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ST. CROIX: A MARGINAL SUGAR-PRODUCING ISLAND

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IN the upward stage of the business cycle the marginal producer may share in the profits of industry: if, however, the cycle continue through a period of overproduction, sharp competition, and low prices, his profits rapidly disappear. This is the situation in the cane-growing island of St. Croix. A few figures suffice for the general situation. The world production of sugar virtually doubled in the last decade—18,000,000 tons in 1920-1921; 30,000,000 tons in 1930-1931.¹ Paralleling this expansion the price of sugar declined from an average of 12.06 cents (c. i. f. New York) a pound in 1920 to 1.33 cents in 1931 and in 1932 reached a record low price of 0.57 cents.² The crisis renders more acute a development that had already begun in St. Croix, a development in which geographical factors play an important part.³

St. Croix has long had a close association with sugar: it was the island's first money crop, and it continues to dominate the economy of the island after two hundred years of production. In early days high prices and slave labor enabled even the more rugged Virgins, St. Thomas and St. John, to share in the industry. At the close of the eighteenth century more than 30,000 acres in the islands were under sugar.⁴ When markets fell in response to the increase of beet sugar and the severe competition of East Indian areas only regions topographically suited to machine cultivation and supplied with cheap labor could continue profitably. At present St. Croix produces all the Virgins' sugar, and the output continues to decline. According to the census of 1930 the crop of 1929 occupied 5823 acres and yielded a harvest of 56,400 tons, whereas in 1917, when the United States acquired the island, the harvest was more than 84,000 tons. St. Croix cannot compete with the world's leading low-cost cane producers. The limiting factors will now be discussed.

¹ A. de Graaff: Die Neugestaltung der internationalen Zuckerwirtschaft, *Weltwirtschaftliches Archiv*, Vol. 37, 1933, pp. 255-281.

² J. C. Clifford: Sugar Industry Faces Sweeter Prospect, *Magazine of Wall Street*, Vol. 51, 1933, p. 676.

³ On the operation of geographical and political factors in the sugar industry, see C. J. Robertson: Geographical Trends in Sugar Production, *Geogr. Rev.*, Vol. 22, 1932, pp. 120-130.

⁴ Waldemar Westergaard: The Danish West Indies Under Company Rule (1671-1754) with a Supplementary Chapter, 1755-1917, New York, 1917. St. Croix had 27,655 acres under sugar; St. Thomas, 2496 acres; St. John, 1863 acres.

RAINFALL AS A LIMITING FACTOR

Insufficient precipitation has always been the chief limiting factor in the sugar industry of St. Croix; and, in general, production has risen and fallen with the amount of annual rainfall (Fig. 1). For what is termed an average crop at least 45 inches of well distributed

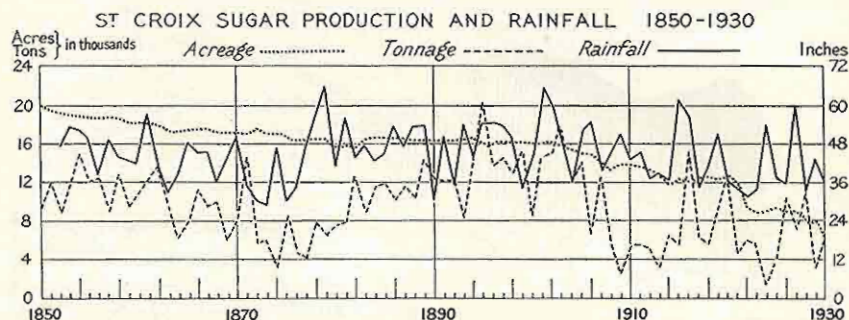


FIG. 1—St. Croix sugar production and rainfall, 1850-1930. Years of heavier sugar production generally follow those of high rainfall. The area under sugar showed a gradual decline from about 20,000 acres in 1850 to about 16,000 in 1900. Since then the decrease has been rapid until in 1931 it dropped below 5000 acres.

rainfall is necessary, and from 50 to 60 inches is required for a good yield.⁵ Records for eighty years show that only during forty-three years was the mean annual rainfall 45 inches or more, whereas during the remaining years the amount ranged down to 29.48 inches, the total for 1873.⁶ Incidentally it may be noted that the rainfall for 1931 established a high record—69.81 inches.⁷

Not only is the yearly total inadequate, but the distribution throughout the year is not dependable. A yearly precipitation of 50 inches or more is enough for a good crop if rightly distributed; but if approximately one-fourth to one-third comes during a single month, as it often does as a result of hurricane influence, and if the balance is not well apportioned, the mean annual figure has little significance. In contrast, the rainfall of Cuba has a high degree of dependability during the crop-growing season.⁸

The number of rainy days is likewise apt to be somewhat misleading. A monthly average of twelve to fourteen days with precipitation during the cane-growing season⁹ suggests optimum weather

⁵ The average production for plant cane is 17 tons an acre, ratoon cane 8 tons an acre. These averages and rainfall requirements for "good" and "average" crops were furnished by Glen Briggs, Director, U. S. Agricultural Experiment Station, St. Croix.

⁶ Climatic statistics were furnished by the U. S. Weather Bureau, Washington, and the U. S. Agricultural Experiment Station, St. Croix.

⁷ Earl B. Shaw: St. Croix's Rainiest Year Causes an Epidemic of Malaria, *Science*, Vol. 76, 1932, pp. 566-567.

⁸ Oliver L. Fassig: Rainfall and Temperature of Cuba, *Tropical Plant Research Foundation Bull.* No. 1, Washington, 1925.

⁹ W. W. Reed: Climatological Data for the West Indian Islands, *Monthly Weather Rev.*, Vol. 54, 1926, pp. 133-160.

for sugar. Often the rains are too light to reach the roots of the cane, and the limited quantity nullifies the ostensible advantage of short intervals between showers.

The causes of the unsatisfactory rainfall régime are to be found in a combination of circumstances. The convectional rain that reaches

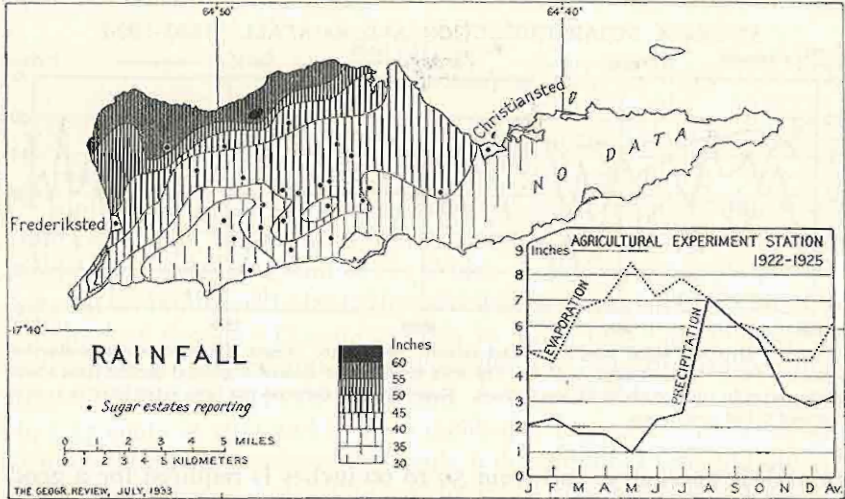


FIG. 2—Rainfall map of St. Croix. Rainfall records for a ten-year period from twenty-five stations were used. The eastern part of the island, which is known to have a comparatively low rainfall, is excluded, for only a single station with a year's precipitation was available.

Inset is a graph illustrating the typical rainfall régime and showing the relation between rainfall and evaporation at the St. Croix Agricultural Experiment Station (see Fig. 4).

a maximum at the time of the high sun is variable in occurrence and, because of the small size of the island, is seldom heavy. The hurricane control, a principal influence in the rainiest period, is likewise erratic. The northwest upland is insufficiently elevated to present an effective barrier to the northeast trades; and, in so far as the sugar lands are concerned, they receive no benefit except a slight increase from drainage, for they lie in the lee of the hill land.

Winds are another element that proves a hazard. Tropical hurricanes, at any time between May and November, may damage the growing cane or ruin it entirely. The constant trade winds, furthermore, encourage a high rate of evaporation—a climatic element unfavorable to moisture conservation. Measurements over a period of four years (1922–1925) indicate that the possible evaporation exceeds mean annual rainfall by an average of 36 inches (Fig. 2).

TOPOGRAPHIC LIMITS OF MACHINE CULTIVATION

Whereas climate affects adversely the possibilities for cane growing in the entire island, topography places definite limits to the area of machine cultivation (Fig. 4). Topographically St. Croix may be

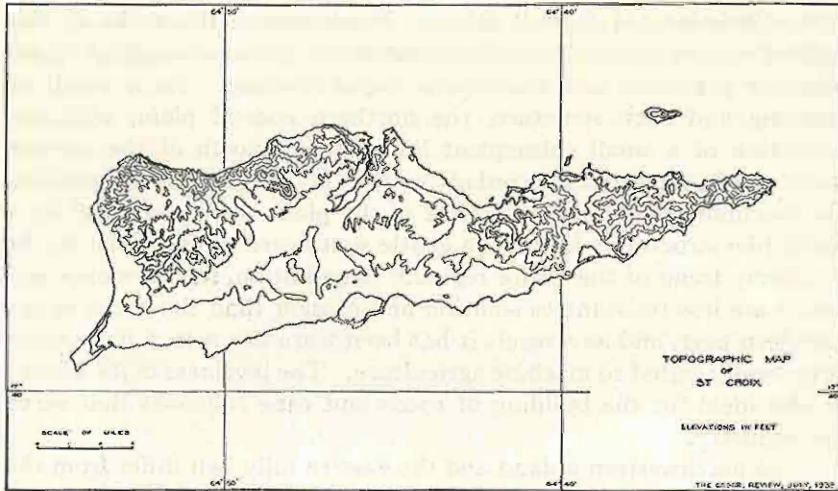


FIG. 3

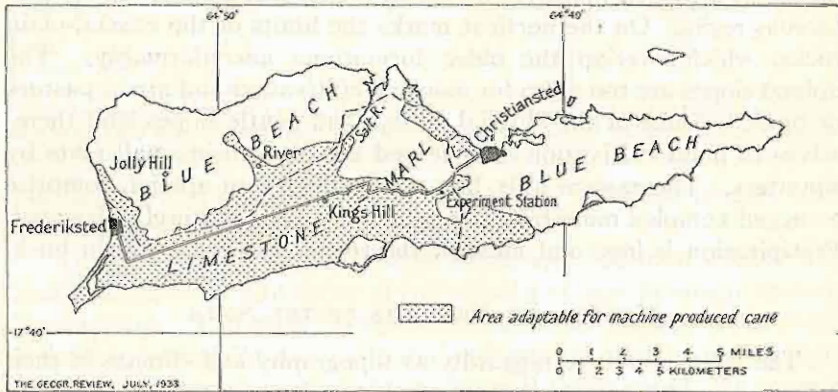


FIG. 4

FIGS. 3 and 4—Topography and rock formations. The topographic map shows the 100- and 200-foot contours, and thence the interval is 250 feet. The northwestern upland and the eastern hill land correspond generally with the "blue beach" formation (limits shown by dashed line); the central and southwestern coastal plain corresponds with the limestone-marl formation. The area suitable for machine cultivation agrees closely with the plains region, excluding the arc-shaped cuesta in its northern part.

divided into a central and southwestern section composed of a nearly level coastal plain, which rises to an arc-shaped cuesta in the north-central part, a northwestern upland area, and an eastern hill region.

The central and southwestern coastal plain contains the larger sugar lands (Fig. 5). The north-central part of this section, however, contains some hilly land that does not lend itself to machine cultivation. Differences in the physiographic history of the two parts of the plain account for this difference in topography. After the emergence of the Tertiary coastal plain, slight warping and erosion produced the cuesta in the north with an axis trending approximately northeast

from Christiansted to Salt River. Furthermore, the rocks of this arched section are semicrystalline limestones, porous enough to retard solution processes and consequent rapid leveling. As a result of warping and rock structure, the northern coastal plain, with the exception of a small subsequent lowland just north of the arcuate cuesta and structurally accordant with it, is topographically unsuited for machine production. The rest of the plain is characterized by a basin-like structure which has a gentle southward pitch similar to the southerly trend of the entire region.¹⁰ In addition, its limestones and marls are less resistant to solution and erosion than the rocks of the northern part, and as a result it has been worn down to a stage topographically suited to machine agriculture. The levelness of its terrane is also ideal for the building of roads and cane railroads that serve the industry.

The northwestern upland and the eastern hilly belt differ from the coastal plain in topography and geologic structure. The northwestern section is a rugged maturely dissected region made up of folded Cretaceous rocks. On the north it marks the limits of the coastal-plain rocks, which overlap the older formations unconformably. The upland slopes are too steep for machine cultivation and are in pasture or bush.¹¹ Some of the alluvial valleys and gentle slopes lend themselves to hand cultivation of cane and are planted in small plots by squatters. The eastern hills, like the northwestern upland, comprise a rugged complex mountain area which has been maturely dissected. Precipitation is less, and most of the region has grown up in bush.

MERITS AND DEMERITS OF THE SOILS

The soils are not so niggardly as topography and climate in their influence on the growth of cane. In many respects they are actually favorable, yet in some they leave much to be desired. The cane section lies largely within one of the three principal soil groups, that of the marls. The other two are the so-called blue beach and the alluvial-coastal plain soils. The marl group includes residual materials derived from the Tertiary limestones, which occupy the south-central part of the island. Favored by smooth topography and productive soils, this section includes St. Croix's best agricultural land. The better marl types yield rich surface soils of granular texture, good tilth, and a depth of nine inches or more. Beneath the surface soil there is a thin transition zone of mixed organic matter and marly lime, which is underlain by soft marly lime at shallow depths. In a

¹⁰ H. A. Meyerhoff: *The Physiography of the Virgin Islands, Culebra and Vieques* (Scientific Survey of Porto Rico and the Virgin Islands, Vol. 4, Part II), New York Academy of Sciences, 1927, pp. 159-170.

¹¹ The term "bush" is a local word applied to a type of vegetation containing many species of trees and shrubs strongly armed with needle-like, piercing spines and prickles. Following Schimper's classification, the writer classifies much of the bush, especially in eastern St. Croix, as "thorn woodland."

few places local accumulations of sodium carbonate or other salts limit production. The surface soils have good moisture-holding capacity, but the marly lime is so porous that the subsoils do not hold moisture over long periods.¹² Their porosity is a distinct handicap,

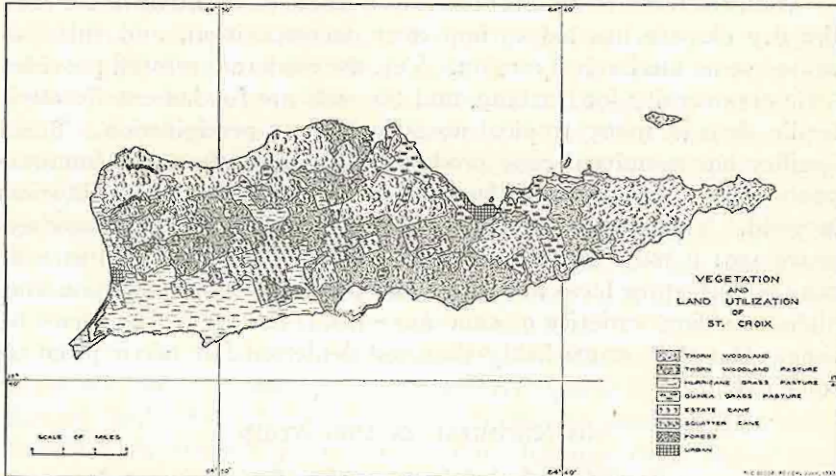


FIG. 5.—Land utilization and vegetation, St. Croix. The land in cane is only one-fourth of the sugar area of 1850 and less than one-third that of 1900. Thousands of acres of land ideally suited to machine cultivation are now given over to cattle raising.

but the marls are capable of supporting excellent crops of cane when moisture conditions are favorable.

There is a small region around River and Fountain estates with soils derived from dioritic or granitic rocks of late Mesozoic or early Tertiary age. This area, because of the granular texture of the rocks, has been eroded into a small lowland section surrounded by blue beach to the east, west, and north and marl to the south. In general, this is a productive cane area.

The blue beach residual soils are formed from rocks consisting of andesitic volcanic types and sedimentaries derived from them, together with small areas of limestone and shale. They cover more than half the land area of St. Croix, including the rugged northwestern highland and the eastern hilly section. It is rather the rugged topography that prohibits their use for machine culture than any natural unproductivity of the soils themselves. Indeed, on areas with less relief in the northwestern section, squatters cultivate small cane plots by hand.

The alluvial-coastal plain group consists of transported soils of two types: the alluvials found in the valleys of the intermittent streams—there are no perennial streams in St. Croix—and the coastal plain soils along the more open sections of the coast. The former

¹² James Thorp: Soil Survey (Reconnaissance) of St. Croix Island, Virgin Islands, U. S. Dept. of Agric., Technical Bull. No. 315, Washington, 1932.

are used to some extent for cane, but the latter receive little cultivation. There are also alluvial deposits around some of these open coastal areas, and it is difficult in places to draw a definite line of demarcation between alluvial and coastal-plain soils.

With reference to St. Croix soils as a whole it should be noted that the dry climate has led to imperfect decomposition, and this has caused some mechanical erosion. Yet, the moderate rainfall provides little opportunity for leaching, and the soils are fundamentally more fertile than in many tropical areas of heavier precipitation. Their fertility has permitted cane production for more than two hundred years without commercial fertilization and with little diminution in yield. Yield of sugar per acre is as high as it was two hundred years ago: it must be remembered, however, that improvements in cane manufacture have brought about a larger sugar extraction and higher-yielding varieties of cane have been developed from time to time. Hence it seems likely that soil depletion has taken place to some extent.

NO RECOURSE IN IRRIGATION

In many countries of deficient rainfall, reservoir or deep-well irrigation permits profitable crop production. However, an artificial water supply does not seem feasible in St. Croix. Recent reservoir-irrigation studies have suggested River, Jolly Hill, and Salt River areas as possible sites; but there are many discouraging factors. In each case only a small drainage basin is commanded, and the reservoir, of necessity located in a comparatively low-lying area and offering a large surface in relation to depth, would be subject to maximum evaporation. Besides, the potential area of cane land that might be benefited by such reservoirs is too small to justify the expense involved.

No less discouraging are the prospects for deep-well irrigation. Most geologists have reported adversely, and even those who are mildly encouraging suggest that such a supplement to natural precipitation will increase the moisture available for cane growing only by ten per cent of the total precipitation. A portion of the seepage from the northwest upland, where precipitation is heaviest, flows underground along the contact between a Tertiary basal conglomerate and the underlying Cretaceous volcanics and folded sediments. Wells sunk to this level will probably intercept the water, but even the ten per cent increase in moisture which may be recovered would not provide ample water for the sugar crop. Furthermore, the whole island is slightly tilted, and the limestone strata dip gently to the south. The dip increases materially the depth of the wells toward the coast; not many borings could tap the water-bearing horizon in less than three or four hundred feet. Once the water-bearing strata are reached, they will yield only the water that has seeped through

from the St. Croix drainage area; for the island rests on a high submarine platform that is separated from the other Antilles on all sides by very great depths. These facts afford little basis for any hope that the moisture for cane production can be increased adequately from reservoirs or deep wells.

Although there has been no advance in the control of the island's water supply, progress has been made in the control of insects and disease pests that prey on the cane. The St. Croix agricultural experiment station agronomist in his 1924 report indicated that the crop was comparatively free from disease,¹³ and, as no mention has been made of insect or disease damage in any following report, it may be inferred that though potentially a hazard such damage has actually been of little moment in recent years. The aridity that handicaps a flourishing cane growth is probably a factor in limiting the loss.

Transportation costs furnish another handicap for St. Croix sugar producers. Although the anchorage at Christiansted is in a basin protected from the sea by Long Reef and Scotch Bank, a tortuous channel leads through the reef. The basin can accommodate only shallow-draft vessels at a considerable distance from shore, and lightering is necessary. Frederiksted, the chief commercial town, is little better off. It is situated on an open roadstead, and deep-draft vessels can anchor at a short distance from shore. The amount of the island's commerce does not warrant the construction of a pier, and freight and passengers must be lightered to and from steamers just as they are at Christiansted.

UNFAVORABLE ECONOMIC FACTORS

To the physical handicaps certain economic handicaps are added. Labor has always given trouble to the sugar producers. It was important even in the early days when slave insurrections occurred; and the emancipation of the slaves in 1848 seriously crippled the industry for the time. The government of the islands, attempting to alleviate this handicap, created a condition of virtual slavery by means of contract and colonization systems, by the importation of cheap labor from the British West Indies, by drastic penal restrictions, and by the use of free rum. This situation existed until the close of the nineteenth century, when labor vigorously opposed existing conditions. Offered higher wages in outside areas, many of the laborers emigrated. Work on the Panama Canal and on the various Caribbean fruit and oil developments attracted some, and with the purchase of the island by the United States in 1917 the favorable emigration laws and a large demand for labor in that country accelerated the general exodus.

¹³ Maybin S. Baker: *The Sugar Industry in St. Croix, Rept. Virgin Islands Agric. Exper. Sta., 1924*, Washington, 1925, pp. 16-19; reference on p. 19.

During the World War the limited number of workers gained the "whip hand," and strikes brought them concessions. Shortage of help continued, in fact, as a problem until the coming of the depression. The class of labor, furthermore, is inefficient; and at the prevailing wage of twenty to thirty cents a day St. Croix labor is fully as expensive as that in the United States.

The small size of the sugar centrals further increases expenses. Limited capacities and failure to operate at capacity bring a high overhead charge in manufacture. Two of the three centrals have seasonal capacities of only 25,000 tons of cane, and the third is but slightly larger. These figures contrast markedly with those of Cuban and Puerto Rican plants, some of which grind from 8000 to 10,000 tons of cane a day.

The advent of prohibition aggravated the sugar situation. Before 1920 St. Croix had an important by-product in the manufacture of her well known rum. Even this advantage was lost. The many disadvantages from which St. Croix sugar suffers are partially compensated by the boon of tariff-free entrance to the continental United States, the world's greatest sugar market. Only by means of this advantage has the industry struggled through the last decade. Whether sugar will continue to dominate St. Croix's exports depends largely on the persistence of present price conditions. If markets remain depressed, the industry will probably decrease further.