Sugar

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No. 1

THE SUGAR INDUSTRY OF THE BRITISH WEST INDIES AND BRITISH GUIANA WITH SPECIAL REFERENCE TO TRINIDAD.

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THE sugar industry has ever been the shuttlecock of politics and its extent and localisation have been determined more by this factor than by economic considerations. The sugar industry of the British West Indies and British Guiana has by no means been immune from these political influences.

Historical Introduction.

Sugar production in these Colonies soon succeeded an original diversity of crops and, with its laborious processes, involved a rapid extension of the lucrative slave trade. With a monopoly of the English market, this industry proved extremely profitable and made the fortunes of many distinguished English families. The wealth of the planters was reflected in their extravagant modes of living, their "Great Houses," luxurious furniture, and costly plate. Absentee proprietors acquired an influence in the deliberations of Parliament which ensured the favourable consideration of their interests; indeed, it may be claimed that their activities were more profitable at Westminster than they could have been in the West Indies. In spite of minor setbacks the period was one of exceptional prosperity.

But this did not continue, and the nineteenth century records a dreary succession of political blows, the cumulative effect of which threatened the existence of the industry. The prohibition of the slave trade by the British in 1807, followed by the abolition of slavery in 1834, left the estates with a disorganised labour force which resulted in diminished production. (1) Even compensation amounting to £16,000,000 proved insufficient to readjust the industry to new conditions. (2) Finally the plantation owners' waning political power was shattered by the English Reform Bill of 1832.

(1) Sugar exports from Jamaica fell from 150,000 hogsheads in 1805 to 89,000 hogsheads in 1834 and to 30,000 hogsheads in 1865.

Pitman: *The Development of the British West Indies* p. 63. *Yale University Press.*

(2) The Commissioners estimated the value of the slaves at £34 million, and the capital valuation of the industry at £219 million.

Slavery was continued in the foreign West Indian Islands and Brazil, but British producers were assisted by a discriminating tariff levied against slave-grown sugar. In 1846 this differential duty was lowered and then abolished. Costs of production in the British Colonies had doubled after the abolition of slavery and, in the absence of a protective tariff, the position became precarious. (3)

The "plantocracies" in the islands and British Guiana endeavoured, with little success, to remedy the labour shortage by sporadic recruitments from Madeira, St. Helena, Sierra Leone, Malta, Germany and other places. In 1845, following the example of Mauritius, began that steady flow of indentured immigrants from India, which continued, almost without intermission, until 1917 when the Government of India terminated the system in response to national feeling. While the earlier methods of recruitment left much to be desired progressive amendments removed the worst abuses and subsequent enquiries revealed the system in a favourable light. Chinese labourers, who made excellent agriculturists were also recruited, but on the score of expense, and in view of the fact that they found more profitable scope for their aptitude in other spheres, the process was discontinued. (4) With indentured labour and other assistance, a moderate degree of prosperity was restored.

(3) In evidence before the Committee of Sugar and Coffee Plantations in 1848 it was stated that the cost of producing muscovado sugar in Antigua rose from 7*s.* 6*d.* per cwt. under slavery, to 16*s.* 6*d.* with free labour; in Barbados from 6*s.* to 15*s.* 6*d.* per cwt.; and in British Guiana to 25*s.* Costs of production in Cuba and Porto Rico during the latter period were estimated at 8*s.* and 8*s.* 6*d.* per cwt., respectively. Beet sugar was not at this time a serious competitor and is said to have cost 24*s.* 4*d.* per cwt. to produce.

(4) Chinese emigration was almost entirely male, tradition binding the women to the ancestral village. Between 1853 and 1913, 15,720 Chinese immigrants were introduced into British Guiana, of whom 13,485 were males and 2,235 females. In 1911 there remained 1,481 males and 1,141 females, the rapid decrease

Another factor was introduced when the rapid expansion of the beet sugar industry brought a threatening and formidable competitor into the field. Aided by protective tariffs and organised in cartels or trusts, the industry secured sufficiently high prices in the home markets to enable it, with the assistance of export bounties, to undersell cane sugar. Germany alone paid

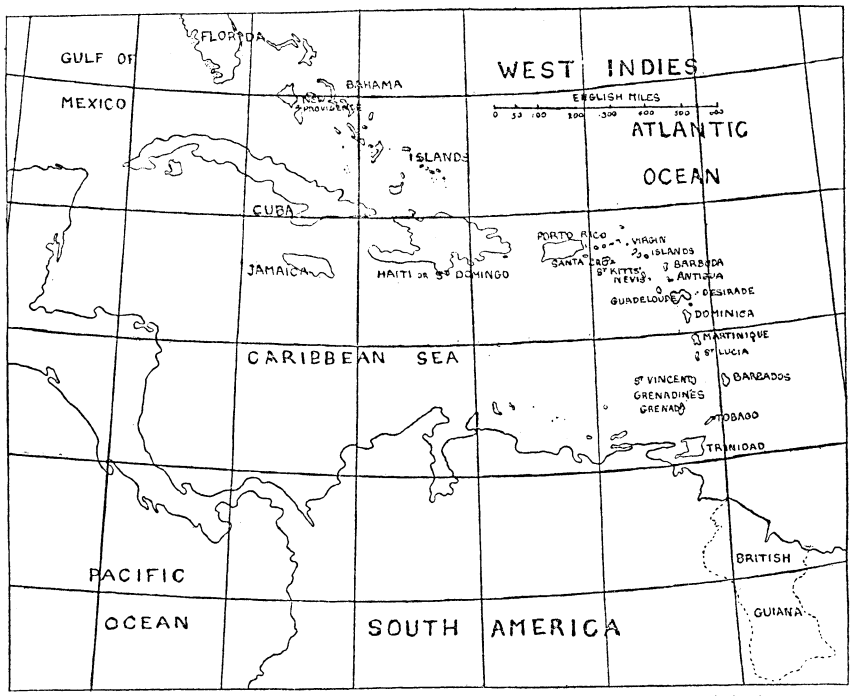


Figure 1.—*The Caribbean region, showing the principal British islands and British Guiana.*

$351,000,000 in sugar export bounties between 1840 and 1903. (5) The unprotected cane sugar industry of the British West Indies and British Guiana felt this competition severely during the seventies, and the position became acute during the eighties when many estates changed hands at greatly reduced valuations. Table I indicates the rapid relative rise of beet sugar production.

TABLE I.

WORLD PRODUCTION OF SUGAR. (6)

Period.	Average annual production in 1000's metric tons.	Percentage of Total.	
		Cane.	Beet.
1850-1851	1,507	90·6	9·4
1859-1860	2,127	79·5	20·5
1860-1870	2,323	71·4	28·6
1870-1880	3,357	58·6	41·4
1880-1890	5,242	47·8	52·2
1890-1900	8,296	41·2	58·8
1900-1910	12,578	42·4	57·6

being due to a readjustment of the sex ratio by male emigration. *See* Campbell, *Chinese Coolie Emigration*, King; and Clementi, *The Chinese in British Guiana*.

(5) It is claimed that the indirect benefits to agriculture more than compensated for this expenditure and for the higher price of sugar paid by the German consumers. $1 equal 4*s*. 2*d*. sterling; 1 cent equal ½*d*.

The situation was aggravated by the declining value of the sugar by-products, molasses and rum, caused by modifications in taste, the cheap price of sugar, and fiscal changes in Martinique and the United Kingdom. (7) Some relief was afforded by the abolition of slavery in Cuba in 1886, and the McKinley Tariff of 1890 by which the United States of America imposed a small discriminating duty against European subsidized beet sugar. Prices, however, continued to decline and British cane sugar was rapidly being ousted from the United Kingdom market by Continental beet sugar.

Table II shows that the price in 1896 was only half that of 1881.

TABLE II.

CANE SUGAR PRICES. (8)

YEAR.	PRICE IN SHILLINGS PER CWT.
1881	21·72
1884	16·41
1887	12·53
1890	13·33
1893	14·20
1896	10·85

(6) Excluding India throughout since estimates for this country are not available prior to 1898-99. Unless otherwise stated one ton equals 2,240lb.

(7) *E.g.*: the value of molasses and rum exported from St. Kitts-Nevis declined from £42,353 in 1882 to £8,903 in 1896. *W.I.R.C.* Report, p. 57.

(8) Unrefined sugar. Figures extracted from *W.I.R.C.* Report, App. C. Pt. 1, p. 196.

Table III indicates the decline in the United Kingdom's import of sugar from the British West Indies and British Guiana, and the rapid increase in the import of beet (chiefly refined) sugar.

TABLE III.

IMPORTS OF SUGAR INTO THE UNITED KINGDOM. (9)
(Quantities in 1,000's tons).

Year.	Cane Sugar.		Beet.		Total Beet and Cane.
	B.W.I. and B.G.	Total.	Refined.	Total.	
1882	198	732	133	398	1,130
1886	99	539	247	586	1,125
1891	54	376	540	1,001	1,377
1896	72	382	738	1,144	1,526

By the Dingley Tariff Bill of 1897 a duty, equal to the amount of the bounty, was imposed upon beet sugar with the result that the U.S.A. replaced the United Kingdom as the principal market for sugar from the British West Indies and British Guiana.

A serious outbreak of sugar-cane disease about 1890, which spread with amazing rapidity and intensity throughout the islands, threatened the very existence of the industry. Losses of cane, estimated at between 25 and 50 per cent. were reported from most of the islands during 1892-94, and later from British Guiana. It is believed that with the active interchange of cane varieties then taking place this disease, caused by *Colletotrichum falcatum*, was introduced from the East by a resistant variety. The Bourbon cane, then in general cultivation proved highly susceptible. (10) Immediate measures were taken to replace the Bourbon cane by White Transparent (or Caledonian Queen) and other more resistant varieties.

In the meantime a development of the greatest importance to the cane sugar industry was taking place in Barbados. In January, 1888, an overseer, Mr. I. B. Pilgrim, noticed some young seedling canes growing in a field adjacent to some experimental cane plots. (11) It had been thought that by long vegetative propagation the sugar-cane had lost the power of producing viable seed. Harrison (the late Sir John) and Bovell, immediately appreciating the commercial

(9) Figures extracted from *W. I. R. C.* App. C. Pt. 1, p. 195.

(10) *See* Nowell, *Diseases of Crop Plants in the Lesser Antilles*, pp. 297-301.

(11) The same re-discovery was made independently and almost simultaneously in Java where the matter was regarded as merely of academic interest until a serious outbreak of Sereh disease attacked the black Cheribon variety.

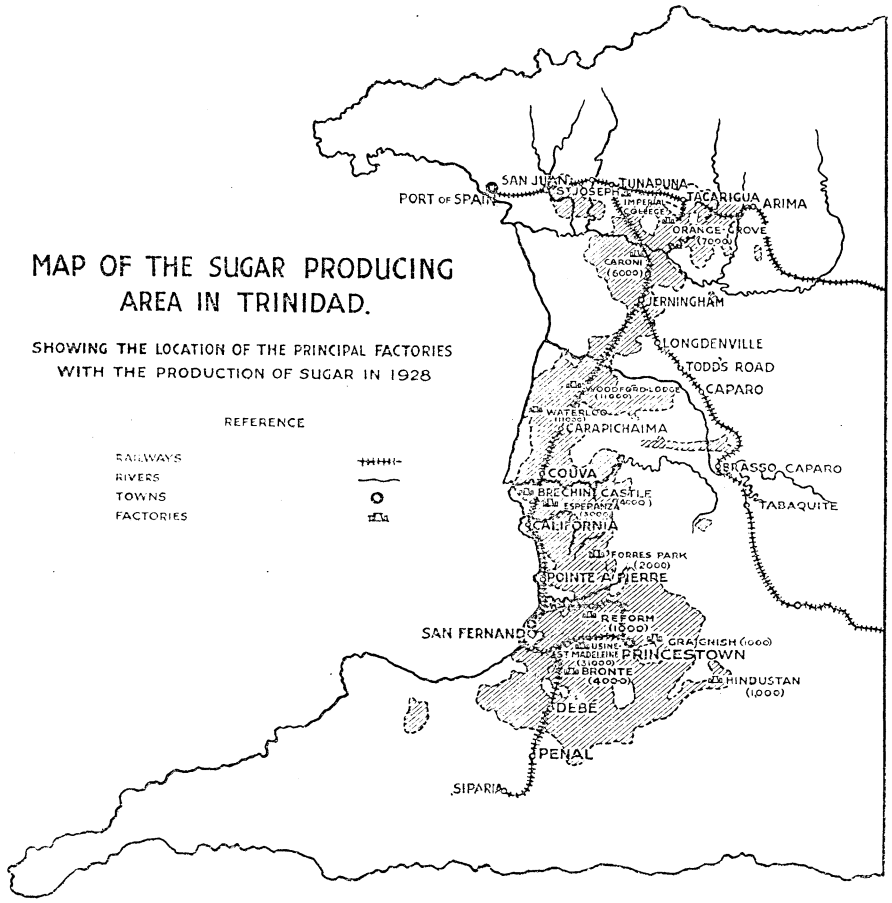


Figure 2.—The sugar production of Trinidad is localised along the western edge of the island, where climate and soil are most favourable.

importance of this discovery, vigorously prosecuted the production of seedling canes which were substituted for existing varieties immediately they gave sufficient agricultural promise. (12)

Planters reduced their costs by operating on a larger scale and introducing manufacturing refinements. A few scattered examples will indicate the widespread nature of this movement. In Trinidad, between 1889 and 1896, 88 factories were reduced to 39; (13) in British Guiana 230 in 1829 to 180 in 1849, and 64 in 1896; (14) and in Tobago 65 in 1862 to 38 in 1896. (15) Considerable sums were expended in modernising these factories and as many proprietors succumbed in the process their places were taken, in some cases, by Companies with wider financial resources.

For example the Colonial Company, between 1870 and 1895 spent £339,000 in improving its machinery and transport facilities in British Guiana and Trinidad, excluding the original cost of its Trinidad factory (£213,000). (16) British Guiana during 1880-1895 imported sugar machinery to the value of £1,307,500 (17) while the Government of St. Lucia loaned £40,000 between 1874 and 1877 for the modernisation of the Cul-de-Sac factories. One small Trinidad estate, Palmiste, between 1883 and 1894 spent £52,600 in reconstructing and modernising its factory and transport facilities. (18)

These improvements considerably lowered the cost of manufacture; for instance, those of the Colonial Company, Ltd., in British Guiana were reduced from £9 15*s*. per ton in 1883-4 to £4 15*s*. in 1895-96, and in Trinidad from £8 9*s*. 5*d*. in 1883, to £3 11*s*. 5*d*. in 1896. (19) Further economies resulted from these improved factories since they not only took a smaller quantity of cane to produce a ton of sugar, but also produced a grade of sugar realising £3 per ton more than Muscovado. (20)

However, in the cultivation of cane lack of scientific knowledge, and the absence of suitable mechanical power, precluded any similar economy. Wages, the principal item, were reduced by amounts varying from 10 to 25 per cent., and further temporary reductions were effected by allowing houses and other buildings to fall into serious disrepair (21) and by neglecting all save imperative operations. Despite these efforts many proprietors were forced to sell their estates at rapidly declining values, while in some islands estates were completely abandoned and allowed to revert to bush. (22)

In 1882 the exports of the British West Indies and British Guiana totalled £8,224,000, to which sugar contributed £6,884,000, or 84 per cent. By 1896, with the fall in the value of sugar, and notwithstanding the introduction of other crops and industries, the total exports had declined to £6,106,000 of which £3,251,000 or 53 per cent. was represented by sugar. (23)

By 1896 the industry was on the verge of collapse, and the situation became so critical that the Imperial Government appointed a Royal Commission of enquiry. The Commission, emphasising the vital importance of the sugar industry, recognised that the abolition of the bounty system would afford the greatest measure of relief. Perhaps the most important result of the Commission was the formation, at Imperial expense, of the Imperial Department of Agriculture, which so stimulated and coordinated scientific agricultural activity in the British West Indies, that it established a previously unknown feeling of confidence. The Department introduced more profitable alternative crops, and stimulated the reorganisation of the diminished sugar industry. (24) The Imperial Government subsidised the Colonial Governments when necessary by meeting the public deficits until 1912 when the improved economic condition removed such necessity.

The industry received a powerful impetus from the abolition of the Bounty System by the Brussels Convention in 1902. The Convention took effect as from 1st, September 1903 and the Imperial Government made a grant of £250,000 to assist these British Caribbean sugar producers during the interim. These indications of the revival of interest in the British West Indies and British Guiana by the Imperial Government

(12) Every known variety of cane is a highly complex hybrid the characters of which segregate and recombine in its seedling progeny in almost every conceivable variation. In rare cases these seedlings possess a better combination of characters than their parents *See Tropical Agriculture,* Sugar Supplement, Vol. IV, No. 9 p. 14, Trinidad.

(13) Lamont, Sir Norman, Bt. *Tropical Agriculture,* Vol. 5, No. 7, p. 167.

(14) *W. I. R. C.* Report, p. 83.

(15) *W. I. R. C.* Report, p. 107.

(16) *W. I. R. C* .App. C. Pt. 1, p. 178.

(17) *W. I. R. C.* Report, p. 28.

(18) Lamont, Sir Norman, Bt., *Tropical Agriculture,* Vol. V, No. 7, p. 167.

(19) *W. I. R. C.* Report, p. 84 and App. C., Pt. 1, p. 178 The term "cost of manufacture" is not defined so that comparison with present day figures is impossible, but these figures may be regarded as relatively correct.

(20) *W. I. R. C.* App. C., Pt. 1, p. 183. When vacuum pan sugar is made the molasses is inferior to that of the muscovado process

(21) *W. I. R. C.* Report, p. 54.

(22) In Barbados 547 sugar estates changed hands between 1851 and 1896. Between 1871-1880 and 1890-1896 the average price fell from £59 to £31 per acre (*W. I. R. C.* Report, p. 54). In St. Vincent a very large area of the best lands were in the hands of a few proprietors who had abandoned or were unable to cultivate a large proportion. The Government subsequently obtained possession of this land and divided it into small holdings. *W. I. R. C.* Report App. A, p. 121.

(23) *W. I. R. C.* Report, App. B, p. 157. Excluding Jamaica, whose sugar industry had already declined in importance, the figures for 1882 were, total exports £6,752,000; sugar £5,974,000 or 88 per cent. In 1896 again excluding Jamaica, and the gold industry of British Guiana, exports amounted to £3,945,000; sugar £2,951,000, or 75 per cent.

(24) In Tortola, Montserrat, Nevis, Dominica, Grenada and Tobago, sugar production, once the staple industry, is now negligible.

encouraged the sugar planters in Antigua, St. Kitts ([25]), and other Colonies to centralise their factories.

Unfortunately for British interests the Reciprocity Treaty of 1903 gave Cuba a monopoly of that portion of the U.S.A. market not catered for by her internal and insular production. This, coupled with the flow of American capital into the island resulted in such an amazing development (*see* Table IV) that the British producers in the Caribbean region were not only completely shut out of the U.S.A. market, but also had to face increasing competition in the unprotected market of the United Kingdom. ([26])

TABLE IV.

CUBAN SUGAR PRODUCTION.

Period.	*Amount in short tons.*
1899-1900	345,568
1902-1903	1,118,724
1912-1913	2,719,961
1922-1923	4,035,259
1924-1925	5,125,970

In 1898 Canada had voluntarily granted the British West Indies a preference of 25 per cent. of the raw sugar duty, increased to $33\frac{1}{3}$ per cent. from 1st July, 1900, and to $37\frac{1}{2}$ per cent. from 1st April, 1907. Before the abolition of the bounties and the granting of a preference to Cuba the British West Indies had found a more favourable market in the U.S.A. but from this period increasing supplies were diverted to Canada. A brief sketch will indicate subsequent relations with Canada. In 1912, by a ten years' reciprocal agreement, the British West Indies were granted an additional preference on raw sugar. ([27]) At the same time concessions granted to Canadian refiners in 1907 and 1909, which had diminished the preference, were repealed. By a second conference in 1920 the preference was increased to 84 cents per 100 lb. for sugar of 96°. ([28]) Again in 1925 the preference was increased to $1 for sugar of 96°. As a result the Canadian sugar market has been of increasing importance to the British West Indies and British Guiana.

When the Liberal Government came into power in 1906 it soon intimated that, while it did not desire to give bounties or to see their revival, it was contrary to its policy to impose countervailing duties or to prohibit the import of bounty sugars. Russia, the only important bounty-giving country outside the Convention, was conditionally persuaded to adhere to the Convention, while Great Britain was released from the Penal Clause, and in this way the danger to the Colonies of a revival of the bounty system was averted.

In 1912 the High Contracting Parties renewed the Convention until 1918, Great Britain withdrawing in 1913. In 1917 France notified withdrawal, and in 1918 Great Britain formally withdrew its pledge of 1902 not to give a tariff preference to Colonial sugar. By this action the Imperial Government was free to grant in 1919 a preference of one-sixth of the full duty to imported British sugar, increased in 1925 to one-third, and stabilised on the basis of £3 15*s*. per ton of sugar of 96° for a period of ten years. At the same time bounties, exceeding any ever given by Continental Governments, were conferred on home grown beet sugar. This small preference on British cane sugar has been the salvation of the sugar industry of the British West Indies and British Guiana, and its stabilisation for a period of ten years has provided a security which has encouraged improvements of a capital nature.

As Table V indicates, production diminished slowly but steadily until the outbreak of the war when the stimulus of high prices resulted in a rapid increase. Unfortunately the demands of the belligerents prevented the profits thus obtained from being utilised in improving the factory and other estate equipment, with the result that the properties depreciated, rather than appreciated, in real value. By the time normal supplies could be resumed the industry was involved in the slump of 1921. Increased scientific knowledge, aided by a stabilised preference, have encouraged the estates to begin a tedious and painful reorganisation with which they can face the future with a chastened and modest degree of hope.

TABLE V.

PRODUCTION OF SUGAR IN THE BRITISH WEST INDIES AND BRITISH GUIANA.

Period.	*Annual Average in tons.*
1902-05	249,000
1906-09	229,000
1910-13	198,000
1914-17	262,000
1918-21	227,000
1922-25	241,000

The Principal Characteristics of the B.W.I. sugar-producing islands and British Guiana.

The following brief accounts indicate the principal local characteristics of the more important sugar-producing islands and British Guiana, and illustrate the wide range of conditions under which cane can successfully be cultivated. At one time sugar formed the staple crop of all the islands but the depression during the nineteenth century compelled those which were unable to centralise their sugar production to a

(25) Gunthorpe's Central Factory, Antigua, planned in 1903, reaped its first crop in 1905. The St. Kitts (Basseterre) Factory was opened in 1912.

(26) Cuba now has to dispose of 1,500,000 to 2,000,000 tons of sugar outside the United States of America, the United Kingdom being her next best customer.

(27) *Cmd.* 6092.

(28) *Cmd.* 864. To protect the interest of Canadian refiners, the full duty, and the preference to a smaller extent, increases rapidly with higher degrees of polarisation. The polariscope scientifically determines the sucrose content of sugar. The "Dutch Standard" hitherto maintained by Canada, but regarded as an anachronism in sugar circles, consisted of a series of sugars ranging in colour from white to almost black, and numbered from 1 to 32.

sufficient degree, to resort to other crops. The diversification of crops now cultivated has thrown into relief those natural differences which were cloaked by the universal cultivation of sugar-cane.

JAMAICA :—Jamaica, the largest of the British West Indian Islands, with a population of 858,000, has an area of 4,450 square miles, the extreme length being 144 miles, and the greatest width 49 miles. The main divide trends from East to West with spurs running North-West and South-East, the latter culminating in the Blue Mountains with a maximun height of 7,388 feet. The surface is cut up into a complex series of ridges, with intervening gullies, liberally supplied with rivers, streams, and springs. Geologically the island exhibits considerable diversity, consisting of an igneous rock foundation overlaid with several distinct formations. The sugar industry is located mainly in the extensive alluvial flats of the parishes of Clarendon and St. Catherine, in the County of Middlesex ; in the alluvial deposits and marl beds of the parish of Westmoreland, and in the alluvial valleys of the Trelawney and Hanover in the County of Cornwall ; and, more recently, in St. Thomas in the East, in the County of Surrey. The average annual rainfall is 76 inches, varying from 105 inches in the North-East to 54 inches in the South. Production has risen rapidly from 14,000 tons pre-war, to 36,000 tons during 1920-24, with an estimate of 64,000 tons in 1926. Of 42 factories only one produces 8,000 tons and 26 less than 1,000 tons. The production of rum is a dominant characteristic of the industry. There is a tendency towards centralised sugar manufacture from canes grown by independent estates, though the configuration of the country is a handicap. Other and more profitable industries, particularly banana growing, have diverted capital and labour from sugar production.

ST. KITTS :—St. Kitts (or St. Christopher) has a population of 22,000 (1921 census), an area of 68 square miles, and is about 19 miles in length, with an average width of five miles except in the narrow South-East peninsular plain where the capital, Basseterre, with a population of 9,000, is located. The main range of rugged mountains, clothed in forest and tree ferns, runs North-West to South-East, culminating in the volcanic cone of Mt. Misery (3,711 feet), and conserves the rather deficient annual rainfall of 45 inches to 50 inches. From the low sea cliffs gentle slopes of detrital volcanic material rise to about 1,200 feet planted to a maximum height of 800 feet to 1,200 feet mainly in sugar-cane. The soil is light and deep, being particularly easy to work, but is susceptible to water shortage and rapidly loses fertility unless manured. The lower slopes are traversed by deep ravines, while most of the mountain water finds its way underground. Sugar remains the principal crop, the whole of the increasing output of nearly 20,000 tons being manufactured by the St. Kitts (Basseterre) Sugar Factory, Ltd., opened in 1912. Cane transport around the island has been rendered easy by road and estate railway. Yields average a little over 20 tons of cane per acre, while the sucrose content is high, and extraction efficient, an average of 8.58 tons of cane being required to produce one ton of sugar during 1925 and 1926. There is no extensive class of peasant cultivators.

Some seasonal labourers are recruited in the neighbouring island of Nevis where the coarse boulder formation of the lower slopes necessitates costly hand labour and results in low yields of cane, small quantities of which are shipped to St. Kitts.

ANTIGUA :—Antigua is irregularly oval in shape having an area of 108 square miles, and a population of 29,000. The steepness of the South-Western volcanic hills renders them unsuitable for cane cultivation. The highly calcareous soil of the North-East hills is usually sufficiently heavy to be fertile when well tilled and drained. The heavy clay soils of the Central Plain in some districts form excellent cane land when liberally manured and well drained, but the occurrence of salt patches renders some of the lands unsuitable for cane cultivation. The low annual rainfall of 45 inches is a serious factor but is partly offset by the retentiveness of the soil. The bulk of the island crop, which recently increased rapidly, is manufactured by the Gunthorpe's factory which in 1927 turned out a record of 19,000 tons of sugar. The estates contributing cane possess some financial interest in the factory. Yields of cane per acre are not high but both sucrose content and extraction are good, an average of 8.76 tons of cane producing one ton of sugar during 1926 and 1927. ([29])

ST. LUCIA :—St. Lucia has an area of 233 square miles, with a maximum length of 24 miles, a maximum breadth of 12 miles, and a population of 56,700. The island is volcanic, the main ridge of mountains traversing the island from North to South at a height of 1,500 feet, with peaks exceeding 3,000 feet in the South-West part. Ridges from the central range provide narrow well sheltered valleys in which discontinuous areas, totalling 4,750 acres, are under sugar-cane. Four factories, each situated in a well-watered valley, produce a total of about 5,000 tons of sugar and a varying quantity of syrup or fancy molasses. There is at present a tendency to extend cane cultivation, by irrigation and by breaking up new lands. The introduction of new varieties of cane, and co-operation between the factories is likely to increase production and efficiency, but transport difficulties hinder expansion or further centralisation.

BARBADOS :—Barbados is a sugar-producing island of exceptional interest. With an area of only 166 square miles it supports a population of 156,000 or 940 to the square mile. The island is flat but rises by wide terraces to a maximum height of 1,100 feet. The surface rock consists

(29) This is nearly twice the yield of the old muscovado process.

of coral limestone except in the North-Eastern, or Scotland, district, where the underlying estuarine and oceanic beds of sandstone, clay and chert are exposed. In the porous limestone areas streams are absent or subterranean. The rainfall varies between 50 inches and 70 inches and the heavy retentive red and black clay loam soils require and receive frequent thorough cultivation and heavy applications of pen, imported sheep, and artificial, manures. Sugar remains the predominant product, the equivalent of about 70,000 tons being annually produced, of which a large, but variable, proportion is exported as syrup or fancy molasses to the North American market. Favoured by a healthy climate, fertile soil with good natural drainage, a large and comparatively energetic labouring population, and locally raised seedling canes of high sucrose content, the estate proprietors have maintained an intensive cultivation of the soil. Ratoons are the exception, cane being frequently rotated with food crops, such as yams, sweet potatoes, eddoes and maize, or fodder crops such as guinea corn and Imphee, or 'cash' crops such as cotton. Although favourable agricultural factors enabled planters to resist the trend towards centralisation of manufacture, the 440 factories of pre-war days have now been consolidated into about 250. There is a tendency for planters to maintain their agricultural independence and sell their canes to a convenient large factory except when a high price for syrup renders the operation of their own antiquated mills profitable. Further centralisation with greater security of supply to the factory appears inevitable. Cane yields are relatively high, sucrose content exceptionally good, but in some of the smaller factories extraction is low. The planters are partly financed by the Sugar Industry Bank. The Imperial Government granted £80,000 to enable the industry to tide over the depression, pending the abolition of the bounty system by the Brussels Convention. This sum was not distributed among the individual plantation owners, as intended, but was kept intact and used as the nucleus of a Sugar Industry Bank. The original sum now amounts to £180,000.

British Guiana:—British Guiana, on the mainland of South America, contrasts in many ways with the varied conditions of the islands. With a coast line of 250 miles, a maximum depth of 600 miles, and an area exceeding 90,000 square miles, she supports a population of only 298,000, of which nearly 40 per cent. are East Indians. The cultivated area of about 200 square miles is confined to the coastal alluvial flat, some ten miles in depth, and the banks of certain rivers for some distance inland. A considerable area of this coastal sugar belt is below spring tide level and has to be protected by elaborate and costly sea defences which, with canals and sluices, keep out salt water and drain, sometimes by pumping, accumulated fresh water during the wet season. The soils are stiff or plastic impermeable clays with varying percentages of silt underlaid by silt or sand. Locally termed 'pegasse' soils possess a distinct black surface layer up to 5 feet in depth formed by decomposed forest material or reeds and rushes. The soils are strongly acid in reaction. Drainage presents the most difficult problem, the land being divided by the main navigation canals some 20 feet wide, the main drains, and the elaborate system of subsidiary drains, which hamper mechanical tillage. The cane is drawn by animals or tractors along the navigation canals in scows or punts, each 50 feet long and 4 feet deep, holding 12 to 15 tons of cane. Cable drawn implements are operated from punts. Humus is deficient except in the best pegasse soils and among other remedies recourse is had to flooding temporarily abandoned fields. Plant canes give high yields and 3 to 5 ratoons are reaped. Exports of sugar during 1920-24 averaged 90,000 tons per annum, there being 39 factories in 1922 with a cultivated area of 61,000 acres. The crop is spread over two periods: February to June, and September to January. Shortage of labour hinders existing plantations and prevents rapid expansion. The Colony is famous for its "Demerara Crystals," which, originally a product of the Bourbon cane, are now produced to some extent in the islands, and, it is to be regretted, improperly imitated outside the West Indies by dyeing sugar produced by different processes.

Trinidad:—The main features of Trinidad have already been described in "Economic Geography." The cane belt lies along the western coast, the northern section the Caroni Plain, the central focussed around the town of Couva, and the southern in the undulating Naparima District (Figure 5). The rainfall averages about 65 inches per annum. For many years the canes have suffered severely from 'froghopper blight.' This damage has become so dominating a factor that it has necessitated and accelerated agricultural improvements. Yields are low, averaging 18 to 20 tons per acre on estates, but special stress is now being laid upon pen and artificial manuring, thorough cultivation, good drainage, and the use of leguminous plants to restore and maintain soil fertility. On the plains, animal and steam cable implements have long been utilised but in the Naparima District cultivation had to be performed almost entirely by hand labour until the recent introduction of powerful caterpillar tractors. The record 1928 crop of 80,000 tons was manufactured by 13 factories, to which one contributed nearly 31,000 tons, and four of the remaining factories over 35,000 tons, or, together more than 81 per cent. It is possible that within the next generation nearly the whole of the island crop will be produced by two factories. Two-fifths of the cane supply is grown by cane farmers who possess no financial stake in the factories but sell their cane on the basis of a sliding scale which varies with the price of sugar. East Indians, formerly introduced under a system of indentured Immigration, now constitute one-third of the total population. The wide diversity of

agricultural wealth, the flourishing oil and asphalt industries, and the need for more intensive cultivation is rendering the labour situation difficult and places a premium upon labour-saving devices.

Pests and Diseases. ([30])

In addition to the local factors described mention should be made of the more important pests and diseases which cause damage varying in incidence with geographical position, seasonal and cultural conditions.

Pests.

The moth borer (*Diatraea saccharalis*, Fabr.) is a serious pest, severe injury resulting from the tunnelling of the larvae in the cane stem. Infestation is diminished by treating planting material with Bordeaux mixture, and destroying attacked shoots, caterpillars, and eggs. It is attacked by parasitic insects of which the most important is *Trichogramma minutum*.

The larger moth borer (*Castnia licus*, Drury) occurs only in British Guiana and Trinidad, where it is responsible for extensive losses of cane. No satisfactory method of control has been evolved but the intensity of attack is diminished by catching the moths, flooding the land, collecting the larvae from the cane, and encouraging insectivorous birds.

Froghoppers occur in British Guiana but cause little damage. In Trinidad *Tomaspis saccharina*, Dist., has become so important that a special Committee of investigation has been appointed. The damage is caused by the sucking action of the adult insect on the cane leaves and may vary between a slight check in growth and complete destruction of the cane. Hardy and Turner ([31]) have shown that the intensity of the damage is closely associated with soil conditions and that those soils bearing 'blighted' cane are so markedly acidic and so deficient in exchangeable calcium that a material improvement in their lime status appears to be a necessary preliminary to their amelioration.

Other insects have attracted attention but are not of great economic significance; some are merely scavengers and attack only already injured or diseased cane.

Diseases.

The most important fungal disease—known as root disease—results in a stunted condition of the stool, and research has indicated that wet weather, poor soil, defective aeration, and insect injuries, are predisposing factors. Thorough cultivation and rotation of crops form the greatest safeguards.

Mosaic, a virus disease, causes losses under a wide variety of conditions, which may extend to the complete destruction of the crop. Clearing the land of infected material, planting resistant varieties such as Uba, and crop rotation, form effective measures of control. Gumming disease, caused by *Bacterium vascularum* (Cobb) E.F.S. occurs in St. Lucia and St. Kitts but can be controlled, particularly by efficient drainage.

Other diseases exist but, since they are subject to effective control, or only affect canes already damaged, are not sufficiently important to warrant consideration.

The Ste. Madeleine Sugar Co., Ltd., Trinidad.

Conditions vary so much from country to country, and even within a country, that the following description of the Ste. Madeleine Sugar Co., situated in the Naparima District, (Figure 10) should indicate better the strenuous efforts that are being made to overcome the present depression than a more generalised account.

Much of the area owned by the present company has been under cane cultivation for over a century without rotation of crops, there being at one time about 100 separate factories. With increasing financial distress the private estates were gradually amalgamated by companies into the existing organisation. Of the 24,500 acres owned by the Company, 11,500 are under estate cultivation, 6,000 are rented to cane farmers, 5,700 are uncultivated, and the remainder consists of pastures and traces. Cane is also received from a considerable area not owned by the Company. The Company maintains 80 miles of standard gauge (4 feet 8½ inches) and 10 miles of 2 feet 6 inches gauge railway, and a network of roads and traces which are supplemented by the Trinidad Government Railway and the public roads and traces.

The Company is endeavouring to reduce its costs of production (Figure 11) by increasing its sugar production, introducing labour-saving devices, and ameliorating soil conditions.

The increased production of sugar (*see* Table VI) and increased efficiency in machinery have resulted in a considerable reduction in manufacturing costs. While most of this increase in crop is due to the acquisition of additional estates, part is the result of a more intensive use of the land. The estate plants 2,000 to 3,000 acres annually, principally between August and November, during the wet season. The canes are reaped some 15 to 18 months later, and then cut annually as ratoons for a variable period. On account of the laborious process of planting,

(30) *See* Ballou: *Insect Pests of the Lesser Antilles* and *Insect Pests of Sugar-Cane in Antigua and St. Kitts*; and Nowell: *Diseases of Crop Plants in the Lesser Antilles.*

(31) See *Minutes and Proceedings of the Froghopper Committee* and the *Journal of Agricultural Science*, Vol. I, 1929 (Turner).

THE SUGAR INDUSTRY OF THE BRITISH WEST INDIES AND BRITISH GUIANA WITH SPECIAL REFERENCE TO TRINIDAD.

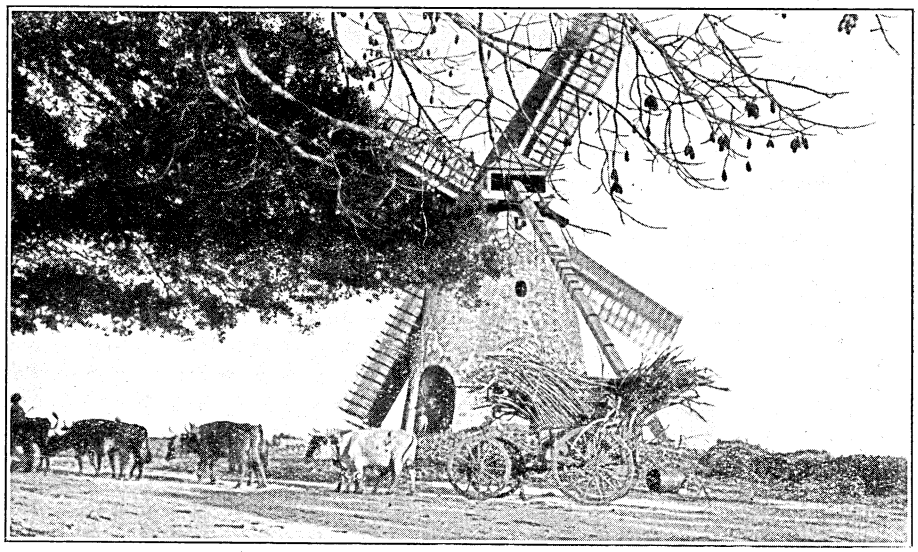


Figure 3.— *A windmill sugar factory, Barbados, now abandoned. Each small estate formerly had its own factory. Note the method of transporting cane to the factory.*

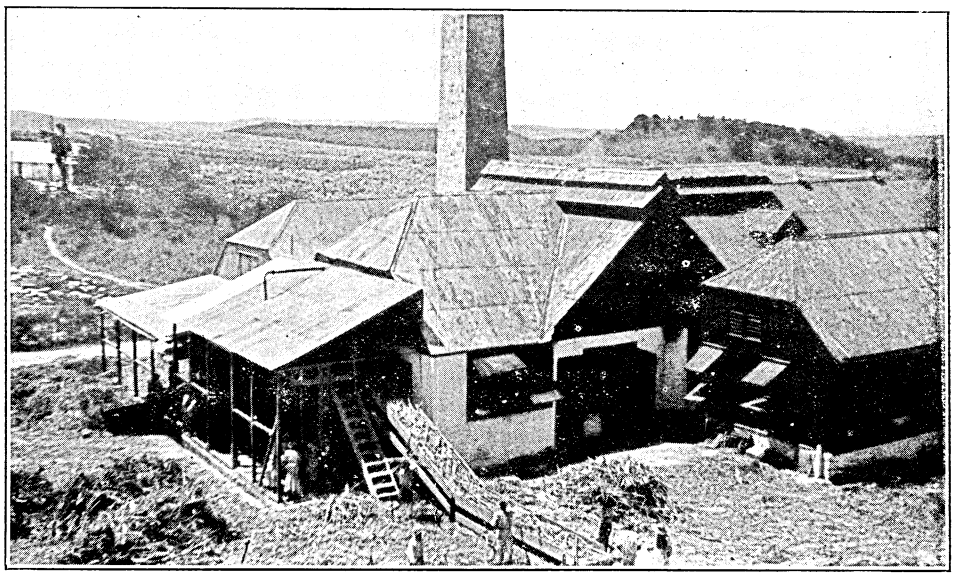


Figure 4.— *A muscovado factory, Antigua, illustrating another stage in the evolution of modern sugar manufacture. Note the hand fed carrier which conveys canes to the mill.*

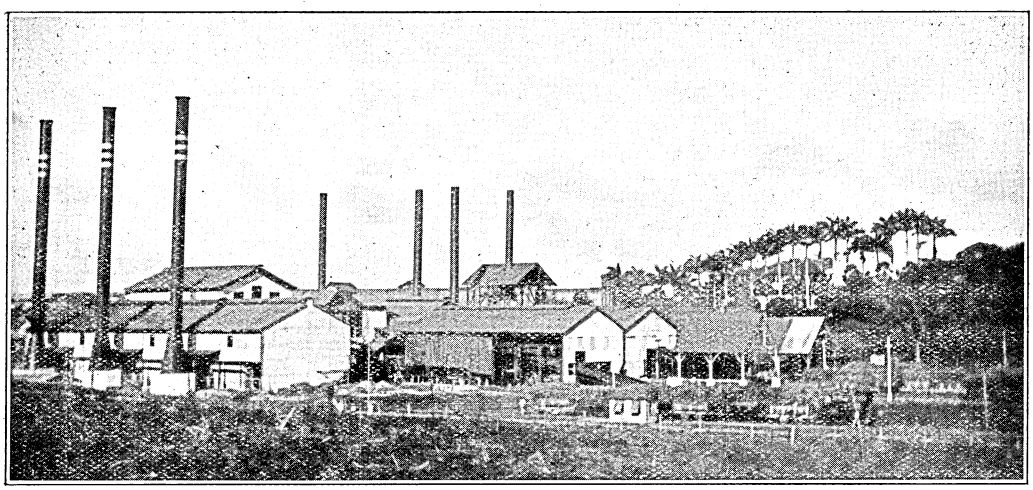


Figure 5.— A portion of a modern sugar factory, Trinidad, capable of manufacturing over 30,000 tons of sugar in a season of about 100 crushing days. Central factories represent a heavy capital investment.

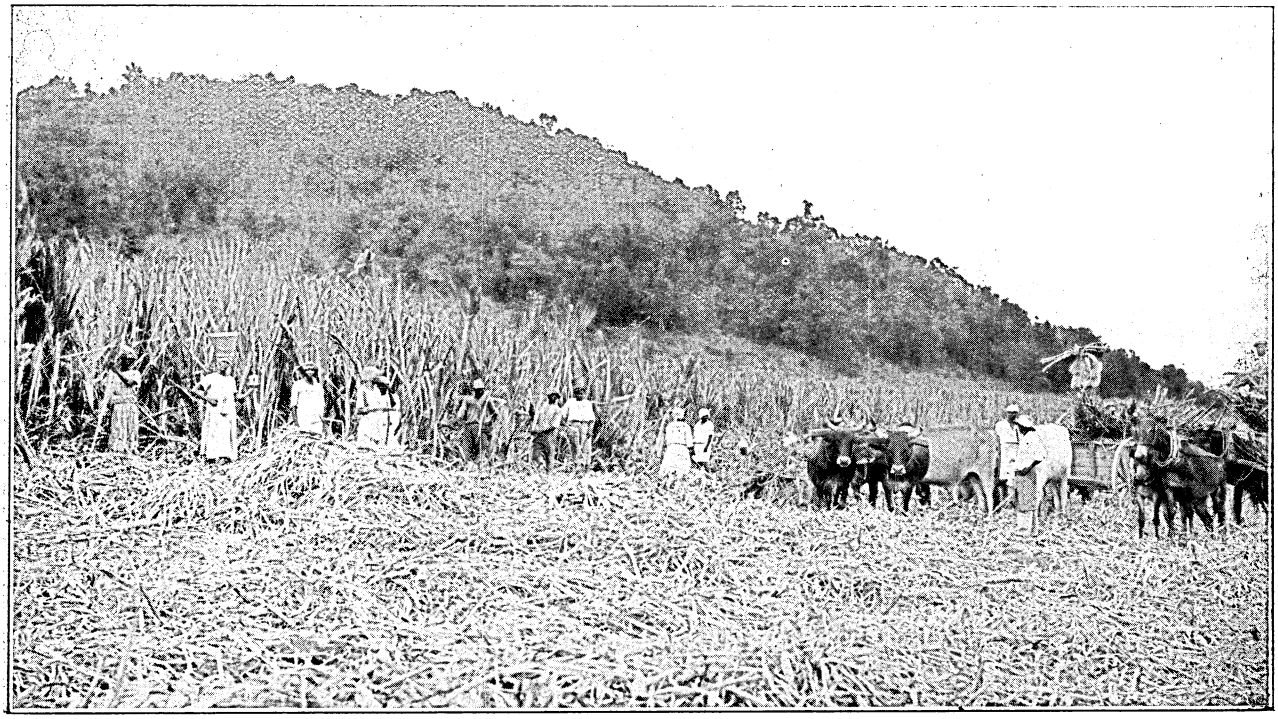


Figure 6.—Cane cutters and loaders, Antigua. The cane carts are drawn by mules or oxen. (Courtesy of Imperial Institute.)

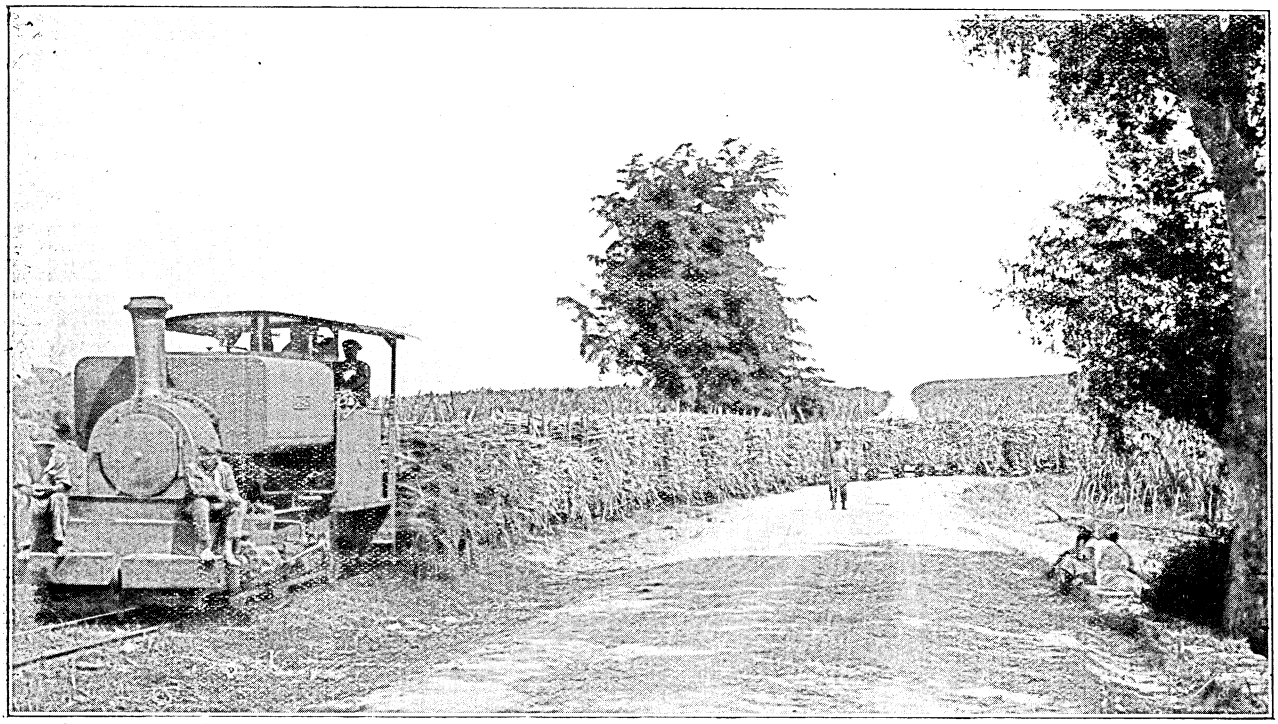


Figure 7.— A train load of canes proceeding to the factory, Antigua. (Courtesy of Imperial Institute.)

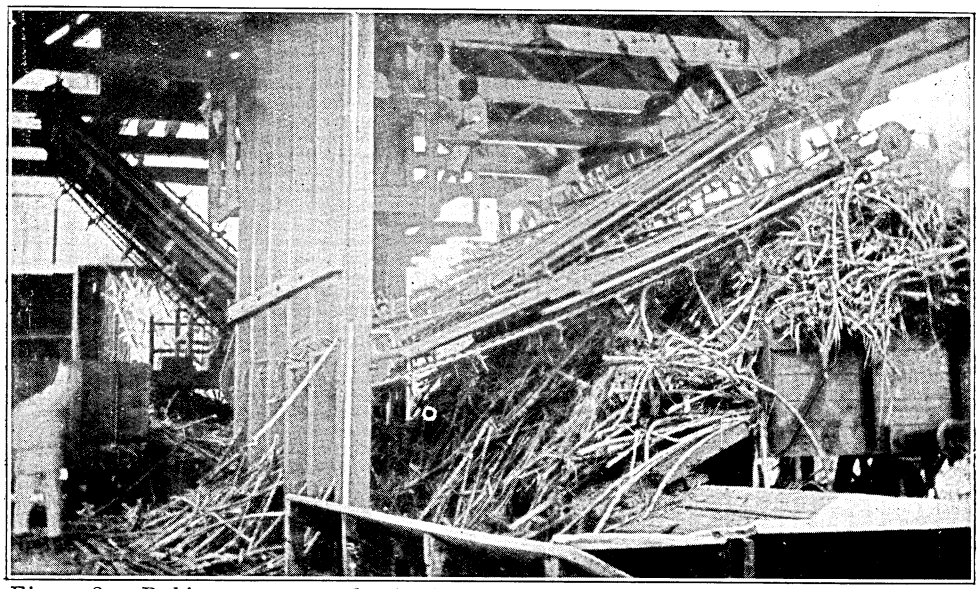


Figure 8.—Raking canes mechanically from the railway truck to the cane carrier. A continuous and even flow of cane must be maintained.

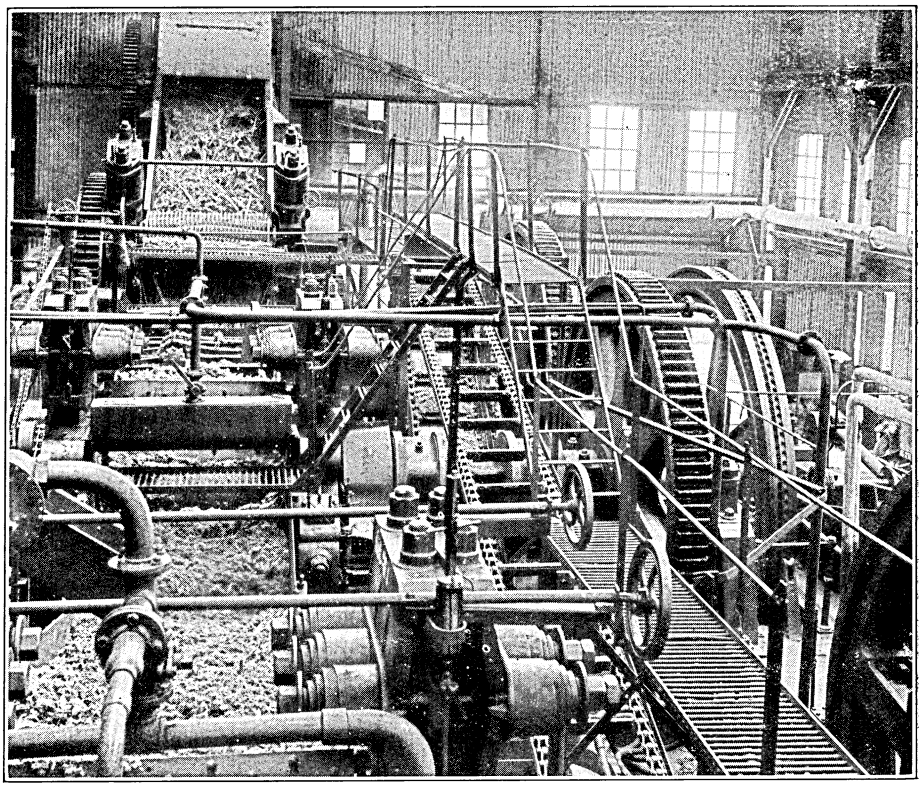


Figure 9.—Portion of Gunthorpe's Factory, Antigua, showing cane passing through the mill. (Courtesy of Imperial Institute.)

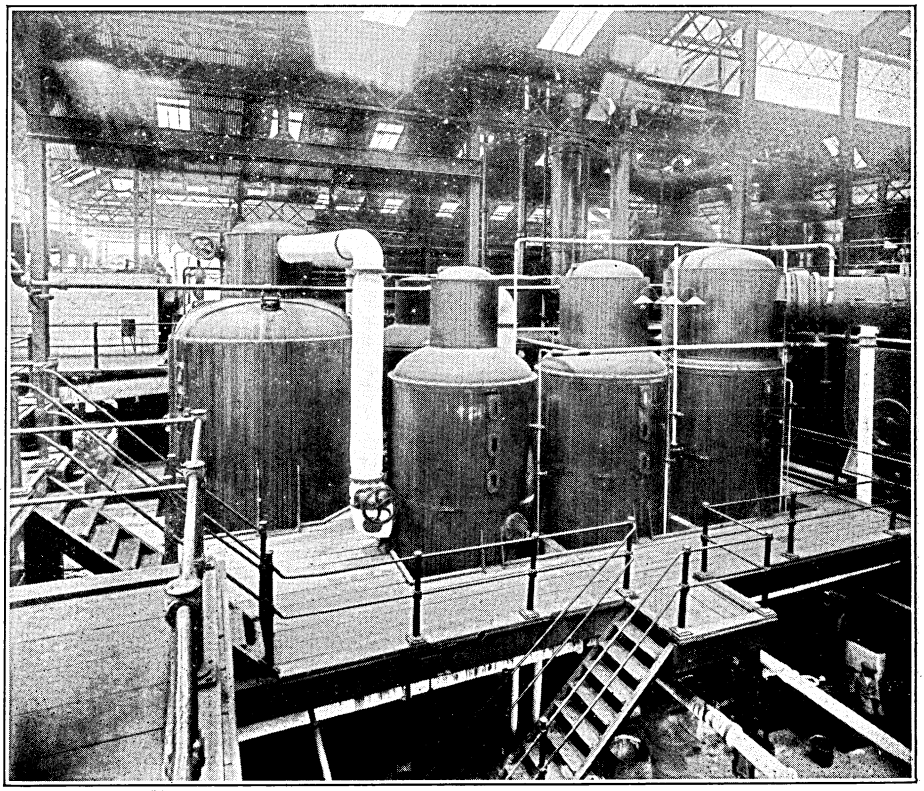


Figure 13.—Multiple effect evaporating plant. (Courtesy of Imperial Institute).

plant canes, in spite of heavier yields, (*see* Table VII), cost more per ton to produce than ratoons.

TABLE VI.

STE. MADELEINE SUGAR COMPANY'S PRODUCTION.

Year.	Crop.	Year.	Crop.
	In tons of sugar.		In tons of sugar.
1875	2,658	1915	17,067
1885	4,876	1925	23,520
1895	9,346	1928	30,939
1905 (32)	8,711		

TABLE VII.

YIELD OF PLANT AND RATOON CANES.

In tons per acre.

Year.	Plants.	1st Ratoons	2nd Ratoons	3rd Ratoons	4th Ratoons
1925	24·19	18·58	13·94	13·33	12·05
1926	28·32	19·60	15·11	13·89	13·75

In selecting varieties special attention is given to their ratooning powers. (33) Many new varieties are constantly being tested and, as they demonstrate their superiority, are used to replace the standard canes which, for reasons requiring further investigation, tend, after a time, to deteriorate. D. 625 and B. 156 have given way to B.H. 10(12) and Uba, the latter possessing exceptional ratooning powers. As excessively ratooned canes are particularly susceptible to froghopper blight and other damage, and tend to increase in cost (Table VIII) it has become the policy to replant after the second ratoon (Table IX) except in the case of Uba.

TABLE VIII.

LABOUR COSTS ONLY OF PLANTING, CULTIVATING, REAPING, CARTING AND LOADING INTO RAILWAY TRUCKS, OF PLANT AND RATOON CANES IN DOLLARS PER TON.

Plant.	Ratoons.				
	1st.	2nd.	3rd.	4th.	Other
3·2	1·47	1·53	1·55	1·40	1·67

(32) This crop was below the average.

(33) Thus B. 6032, a good plant cane, ratoons badly and is therefore being discarded. Several canes with excellent records in Java have been introduced but as in that country they are grown only as plant canes it is doubtful whether they will ratoon well. Cane seedlings have their country of origin indicated by letters and an index number. Thus B., Ba., and B.H. stand for Barbados, D. for Demerara, P.O.J. for Java, S.C. for St. Croix, &c.

TABLE IX.

PLANT AND RATOON CANES.

Average acreage division during 1925 and 1926.

	Acres.	Percentage of total area.
Plants reaped	2,622	35·0
1st Ratoons	2,615	35·0
2nd Ratoons	1,459	19·3
3rd Ratoons	395	5·3
Remaining Ratoons and Standovers	407	5·4
Total	7,498	100·0

The increase in the crop requires additional labour and land. Prior to 1917 labourers, who were indentured to estates for five years, were brought from India, each estate indenting for the number required. Since the cessation of indentured immigration many Indians have been repatriated (34) while the growth of the sugar and other agricultural industries, the development of the oil and asphalt industries, and the expansion of motor traffic and road work, have intensified the demand for the remaining labour force. The Company has endeavoured to induce labour to remain by laying out house lots, and providing facilities for the cultivation of cane by peasants, who are known as cane farmers New areas have been opened up, labour-saving methods and devices introduced, and railway facilities for the delivery of farmers' cane established in areas not owned by the Company. Nearly 40 per cent. of the cane crushed by the factory is now supplied by farmers. The latest development lies in the Oropouche Valley, an area of some 10,000 acres, where, owing to lack of transport facilities, peasant proprietors have hitherto eked out a miserable existence by growing food crops, particularly rice, and small patches of indifferent 'cash' crops. With estate railway facilities this area will provide an increasing quantity of cane without seriously interfering with the existing estate labour supply. Since the farmers possess inadequate capital the Company advances money, through its Agricultural Credit Societies, which is recovered when payment is made for canes. When, in 1920, sugar reached an unprecedented high level (35) the various sugar estates, in their anxiety to secure additional cane, advanced money recklessly and established purchasing scales in their neighbours' territory. Many farmers received advances from more than one estate. With the slump in the price of sugar, and therefore of cane, in 1921 (*see* Figure 12) many of these advances became irrecoverable

(34) 9,111 East Indians were repatriated between 1920 and 1927. The total agricultural population is about 96,000.

(35) On 19th May, 1920, 96° sugar, f.o.b. Cuba, sold at £101 18*s*. 4*d*. per ton and fell on 28th December, 1921 to £7 14*s*. 0*d*. per ton.

and heavy losses were incurred. Many farmers gave up cultivation and the supply of cane was nearly halved. To avoid wasteful competition, eliminate unnecessary haulage, and facilitate the recovery of advances, the sugar estates agreed, in 1922, to restrict the purchase of cane by each factory within defined areas, and to adopt the same sliding scale of payment. To encourage farmers the Company has established an understood, though not guaranteed, minimum price of $2.88 per ton of cane, and has improved the conditions of land tenure. Uba, which ratoons exceptionally well, and smothers weeds by its dense growth, has reduced labour requirements, and the rapid expansion in the Ste. Madeleine Sugar Co.'s crop during the past five years is largely due to the extended use of this variety. The heavy nature of the soils prevented cattle ploughing and the undulating land prohibited the use of steam cable ploughs, so that preparation for planting had to be accomplished in the wet season with hand labour. The recent introduction of 60 H.P. caterpillar ([36]) tractors each drawing a four-furrow plough furnished with 28-inch discs, or with chisels or knives, has enabled considerable preparation for planting to take place in the dry season (Table X). With additional equipment it is anticipated that all land to be replanted will be ploughed or chiselled ([37]), made into beds and formed, and perhaps drilled ([38]), by mechanical means thus effecting a very considerable saving in hand labour. The present equipment consists of four 5-ton, one 10-ton, and three 60 H.P. tractors, four Holt and one La Crosse ploughs, two Killifer subsoilers, two Killifer chisels, three road graders (also used for bed formation) one Killifer cultivator, and one harrow. ([39]) (figure 13.)

TABLE X.

WORK DONE BY TRACTORS

Dry Season, 1928.([40])

Acres.		
1,372	....	ploughed
570	....	graded or round ridged.
190	....	unploughed fields chiselled.
131	....	unploughed fields chiselled a second time.
136	....	chiselled after ploughing.
21	....	drilled.
Miles.		
38		roads and traces graded.

(36) The numerous drains and ravines, necessitated by extreme heaviness of the soil, involve the use of caterpillar tracks.

(37) The ploughs will not throw a furrow uphill so recourse is had to chiselling where no double slope is available.

(38) Drains are normally 25 feet apart and the drills are made, usually five feet apart, across the beds to carry off surplus water. Mechanical drilling across the bed would destroy the camber, and the drains. Mechanical drilling along the bed would interfere with drainage. A compromise is therefore being tried, the centre being mechanically drilled along, and the sides hand drilled across, the bed.

(39) The tractors consumed 30,000 gallons of gasolene at 40 cents a gallon, the tax on which amounted to $3,600. It is hoped to introduce tractors using crude oil, which at about 10 cents per gallon would represent a very considerable saving. At present the weight of tractors using crude oil is a severe handicap.

It has been the practice in the past to allow fields whose fertility showed signs of exhaustion to revert to bush for a number of years. With adequate land this method was very suitable, but it is clear that with increasing crops fuller use will have to be made of the land. The Company is attempting to maintain the fertility of the soil for longer periods, to evolve a quicker method of restoring fertility, and to discover varieties of cane tolerant to poor conditions.

Great stress is laid upon the value of pen manure, and it is the practice to apply 20 tons per acre shortly before or after planting. When not working, all animals are kept in covered or open pens containing a layer of cane trash, grass, megass, ([41]) or other vegetable matter, into which is trampled the animal excreta and urine. Additional material is added until at the end of the dry season the pens are 4 feet to 5 feet deep in manure. Some 26,000 to 28,000 tons of manure are produced by this method, but as this is insufficient to meet the requirements of plant canes alone, supplementary sources have to be developed. Trials are being made with methods of producing artificial farmyard manure, and with an efficient and economical method, a very considerable expansion of manuring will take place. Indifferent results have been obtained with artificial manures, and elaborate experiments under statistical control are now being prosecuted. The degree of acidity and the lime status of the greater part of the Company's soils have recently been shown to be closely correlated with the intensity of froghopper blight. Since the amount of lime required to correct this undesirable acid condition would be large (frequently more than 20 tons per acre) the cost involved is regarded as entirely prohibitive. ([42]) Experiments are nevertheless being made to test the effect of smaller applications on areas where lime deficiency is of lesser magnitude.

Extensive trials are being made with green dressings as a means of soil amelioration. It is now the invariable practice to plant the cane banks with Sword Bean (*Canavalia ensiformis*),

(40) During 1924, the first year, 40 acres only were ploughed. One tractor will plough four to five acres a day, and, where the contour of the land prevents ploughing, chisel or knife seven acres a day.

(41) Cutting up the vegetable matter hastens decomposition. Since there is inadequate labour to handle the manure this is not done during the dry season. Enormous quantities of vegetable matter are necessary, and, to save labour, mechanical grass cutters have been introduced. To save cartage, open pens for bison are established in the fields to be manured but in Trinidad other animals, *e.g.*. Zebus and mules are too susceptible to climatic conditions.

(42) Ground limestone delivered to estate costs about $5 per ton. Land can be purchased for $25 to $50 an acre.

Sunn Hemp (*Crotalaria junces*), or Woolly Pyrol (*Phaseolus mungo*), usually an early and a late-maturing variety on alternative banks, which are turned into the soil as the banks are required for moulding (or earthing up) the cane. Fields that have been ploughed, but are not required for planting for periods up to three months, are broadcasted with Sunn Hemp or Woolly Pyrol, to provide a quick cover for keeping down weeds and preventing wash. The cover crop is turned in at cane planting.

To restore the fertility of fields more quickly, it is proposed to plant abandoned fields in *Tephrosia candida*, Pigeon peas *Cajanus indicus*(43) or Bengal Beans (*Stizolobium* sp.) (44) but, as ploughing is necessary, this method cannot become general practice until additional equipment is available.

Fortunately Uba is more tolerant than seedlings to poor soils, and this variety has therefore been extended to all soils on which seedling canes could not profitably be cultivated. (45) Unfortunately Uba does not shed its trash and has to be burnt before reaping, thus destroying humus and useful (and harmful) parasites. (46) It is of low sucrose and undesirably high fibre content, and is troublesome in the factory. But for these disadvantages the cultivation of Uba would have been extended even more rapidly.

(43) Pigeon Peas are a popular local food and suffer from praedial larceny.

(44) Bengal Beans provide forage and beans suitable for stock.

(45) This should be borne in mind in comparing yields and costs of Uba and seedlings.

(46) This may account for the increasing prevalence of the moth borer.

These measures also form part of the comprehensive scheme for froghopper control. Among other methods, recourse is had to insecticides, the most suitable of which is at present Cyanogas (Calcium Cyanide powder) which is effective under favourable conditions and is dusted on the cane stools immediately the presence of froghopper nymphs is reported.(47) Greater stress is, however, laid on soil amelioration and improved agricultural methods.

While these measures are tending to reduce labour demands, there still remains a shortage during the crop season. Since transport difficulties limit the crop to about 100 days (48) during the dry season, which lasts from about the end of January to the beginning of June, all other considerations have to be subordinated to the daily delivery of 2,500 to 3,000 tons of cane to the factory. The two mills work day and night, except when out of cane, stopping only from Saturday afternoon to Sunday afternoon to effect the necessary cleaning, repairs, and adjustments. Factory costs increase rapidly with diminished deliveries of cane (Figure 14). As 44 per cent. of the 5,000 to 6,000 farmers produce less than 5 tons, and 80 per cent. less than 20 tons, per annum, evenness of supply to the factory is extremely difficult to maintain. At the beginning of the season it is impossible to ascertain whether the farmers' canes are ripe

(47) The cost of Cyanogas and its application average about $6 per acre.

(48) In South Africa the crop season extends over seven or eight months. Hence in Trinidad a factory must be twice the size to deal with the same crop. The cost of a factory in Trinidad is about £20 to £25 for every ton of sugar produced.

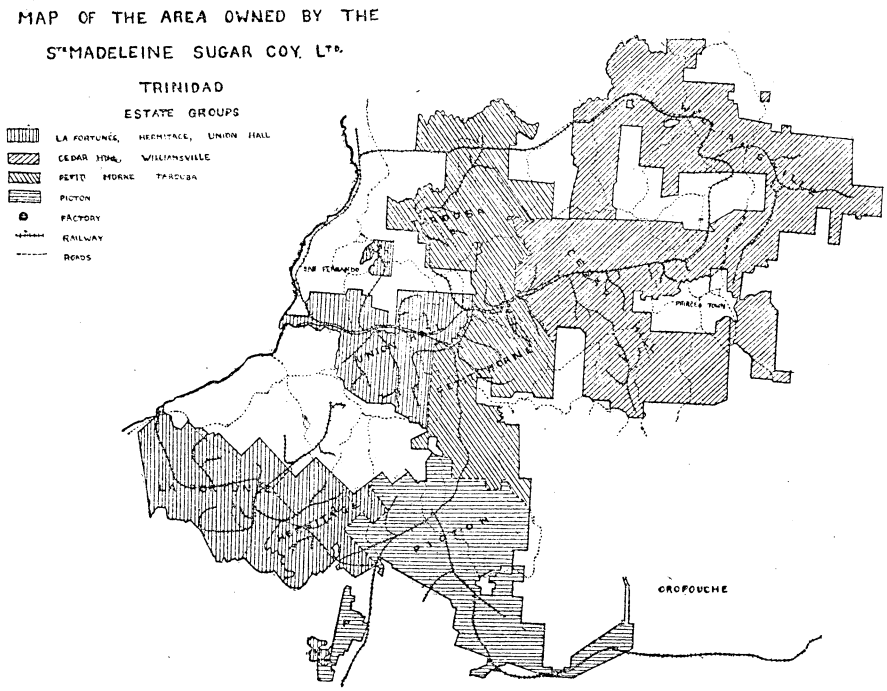


Figure 10.—The Ste. Madeleine Sugar Company has a large estate, 24,500 acres, situated in the Naparima District, where every effort is being made to overcome the depression in the sugar market.

and many farm areas are inaccessible until the dry season is well advanced. To surmount this difficulty, the Company during recent years has adopted the practice of supplementing the estate animal transport by hiring farmers' carts. As the season advances and the farmers' canes become ripe, and transport easier, the farmers use their carts for their own canes. (See Figures 15 and 16.)

In addition to the difficulties experienced in regulating the daily supply, ensuring a good quality, avoiding loss in the weighing and transit of cane, and recovering advances, &c., small farmers do not regularly replant a portion of their land. Since their responsibilities are small, they can, with little loss, give up cane growing during a depression and so cause wide variations in annual supply (*see* Table XI). Badly cultivated patches of cane constitute a reservoir of diseases and pests. To encourage larger farmers, the Company offers better terms of payment. These contracting farmers, who now number 31, supplied nearly 30,000 tons of cane in 1928. If each farmer averaged 50 tons of cane per annum, the Company's cane farmers could be reduced to 1,500 who might, through their Agricultural Credit Societies, be co-operatively organised for the delivery of cane.

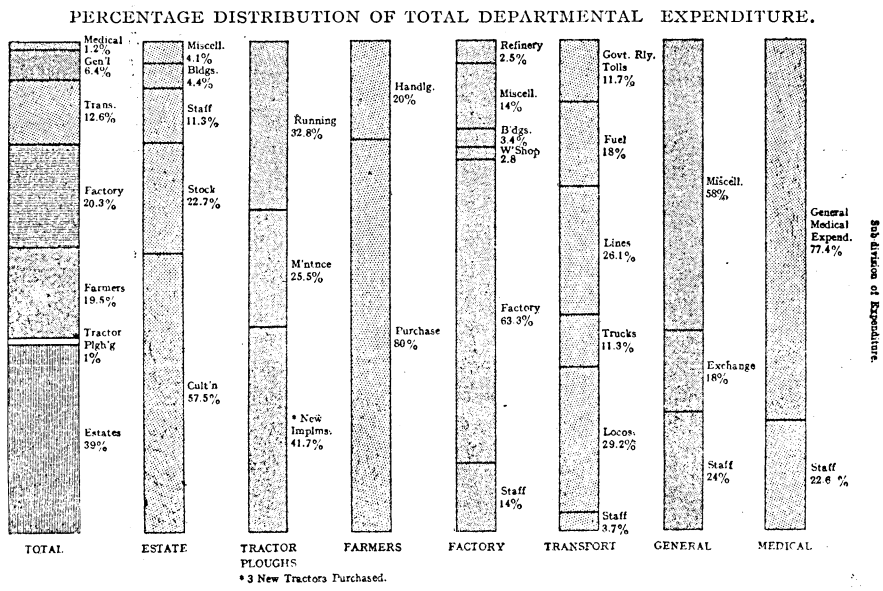
The estate traces are mere earth tracks which become impassable during wet weather. (49) The Company now employs grading machines (50) that give a camber which helps to drain the traces and maintain the surface. Thirty-eight miles were dealt with in 1928.

(49) In the exceptionally wet "dry" season of 1927 no less than 30,000 tons of cane remained unreaped owing to the impassable condition of the traces.

(50) As mentioned above these machines have proved very effective in round-ridging cane beds.

For carting, and providing manure, the Company maintains over 2,000 head of stock. (Table XII.) Among mules 35 per cent. of the available working days were lost for various reasons. Of the days worked less than 30 per cent. were utilised for carting canes. (Table XIII.) Animals are therefore expensive as a means of haulage. Experiments are being made with tractors, the main difficulty being to find a suitable type of cane cart. It is anticipated that since each tractor will haul a fleet of carts, and cartage will be less dependent upon weather conditions, a considerable amount of labour will be freed for other urgent requirements. (51) But for the difficulty of securing an adequate supply of pen manure, this would enable many head of cattle and mules to be dispensed with. To supplement the synthetic methods previously mentioned, the Company has centralised its dairy cattle, and, with expansion, it is anticipated that the sale of milk and milk products (52) will cover all the dairy expenses and thus a considerable quantity of manure will be supplied free of cost.

The Company, like all other cane sugar producers, is on the look-out for a cane harvester (53) that will not only cut, but also top, the cane mechanically.



THE TOTAL ANNUAL LOCAL EXPENDITURE AVERAGES $\$1\frac{3}{4}$ MILLION PER ANNUM.

Figure 11.—*The costs of production of sugar by the Ste. Madeleine Sugar Company are graphically presented by this chart.*

(51) Owing to the increasing difficulty of obtaining carters many youths unsuited to the work are employed. The tractors will afford an outlet for the preference for mechanical work shown by West Indians who dislike field work.

(52) In 1927 Trinidad imported condensed milk to the value of £100,495 and milk products or their substitutes to the value of £109,365, *C.P.* 68, 1928.

(53) Each cutter averages 2 65 tons per day. Hence an average of more than 1,000 men are required daily merely to reap cane for the factory, and a similar number for carting.

TABLE XI.

TRINIDAD CANE-FARMING AND SUGAR CROP RETURNS.

Period.	Island.					Ste. Madeleine Sugar Company.					
	Sugar produced tons.	Tons crushed.		Cane-farmers.		Sugar produced tons.	Tons crushed.		Price per ton of cane $	Cane-farmers	
		Estate.	Farmers.	East Indian.	West Indian.		Estate.	Farmers.		E.I.	W.I.
1898-1902	56,287	292,515	134,651	3,261	4,174	....	99,653	21,226	....	653	812
1903-1907	50,060	347,711	178,192	5,439	5,162	13,461	90,730	41,662	....	1,587	1,172
1908-1912	48,302	393,805	157,590	6,409	5,839	13,153	120,274	35,612	....	1,872	1,233
1913-1917	58,365	397,215	282,404	9,933	7,008	17,606	124,875	56,692	....	3,063	1,400
1918	45,256	252,783	266,144	12,158	8,244	16,643	95,442	80,388	3.84	4,712	2,332
1919	47,850	275,451	270,324	12,370	8,568	16,482	95,570	72,551	4.74	4,322	2,292
1920	58,416	319,421	344,226	14,536	10,824	17,510	93,494	86,344	8.40	4,393	2,778
1921	54,933	286,974	389,399	15,046	11,379	17,740	84,232	106,367	4.84	5,132	3,643
1922	59,948	340,358	355,364	12,605	8,745	17,880	76,334	95,551	2.57	4,072	2,651
1923	41,619	253,211	186,445	9,670	6,830	13,732	74,891	53,938	4.90	3,077	1,952
1924	52,045	324,361	237,298	9,952	7,116	17,203	109,336	59,792	4.52	2,965	1,835
1925	69,629	395,105	327,614	11,508	7,966	23,520	141,825	83,045	2.88	3,455	2,188
1926	73,561	384,002	358,879	13,492	9,447	29,365	162,358	111,316	2.88	3,862	2,822
1927	51,982	330,391	286,700	11,858	7,527	19,434	134,940	78,135	3.45	3,390	1,814
1928	81,551	449,634	375,162	13,224	7,444	30,939	176,691	113,020	2.97	4,712	2,174

With these measures fully developed, labour will be rendered available (Table XIV) for the cultivation of young plant and ratoon canes which at present have to be neglected during crop. The crop season is the main planting season for the cane farmers, partly because planting material can be obtained very cheaply (54) and partly because the farmer prefers a twelve month growing period. To relieve the crop pressure, the estate provides cheap planting material during the wet season, but little advantage is taken of this facility.

Unfortunately, part of the crop season coincides with the East Indian marriage season, and, since the guests are numerous, particularly in times of prosperity, temporary dislocation of estate work sometimes results. The rice planting and reaping seasons, and the competition of

(54) The top joints of the cane only are used during the dry season because they give a better 'spring' and are useless for sugar production.

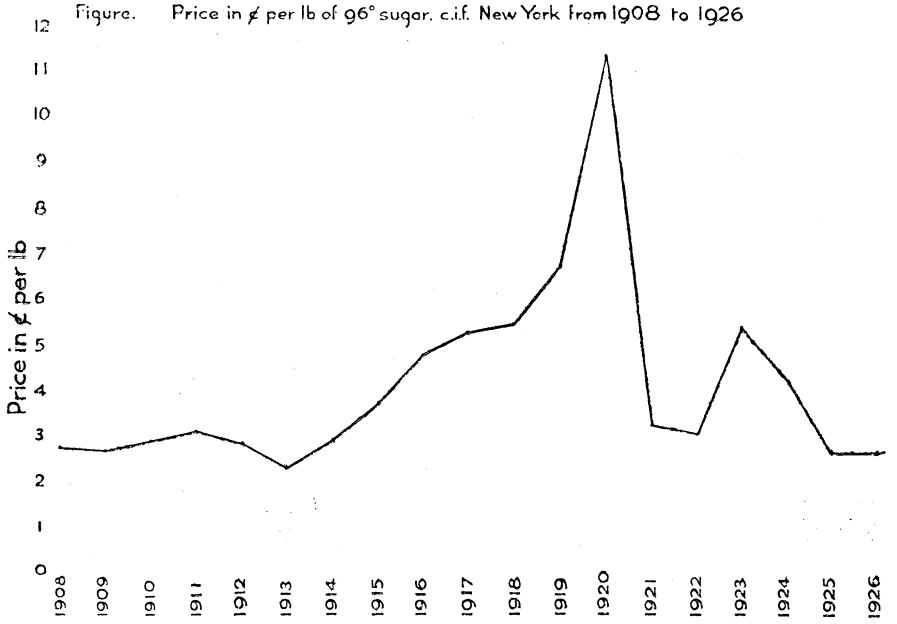


Figure 12.—Note the rapid rise in price during the war, followed by the post-war boom when sugar rose to an exceptionally high level. The sudden fall in 1921 brought disaster to many sugar producers, and the industry is still attempting to adjust itself to the new level of prices, which approximates to that of the pre-war period though costs of labour and materials are still high.

cane farmers at certain periods of the year, also interfere with estate routine, though on account of the higher pressure of work any interference during the crop season is more serious.

TABLE XII.

UNITS OF LIVE STOCK.
30th June, 1926.

Horses	78
Mules	580
Oxen	322
Cows	422
Calves	351
Steers	138
Heifers	162
Bulls	36
Others	89
Total	2,178

Labour-saving devices have reduced the factory labour demands to such small relative dimensions that although the numbers fluctuate greatly (Figure 17) they have little effect on the general labour situation. Owing to the seasonal variation in employment, some difficulty is experienced in retaining suitably qualified mechanics.

TABLE XIII.

DISTRIBUTION OF MULE AND OXEN UNITS, 1925-26.

	Mule units. Percentage Distribution.	Oxen units. Percentage Distribution.
Lost	35·4	54·6
Implemental tillage	1·4	1·9
Working derricks	2·4	—
Carting canes	17·9	5·7
Carting forage	12·0	13·0
Carting bedding	10·1	14·9
Carting manure	7·3	6·7
Miscellaneous Cartage, &c.	13·5	3·2
Total Possible Units*	164,000	96,500

* Calculated on the basis of five days per week for 50 weeks equals 250 days per annum.

A problem of great importance is the profitable disposal of factory by-products, particularly molasses and megass. At one time a rum distillery played an important part in the economy of a cane sugar factory, but taxation and 'prohibition' have rendered returns from this source negligible. The profitable use of molasses for power alcohol, cattle food, fertilizer, &c., is being investigated. Megass is used primarily as fuel, and not only meets the normal requirements of a modern factory, but also produces a large surplus. Attempts are being made to utilise it profitably as fibre board or paper pulp.

Lack of deep water facilities at Port-of-Spain, and the additional handling necessitated by lighterage increase the cost of exporting sugar. A small tax is imposed upon sugar exports to meet the cost of repatriating East Indians who have served a term of indenture.

This brief and superficial description does not pretend to detail all the problems of all cane sugar producers, or even those of Trinidad. Some of the differences in other parts of Trinidad have already been noted, while many more might be enumerated. In the Caroni Plain, for example, small scale experiments indicate that irrigation might enable conditions to be produced artificially which would diminish froghopper blight and reduce costs of production. The political future of sugar is so obscure that it is doubtful whether the necessary capital would be forthcoming. Every estate has its own peculiar problems but it is hoped that the above account has served its purpose of indicating the manner in which the present situation is being faced.

TABLE XIV.

PERCENTAGE DIVISION OF ESTATE LABOUR UNITS.

Subsoiling	*6·5
Round Ridging	*3·1
Draining	5·8
*Drilling, planting and supplying	9·1
Weeding	24·9
Digging Para grass	3·8
Clearing Pastures and Traces	*2·1
Making and applying manure	13·7
Destroying Froghoppers	4·2
Stripping and cutting canes	7·5
Heading, packing and loading canes, and working derricks	7·8
Carting canes	*7·4
Other operations	4·1
1,047,896 units	= 100·0%

* These operations can either be performed to a large extent, or be substituted by mechanical methods. This would tend to reduce the number of units employed in other operations, *e.g.* : weeding, which accounts for a very large percentage of the total labour units. It takes approximately five men-days to produce, reap and deliver to the railway trucks one ton of cane.

The Colonies in Relation to the World's Sugar Industry.

Attempts to compare the efficiency of sugar production in various countries are apt to be extremely misleading since conditions differ so fundamentally. The fact that yields of cane in Java and the Hawaiian Islands average more than 45 short tons per acre, whereas in Queensland, Mauritius, the Philippines, South Africa, and other areas, the average production is less than 20 short tons per acre, does not necessarily indicate inefficiency in the latter countries. That the high yields of Java and the Hawaiian Islands are due principally to irrigation is illustrated by the fact that, the yields per acre on estates in the Island of Hawaii dependent upon rainfall, averaged only 55 per cent. of those on irrigated estates in the Islands of Oahu and Main, during the period 1907 to 1921. (55) Even in comparing Java and Hawaii several important differences should be noted. In the former country, plant canes only, maturing in 11 to 15 months, are grown, and cane is rotated with food crops, particularly rice. In Hawaii the growing period is 18 to 24 months and ratooning

(55) See Report of the Experimental Station, H.S.P.A., 1922. In Java more than 90 per cent., and in the Hawaiian Islands more than 50 per cent. of the area under sugar cane is irrigated.

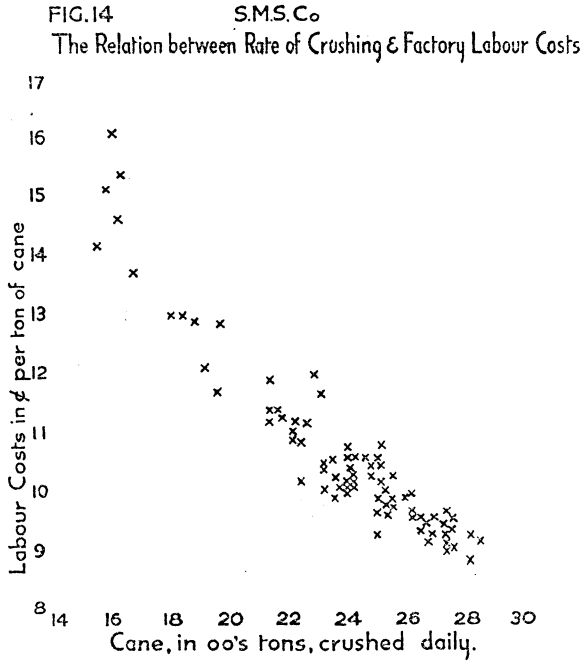


Figure 14.—*The above diagram indicates that as the quantity of cane crushed increases, factory labour expenses decrease. Saturdays and Sundays, when crushing is not continued throughout the* 24 *hours, have been omitted. Oil fuel has been omitted from costs since its consumption is largely independent of the rate of crushing. The following table shows some of the coefficients of correlation obtained between rates of crushing and factory running costs. Each result is significant.*

Year	*Co-efficient of Correlation*	*Pairs of Variables*
1920	—0.87	90
1921	—0.88	90
1924	—0.89	78
1925	—0.91	83

is practised. The yield per acre during a given time is, therefore, much higher in Java. In Mauritius the average yield per acre is considerably reduced by the fact that half the cane area is in the hands of Indians, whose primitive methods yield only 14½ short tons per acre. The virgin soil of Cuba tends to increase, and the practise of long ratooning to decrease, yields per acre.

Nor do costs of production afford us a reliable criterion of efficiency since rates of wages and labour efficiency vary so widely. In Java, with a population exceeding 35 millions, and an area of less than 50,000 square miles, the daily wage for unskilled male labourers is 20 cents. In Hawaii, with labourers recruited from 18 countries, the daily wage is about $1.50. Other average rates include Queensland $4.08, Cuba $1.20, Mauritius 84 cents, Natal 64 cents, the Philippines 36 cents, and Trinidad 45 cents.

Climatic and soil conditions, the length of the crop season, the type of sugar manufactured, local topography, the proportion of cane purchased, land tenure and values, and many other variable factors, introduce innumerable complications into comparative tests of efficiency. While the favourable peculiarities of certain countries indicate desirable goals, failure in others to attain them does not necessarily indicate inefficiency.

Since the development and prosperity of each country is largely dependent upon its ability to compete in world markets we may usefully study

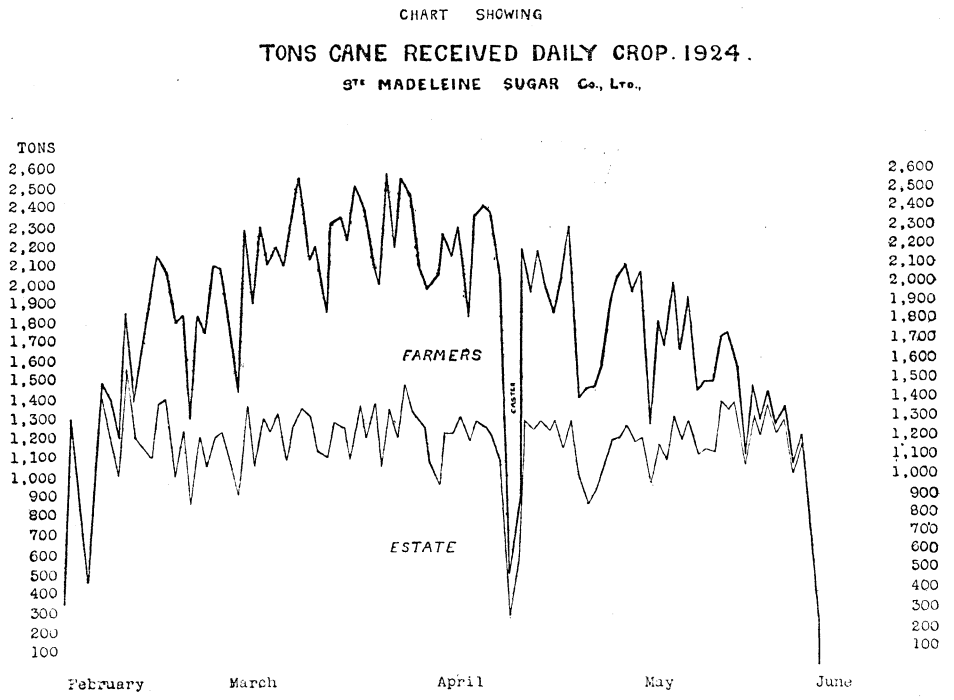


Figure 15.—*Apart from small daily fluctuations the delivery of estate cane remains relatively uniform. The supply of farmers' cane varies considerably.*

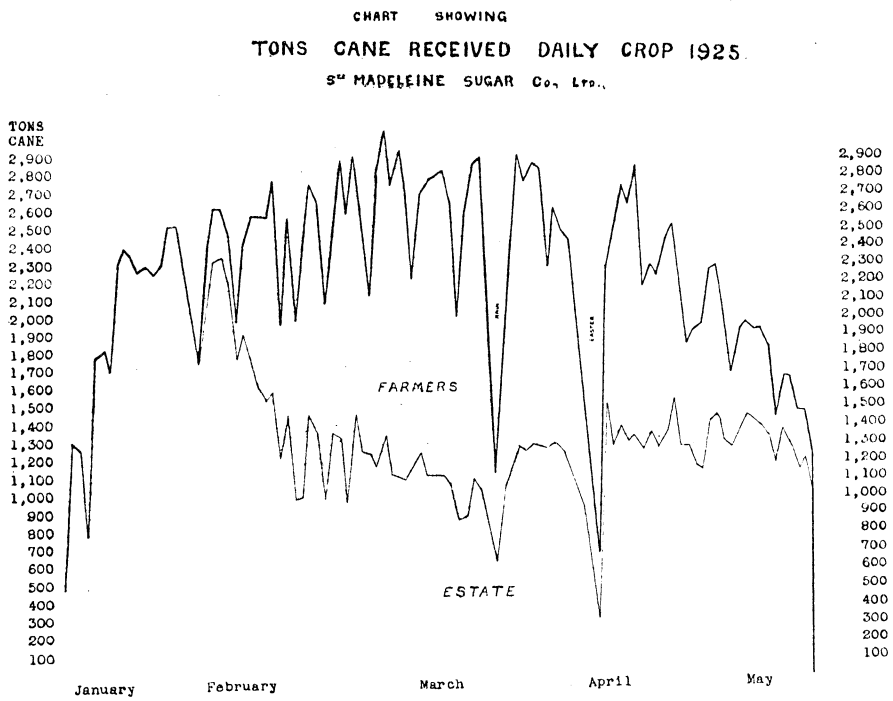


Figure 16.—The delivery of estate cane during the early period of the crop has been increased by hiring farmers' carts. The delivery of farmers' cane exhibits an irregularity similar to that for 1924. The aim of the estate is to reach the maximum capacity of the factory as early in the season as possible and to maintain that delivery throughout the season.

comparative costs of production. In Table XV an attempt has been made to reduce the costs of production to the same basis. (56)

TABLE XV.

COST OF PRODUCTION OF ONE TON (2,000 LB.) OF RAW SUGAR.

Java	$49
Cuba	50
Trinidad	55
Hawaii	68
South Africa	87
Queensland	121

These figures should be regarded as only approximately correct and subject to considerable yearly variation. One may, however, legitimately draw the conclusion that Queensland, South Africa and, Hawaii, can compete neither in the world, nor in their internal, markets without heavy subsidies or protection.(57) The difference in cost between Java, Cuba, and Trinidad, is relatively small. Java's sugar is normally marketed in the Far East, and only sporadically competes in the markets to which the British West Indies and British Guiana send their sugar.

(56) The figure for Trinidad has been calculated from the books of the S.M.S.C. for 1925 and 1926. The remaining figures are taken from Maxwell: *Economic Aspects of Cane Sugar Production; Norman Rodger.* Taxes have been omitted. A price of $68 per ton (2,000 lb.) of sugar, f.o.b. Port of-Spain, should enable an estate in Trinidad to realise 10 per cent. on its capital.

(57) The import duty on cane sugar into Australia is equivalent to $40.56 per short ton, and on sugar not otherwise specified $60.84.

Since the increased world production of sugar has depressed prices to an unprofitable level, one might expect those countries with the highest costs of production to be in dire straits. Such, however, is not the case, and, for the reason, one must make a cursory survey of the principal markets.

The United States and the United Kingdom are the principal consuming countries whose requirements are only partially met by internal production. The United States' consumption averages nearly 6 million short tons of which her internal cane industry supplies 2 per cent., her beet industry 16 per cent., and her insular possessions, Hawaii, Porto Rico, the Philippines, and the Virgin Islands, 25 per cent., all of which is admitted duty free, the equivalent of a protection of $44 per short ton. Hence Hawaii, in spite of her high cost of production, is guaranteed not only a ready market but also prosperity. Practically the whole of the remaining $3\frac{1}{4}$ million short tons is supplied by Cuba which enjoys a preference of 20 per cent. in duty, equivalent to $8.80 per short ton, which, with her low cost of production, guarantees a market but not prosperity. Cuba, with her production of about 5 million short tons, is therefore compelled to find other markets for about $1\frac{3}{4}$ million short tons. The Continental beet industry, protected in its internal markets, produces more than 1 million short tons in excess of its requirements.

Excluding India which produces, and consumes more than, 3 million short tons of low grade sugar, British production amounts to about $1\frac{1}{2}$ million

short tons, and consumption to 3 million short tons. Nearly half this production is located in Queensland, and South Africa (58), where the internal protection is such that it not only guarantees prosperity, and thus encourages expansion, but also enables sugar to be exported at prices far below the cost of production. Since these Dominions enjoy Imperial Preference most of the surplus is exported to the United Kingdom.

TABLE XVI.

IMPORTS OF AUSTRALIAN AND SOUTH AFRICAN SUGAR INTO THE UNITED KINGDOM.

In 1000's tons.

From	1914	1920	1924	1925
Australia	9	1	44	88
South Africa	—	13	8	36
Total	9	14	52	124

The beet sugar industry in the United Kingdom, stimulated by heavy bounties (Table XVII) has rapidly risen to a production exceeding 200,000 tons, all of which finds a lucrative market

(58) Australia approximately ½ million tons and Natal ¼ million tons.

TABLE XVII.

BEET SUGAR INDUSTRY OF THE UNITED KINGDOM.

Amounts paid in subsidies.*

Period.	*Amount in pounds sterling.*
1924-25	492,040
1925-26	1,066,059
1926-27	3,225,858
1927-28	4,309,259
1928-29	3,250,000 (estimated)

* *West India Committee Circular, 1928, p. 317.*

in the United Kingdom. Most of the balance of British sugar is produced in the Crown Colonies, Mauritius, Fiji, the British West Indies and British Guiana, the bulk of which has to be exported. These Colonies, in common with all other Empire producers, enjoy a preference in the United Kingdom equivalent to about $16 per short ton, but share none of the additional advantages afforded to the Dominions and Home producers.

The United Kingdom consumes about 1¾ million short tons of sugar per annum. Before the War 66 per cent, of her supply came from Europe, Germany alone contributing 35 per cent. (59) In 1927, 70 per cent. of her imports came from foreign countries, Cuba and Europe being the principal sources. Canada, by a reciprocal treaty affords the British West Indies and British Guiana

(59) Average for the three years 1911-13.

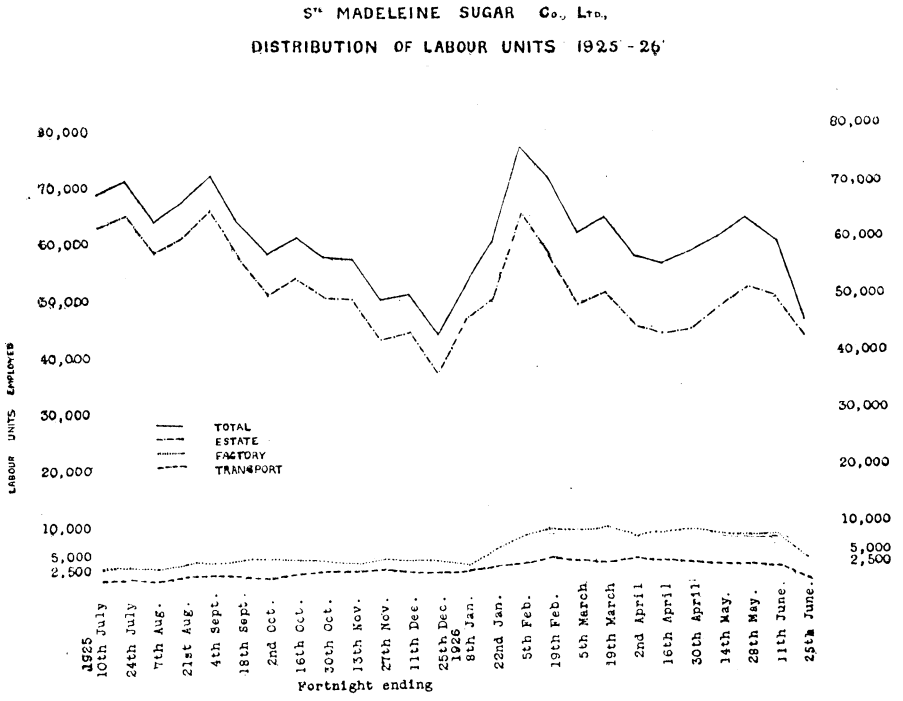


Figure 17.—The slight difference in the diagram between the total, and the aggregate units employed on estates, in the factory, and in transport, is represented by the numbers employed in handling shipments of sugar. During February-May, the crop season, every available unit of labour is employed. The peak in the early part of February is partly due to the employment of farmers for carting. During the remainder of the crop they are principally engaged in dealing with their own canes. Planting accounts largely for the heavy employment during August and September.

a preference in excess of that afforded by the United Kingdom, though the benefits to the producers approximate the same. The exports of the British West Indies and British Guiana are, therefore, divided between the United Kingdom and Canada, the latter country taking an annual average of 173,000 short tons during 1923-27. (60)

TABLE XVIII.

EMPIRE PERCENTAGES OF UNITED KINGDOM SUGAR IMPORTS.

1880	1914	1924	1927
24	9	16	30

The preference has stimulated the imports of Empire produced sugar.

Although these modest preferences guarantee a market to the British West Indies and British Guiana, and are vitally important, they by no means guarantee prosperity, and we have the anomalous position that, although the Colonies produce by far the cheapest sugar within the British Empire, they are the least prosperous. (61) With all sugar tariffs and bounties swept away, they alone among the British Empire sugar producers would survive (62), yet, under existing conditions, they are nearest to extinction. Sugar production in the British Colonies is more a political gamble than an economic proposition.

(60) Figures kindly supplied by Canadian Trade Commissioner.

(61) Although the cases are not parallel it is of interest to note that if the British West Indies and British Guiana enjoyed the same bounty as the United Kingdom beet industry nearly £6,000,000 would be available for distribution among the producers. The Ste. Madeleine Sugar Co. lost, on an average, $3 on every ton of sugar produced between 1921 and 1927.

(62) As before, India is excluded. Only 10 per cent. of the world sugar production is unprotected, 8 per cent. being produced in Java alone.

SUMMARY.

1. Sugar production has always been the subject of considerable political interference which, until the beginning of the nineteenth century, was calculated to foster and protect the British West Indies and British Guiana.

2. Throughout the nineteenth century the Colonies were the subject of political contempt, and the state-aided competition of the beet sugar industry brought the Colonial cane sugar industry to the verge of extinction.

3. Alternative crops were introduced, some islands gave up cane cultivation, cane areas shrunk and were consolidated, private estates gave way to companies factories were centralised, and yet the depression continued.

4. The West India Royal Commission, followed by the abolition of the bounty system, and the formation of the Imperial Department of Agriculture for the West Indies, marks a new era in Imperial politics. The interest in, and interference with, the Colonies by the Imperial Government has saved the Colonial sugar industry, but has not restored prosperity.

5. Each island has its own peculiarities, the salient characteristics of which have been briefly described together with the influence of the major pests and diseases.

6. In order to illustrate the methods of development a more detailed examination is made of a large sugar estate. The focus of research is shifting from the factory to the field and transport sections.

7. A survey of the world's sugar industry reveals the British West Indies and British Guiana in a favourable light yet, in spite of the fact that they produce the cheapest sugar within the Empire, they remain the least prosperous. Only improved political treatment, or increased prices, both of which appear remote, and are outside the control of the producer, can restore prosperity to the sugar industry of the British West Indies and British Guiana.

ACKNOWLEDGMENTS.

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