | 14.37 |
| Baltimore, MD | | | | | | | | | | | | 8.13 | | | 3.48 | |
| Richmond, VA | | | | | | | | | | | | 1.51 | | | | 3.93 |
| Atlanta, GA | | | | | | | | | | 6.06 | 11.10 | | 6.90 | | | |
| Cincinnati, OH | | | | | | | | 6.45 | | | | | 14.93 | | | |
| Detroit, MI | 5.47 | | | | | | | | | | | | | | | 1.21 |
| Chicago, IL | | 13.20 | | 3.75 | 5.54 | 0.06 | 9.88 | | | | | | | | | |
| Minneapolis, MN | | 3.80 | | | | | | | | | | | | | | |
| St. Louis, MO | | | | | | 1.11 | | 6.38 | | | | | | | | |
| New Orleans, LA | | | | | | | | | | | | | 6.99 | | | |
| Dallas, TX | | | 5.21 | | | | 0.82 | | 5.67 | | | | | 1.90 | | |
| Denver, CO | | | 5.58 | | | | | | | | | | | | | |
| Seattle, WA | | | | | | 5.47 | | | | | | | | | | |
| Los Angeles, CA | | | | | | | 25.05 | | | | | | | | | |
| U.S. TOTAL | 5.47 | 17.00 | 10.79 | 3.75 | 5.54 | 6.64 | 35.75 | 12.83 | 5.67 | 6.06 | 11.10 | 9.64 | 28.82 | 1.90 | 3.48 | 44.23 |
| Unused Capacity | .000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.09 | 0.00 | 0.00 | 0.28 |

[a]Assumes 20.75 million cwt. of beet sugar and 15.00 million cwt. of Hawaiian cane sugar available from Stockton, California, refined sugar source, which leaves a capacity of 3.67 million cwt. of sugar unused.
[b]"(DOM)" indicates domestically (United States) grown sugar.
[c]Assumes 11.99 million cwt. of Louisiana-grown cane sugar and 0.84 million cwt. of Hawaiian cane sugar available from the New Orleans refined sugar source, which leaves a capacity of 35.91 million cwt. for imported sugar from the Louisiana refining point.
[d]Assumes 2.67 million cwt. of Texas-grown cane sugar and 3.00 million cwt. of Hawaiian-grown cane sugar available from the Sugar Land, Texas source, which leaves a capacity of 1.90 million cwt. for imported sugar from the Texas refining point.
[e]"(IMP)" indicates imported sugar.

TABLE 32. OPTIMUM FLOWS OF SUGAR IN THE UNITED STATES IN 1985 UNDER THE SUGAR GROWER SUBSIDY POLICY, REFINER REVENUE MAXIMIZING CRITERIA-BASING POINT PRICING

| Destinations | Source (unlimited capacity assumption) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bay City MI | Moorhead MN | Greeley CO | Billings MT | Nampa ID | Moses Lake WA | Stockton CA[a] (DOM)[b] | New Orleans LA[c] (DOM) | Sugar Land TX[d] (DOM) | Clewiston FL (DOM) | Savannah GA (DOM) | Balti-more MD (DOM) | New Orleans LA[c] (IMP)[e] | Sugar Land TX[d] (IMP) | Balti-more MD (IMP) | New York City NY (IMP) | Boston MA (IMP) | Total Consumption |
| | (million cwt.) | | | | | | | | | | | | | | | | | |
| Boston, MA | | | | | | | | | | | | | | | | | 8.35 | 8.35 |
| Albany, NY | | | | | | | | | | | | | | | | 24.72 | | 24.72 |
| Pittsburgh, PA | | | | | | | | | | | | | | | | 14.37 | | 14.37 |
| Baltimore, MD | | | | | | | | | | | | 8.13 | | | | | | 8.13 |
| Richmond, VA | | | | | | | | | | | | 1.51 | | | 3.48 | 3.93 | | 8.92 |
| Atlanta, GA | | | | | | | | | | 6.06 | 11.10 | | 6.90 | | | | | 24.06 |
| Cincinnati, OH | | | | | | | | 12.83 | | | | | 8.55 | | | | | 21.38 |
| Detroit, MI | 5.47 | | | | | | | | | | | | | | | 1.21 | 2.75 | 9.43 |
| Chicago, IL | | 13.20 | | 3.75 | 5.54 | 0.06 | 9.88 | | | | | | | | | | | 32.43 |
| Minneapolis, MN | | 3.80 | | | | | | | | | | | | | | | | 3.80 |
| St. Louis, MO | | | | | | 1.11 | | | | | | | 6.38 | | | | | 7.49 |
| New Orleans, LA | | | | | | | | | | | | | 6.99 | | | | | 6.99 |
| Dallas, TX | | | 5.21 | | | | 0.82 | | 5.67 | | | | | 1.90 | | | | 13.60 |
| Denver, CO | | | 5.58 | | | | | | | | | | | | | | | 5.58 |
| Seattle, WA | | | | | | 5.47 | | | | | | | | | | | | 5.47 |
| Los Angeles, CA | | | | | | | 25.05 | | | | | | | | | | | 25.05 |
| U.S. TOTAL | 5.47 | 17.00 | 10.79 | 3.75 | 5.54 | 6.64 | 35.75 | 12.83 | 5.67 | 6.06 | 11.10 | 9.64 | 20.82 | 1.90 | 3.48 | 44.23 | 11.10 | 219.70 |
| Unused Capacity | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.09 | 0.00 | 0.00 | 0.28 | 0.00 | 11.04 |

[a]Assumes 20.75 million cwt. of beet sugar and 15.00 million cwt. of Hawaiian cane sugar available from Stockton, California, refined sugar source, which leaves a capacity of 3.67 million cwt. of sugar unused.
[b]"(DOM)" indicates domestically (United States) grown sugar.
[c]Assumes 11.99 million cwt. of Louisiana-grown cane sugar and 0.84 million cwt. of Hawaiian cane sugar available from the New Orleans refined sugar sources, which leaves a capacity of 35.91 million cwt. for imported sugar from the Louisiana refining point.
[d]Assumes 2.67 million cwt. of Texas-grown cane sugar and 3.00 million cwt. of Hawaiian-grown cane sugar available from the Sugar Land, Texas, source, which leaves a capacity of 1.90 million cwt. for imported sugar from the Texas refining point.
[e]"(IMP)" indicates imported sugar.

The majority of the 11.04 million cwt. of unused annual sugar industry capacity occurred in New Orleans and a small portion of the unused capacity was in New York. The grower subsidy policy option would require that 219.70 million cwt., or 95 percent of the sugar production capacity to be delivered. The projected beet sugar production would be completely used with the unutilized production capacity occurring in the cane refining industry. Total deliveries from the cane refiners were projected to be 139.83 million cwt., or approximately 87 percent of the total 1976 cane refining capacity in the United States.

## Future Expansion of the Sugar Growing and Refining Industry

The only sugarbeet producing areas which could expand production without having to ship their additional output to markets over 1,000 miles away are the Michigan-Ohio (least-cost shippers to the Detroit and Cincinnati markets) area and the Minnesota-North Dakota (least-cost shippers to the Minneapolis and Chicago markets) area. The 1985 projections of production and consumption (under both government sugar policy alternatives) provided for markets in Chicago and Detroit greater than the output of refined sugar from Minnesota-North Dakota and Ohio-Michigan, respectively. Increased production among western beet growers and refiners would necessitate shipping the additional refined sugar east to the Chicago and other midwest markets. The greatest nonutilization of cane refining capacity in freight cost minimizing solutions appeared in the California, Louisiana, and New York refining areas. Texas and the southeastern United States do not fulfill the refined sugar needs of their nearest consuming areas and; consequently, the long-term shift in cane refining capacity would be away from California, New Orleans, and New York, to Texas and the southeastern United States. This shift in cane refinery capacity would minimize freight costs for refined sugar.

## Conclusion

Movements of sugar in 1976 showed several areas to be at a disadvantage for producing sugar because of high freight costs. The sugar producing states in the Northwest including Colorado, Wyoming, and Montana were at a disadvantage when competing for the Chicago market and other markets to the east. Florida, Ohio-Michigan, and Texas-Louisiana sugar growers were all located close to large sugar markets which indicated a secure market for the future at low freight costs. California, Louisiana, and Texas growers face competition from Hawaiian-grown and imported sugar for local sugar markets.

Projections were made for domestic sugar production and consumption to 1985. The areas of the United States where sugar production was projected to increase were the Red River Valley of Minnesota and North Dakota, Washington State, and Florida. Over 30 percent declines in sugar production were projected in the Montana-Wyoming and the Idaho-Utah-Oregon sugarbeet growing areas. The acreage in other sugar crop areas of the United States was expected to remain relatively constant to 1985.

Government policy alternatives will be major factors affecting the future of the sugar industry should low world sugar prices persist into the mid-1980's. Sugar growers' subsidies would maintain sugar consumption at high levels without allowing HFCS penetration. A government sugar policy of restricted sugar imports would provide a price umbrella for HFCS, allowing a substantial penetration by HFCS into the sugar market. High levels of HFCS substitution for sugar throughout the United States would leave the Washington and California sugarbeet growing areas in a disadvantaged position because of the decreased demand in local and other United States markets for refined sugar.

If the sugar price cycle continues its historical pattern of a price peak every six to eleven years followed by overproduction and low world prices, which is then followed by underproduction and another price peak, observers of the sugar market could expect another price peak sometime between 1980 and 1985.

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