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SUGAR, SUGAR ECONOMICS

Among the various types of sugars marketed, the mass consumption of sucrose far outweighs by volume the consumption of other products. Sucrose, also called table sugar, is a disaccharide which, upon hydrolysis, yields two monosaccharides: glucose and fructose. Various types of sugar vary in sweetness (1).

The creation of sugar in the leaves of natural plants is considered the most efficient way of capturing solar energy. Table 1 illustrates the area of land needed to capture 27.7×10^3 kJ (6.61×10^3 kcal) of solar energy (2) in various food products.

Sucrose (table sugar) is a white crystalline substance. It is marketed in the form of various shades of brown-colored crystals (brown sugar), as white powder (powdered sugar), and also as high density syrup (liquid sugar). There are many distinguishing properties of sugar: pleasant sweetness, nutritional value (easy digestive resorption), good texturing for bakery products, good preservative qualities in jelly products, etc. One important feature of sugar as a product manufactured for food that is greatly overlooked is its unlimited shelf life.

When properly manufactured, cane and beet sugars are identical in physical, chemical, electric, and thermodynamic properties (see Sugar, beet sugar; Sugar, cane sugar).

In addition to providing essential nutritional value to support life, the sugar industry has made a profound impact in history and in the social evolution of humankind. Industrial production of sugar (sucrose) is based on sugarcane and sugar beet processing. Sugarcane is grown and processed in tropical and subtropical countries. These regions are inside a belt whose northern border crosses the North American continent at southern California and South Carolina, and the European continent at the southern border of Spain, the Asian continent at northern Arabia, Pakistan, and south China, and the Pacific Ocean at the 37th parallel. In the southern hemisphere, the borderline goes through south Brazil, crosses the Atlantic Ocean, the African continent at Natal, the Indian Ocean, below the northern coast of Australia, and the Pacific Ocean at the 34th parallel. All regions outside this belt, in the northern and southern hemispheres, depend on sugar beet processing for sugar manufacture.

Despite the fact that refined cane and beet sugar are physically and compositionally identical, the histories of their development are very different. The story of both sugars, cane and beet, is woven into historic tales of adventure and discovery. In trade and commerce, today as in the past both industries play major roles. In the literature there are many records of the fascinating role of sugar in the destinies of nations in war and peace (3).

1. Sugar Economics and Statistics

By the beginning of the twentieth century, the sugar industry had evolved to the point of playing a significant role in supplying the caloric needs of the world's population. By the end of 1914 the world cane sugar output stood at 11,523,158 t, while the beet sugar output had risen to 9,051,767 t, bringing the total world sugar production to 20,574,925 t/yr. During the next twenty years with increase of population and consumption,

Table 1. Land Area Needed for Various Food Products[a]

Food products	Needed land, hectare[b]
sugar	0.4
potatoes	1.2
corn	2.4
wheat	2.4
hogs	5.3
whole milk	6.7
eggs	21
chickens	25
steers	45

[a]See text.
[b]To convert hectare to acres, multiply by 2.5.

world sugar output continued to rise. Consequently, in the period of 1929–1930 cane sugar production reached 17,381,000 t, whereas beet sugar held its ground at 9,359,000 t, for a total world sugar output of 26,740,000 t/yr.

The effect of World War II was very drastically felt in the sugar industry. Raw materials, machine parts, and maintenance items needed to maintain sugar processing were diverted to the war industry. Many sugar industry experts were conscripted into the armed forces. In the European theater of war, factories and agriculture were destroyed. At the end of World War II sugar production barely totalled 19,162,000 t/yr.

The post-war period and the decades following it created very favorable conditions for the healthy recovery of both the cane and beet sugar industries. In the very early years of rebuilding, the war-torn European industry accepted the concept of creating very high capacity processing facilities with extensive automation. In realizing this concept, many small factories were closed and abandoned. Unfortunately for countries coming under Soviet dominance, this concept was not applied. The sugar industry in Eastern and Central Europe still suffers from the negative consequences of this failure. Nevertheless, during the past half-century the global recovery and ensuing progress of the sugar industry have been dramatic (4).

Although a great expansion of the world sugar industry occurred, U.S. sugar processing suffered three setbacks resulting from the appearance of corn sweeteners, noncaloric sweeteners, and the effects of health movements and fads. Despite caloric sweetener consumption increases in the United States from 56.3 to 65.1 kg per capita during the time period from 1980–1992, the U.S. sugar industry lost ground, moving from 38 to 29.3 kg in per capita consumption. Two new products expanded into the market corn-based and the artificial (noncaloric) sweeteners. These products' consumption rose from 20.9 to 35.4 and 4.4 to 11 kg per capita, respectively (5, 6). However, sugar remains irreplaceable in many bakery, candy, confectionery, and other products. Further, factual claims of major nutrition science centers and the FDA that the sugar is a GRAS and healthy product when used in moderation have helped to consolidate the position of the U.S. sugar industry (Fig. 1).

In each country of the modern world, sugar production and trade play major social, political, and economical roles. In order to regulate and protect export, import, stocks, subsidies, tariffs, etc, an enormous number of laws have been enacted and agreements concluded on sugar, both domestically and internationally. Also, insofar as sugar is a basic staple for a large population, each country keeps a watchful eye on sugar production, consumption, and price, which vary widely from country to country, as shown in Table 2 (7, 8).

During the years 1984–1994, world sugar consumption showed a constantly increasing trend, whereas production trailed slightly (9). The sugar disappearance (trade term) in the time period increased from 98,226,900 to 113,270,100 t/yr (+15, 043, 200 t/yr). Production did not keep pace and rose from 100,436,500 to only 110,784,200 t/yr. This created a shortage in the ending stocks of 4,695,500 t of sugar per year (Fig. 2).

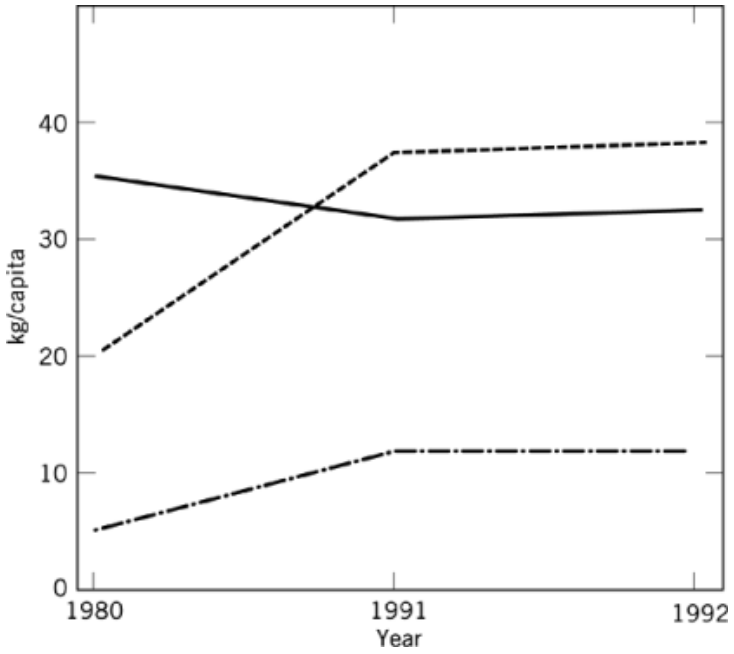

Fig. 1. U.S. sweetener consumption, 1980–1992, where (▬) represents sucrose; (– – –), corn sweeteners; and (·–·–), noncaloric sweeteners.

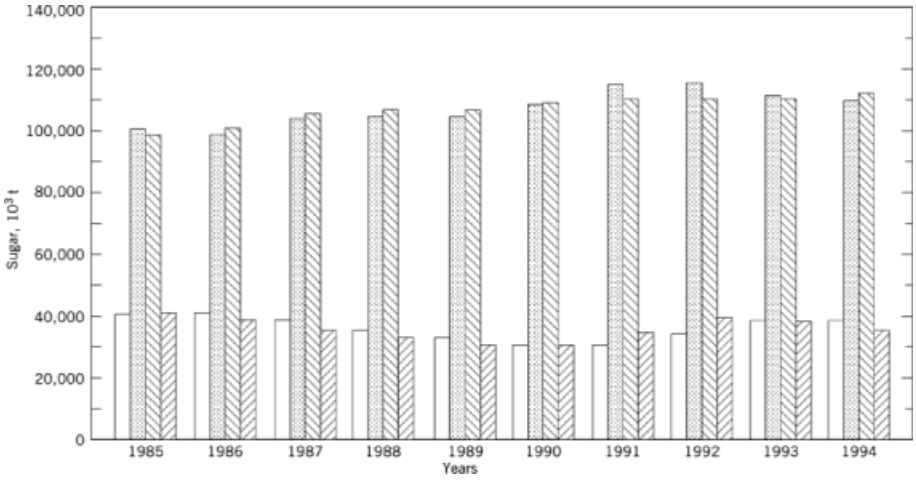

Fig. 2. World sugar balance, where □ represents opening stocks; ■, production; ▧, consumption; and ▨, ending stocks (9, 10).

A 1995 report by Landell Mills Commodities Studies (Oxford, England) (7), pointed out that the United States sweetener industry (cane, beet, HFCS) provides 420,000 jobs a year and has a positive economic impact of $26.2 billion. By interpolating these data, it is likely that the world sweetener industry provides jobs to more than 15 million persons and affects the world economy by more than $100 billion (see Sweeteners).

Table 2. World Sugar Production, Consumption, and Retail Prices, 1993–1995

Country	Production, $t \times 10^3$	Consumption, $t \times 10^3$	Price, U.S. $/kg
Japan	857	2598	2.29
Norway		175	1.45
Taiwan	502	561	1.45
Austria	520	408	1.36
Ireland	192	153	1.23
Spain	1345	1299	1.14
Bulgaria[a]	9	200	1.10
the Netherlands	1230	673	1.10
Portugal	3	329	1.10
Brazil[a,b]	10112	7840	1.03
United Kingdom	1561	2493	0.97
United States	6214	8561	0.86
Argentina	1093	1236	0.81
Hungary	282	431	0.79
South Africa	1259	1330	0.73
Peru[a]	516	695	0.64
Poland	2170	1606	0.61
Canada	124	1163	0.59
Turkey	2192	1855	0.53
Egypt[a]	1092	1649	0.51
India[a]	10450	13184	0.48
France	4772	2559	1.50
Denmark	566	254	1.45
Russia[a]	2697	5404	1.43
Finland	154	244	1.34
Switzerland	152	317	1.21
Germany	4740	3103	1.12
Greece	315	359	1.10
Belgium	1133	558	1.10
Pakistan[a]	3176	2844	1.08
Italy	1541	1870	0.99
Sweden	414	391	0.95
China[a]	6541	7874	0.86
Australia	4483	855	0.79
Philippines	1860	1791	0.75
Mexico[a]	3859	4352	0.66
Indonesia[a]	2496	2916	0.61
Colombia[a]	1918	1198	0.59
Thailand[a]	4009	1457	0.55
Venezuela	505	741	0.53
Costa Rica	328	194	0.48
Guatemala[a]	1147	399	0.46

[a]Sugar of lesser quality: plantation white cane sugar, grayish beet sugar.
[b]A large volume of sugar is used for alcohol production.

During the past two centuries the world sugar industry has evolved into a large and powerful business that has as a mission the responsibility for contributing to the supply of food that sustains life in humans. As of 1995, sugar was produced and refined in 126 countries in 1613 raw cane mills, 139 refineries, and 899 beet sugar factories (Table 3). The ever-increasing world population makes inevitable the future rationalization

of sources and means for food supply. The world sugar industry will play an increasingly important role in realizing that goal.

Table 3. World Sugar Processing Facilities, 1995

Country	Cane	Refineries	Beet	Country	Cane	Refineries	Beet
Afganistan			1	Hungary			12
Albania			2	India	413		
Algeria	4			Indonesia	69		
Angola	3			Iran	2		37
Argentina	23			Iraq	1		1
Australia	28	4		Ireland			2
Austria			3	Italy			31
Bangladesh	16			Jamaica	9		
Barbados	3			Japan	22	31	8
Belarus			4	Kazakstan			9
Belgium			11	Kenya	8		
Belize	1					4	
				Republic of Korea			
Bolivia	6						
Brazil	207	14		Kyrgyzstan			3
Bulgaria			7	Latvia			3
Burkina	1			Lebanon		4	
Burundi	1			Lithuania			5
Cameron	3			Madagascar	5		
Canada		5	2	Malawi	2		
	1			Malaysia	3	2	
Central African Republic							
				Mali	2		
Chad	1			Martinique	1		
Chile			5	Mauritius	18		
China	147		29	Mexico	65		
Colombia	13			Moldova			12
Congo	1			Morocco	3	2	11
Costa Rica	21			Mozambique	6		
Cote D'Ivoire	4			Myanmar	7		
Croatia			3	Nepal	6		
Cuba	56	11		the Netherlands			6
Czech Republic			40	New Zealand		1	
Denmark			4	Nicaragua	7		
	14			Nigeria	7		
Dominican Republic							
				Pakistan	64		4
Ecuador	6			Panama	4		
Egypt	9	2	1		1		
				Papua, New Guinea			
El Salvador	10	2					
Ethiopia	2			Paraguay	7		
Germany		1	41	Peru	13	6	
Fiji	5			Philippines	41	8	
Finland		1	3	Poland		1	79
France		4	47	Portugal	1	2	1
Gabon	1			Puerto Rico	4	2	
Greece			5	Reunion	4		
Grenada	1			Romania			33
Guadeloupe	4			Russia		3	97
Guatemala	19			Rwanda	1		

Table 3. *Continued*

Country	Cane	Refineries	Beet	Country	Cane	Refineries	Beet
Guyana	10			Saudi Arabia		1	
Haiti	4			Senegal	1		
Honduras	8			Sierra Leone	1		
Singapore		1		Thailand	51		
Slovakia			10	Trinidad and Tobago	2		
Slovenia			1				
Somalia	2			Tunisia		1	3
South Africa	15			Turkey			27
Spain	2		21	Uganda	2		
Sri Lanka	4			Ukraine		4	198
St. Chris.-Nevis	1			United Kingdom		2	10
Sudan	5			United States	38	13	34
Suriname	1			Uruguay	2	1	
Swaziland	3			Venezuela	21		
Sweden		1	4	Vietnam	8	2	
Switzerland			2	Yugoslavia			21
Syria			6	Zaire	1		
Taiwan	16			Zambia	1	1	
Tanzania	5			Zimbabwe	2	2	
				Totals	1613	139	899

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Related Articles

Sugar, beet sugar; Sugar, Cane Sugar; Sweeteners; Sugar Derivatives