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TRANSFERENCIA INTERREGIONAL DE TECNOLOGÍA BIOLÓGICA EN EL CARIBE

Repercusiones de la investigación de John R. Bovell en la industria azucarera de Puerto Rico, 1888-1920

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RÉSUMÉ

L'auteur analyse la contribution de John R. Bovell — des Barbades — a la variété et hybrides de la canne à sucre, à l'industrie sucrière de Porto Rico. Il soutient que l'industrie sucrière du pays évita la "maladie de la mosaïque" grâce aux recherches effectuées par Bovell sur nouvelles variétés de canne. Par ailleurs, on analyse dans ce texte les politiques de la South Porto Rico Sugar Company, corporation nordaméricaine du New Jersey qui embauchait des élèves de Bovelll — des blancs en provenance des Barbades —, dont la perspective sociale était comparable à celle des chefs locaux formés en Louisiane. L'auteur mentionne également Noël Deerr, chercheur respecté dans le domaine des études sur la canne à sucre dont l'auteur a découvert l'un des rapports. L'article, en conclusion, met en avant que le transfert tecnobiologique constitue une dimension des connexions existantes entre les circuits de l'industrie sucrière nordaméricaines et britanniques dans les Caraïbes.

SAMENVATTING

Het artikel analyseert de bijdrage van John R. Bovell, een onderzoeker van Barbados gespecialiseerd in suikerrietsoorten, aan de suikerriet industrie van Puerto Rico. De auteur meent dat de suikerriet industrie van Puerto Rico overleefde verschillende suikerriet ziektes dankzij zijn onderzoek over nieuwe suikerriet varianten. Het artikel analyseert vooral de politiek van de South Porto Rico Sugar Company, amerikaans eigendom van New Jersey, die het onderzoek van de suikerriet had bevorderd, en daarvoor leerlingen van Bovell had gehuurd. Deze blanken van Barbados hadden een soortgelijke visie als hun managers, die afkomstig waren Louisiana. Ook wordt de rol van de onderzoeker en historicus, Noël Deerr, geanalyseerd, vooral zijn bericht over de situatie van de suikerriet, dat door de auteur werd ontdekt. Het artikel concludeert dat de transferentie van biologische technologie een dimensie was van de contacten, die bestonden tussen de Amerikaanse en Britse suikerriet netwerken in het Caraïbisch gebied.

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INTERREGIONAL TRANSFER OF BIOLOGICAL TECHNOLOGY IN THE CARIBBEAN

The impact of Barbados' John R. Bovell's cane research on the Puerto Rican sugar industry, 1888-1920s[1]

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ABSTRACT

This article examines the contribution of Barbados' John R. Bovell's research on cane varieties and hybrids to the sugar industry in Puerto Rico. It argues that Puerto Rico's sugar industry survived mosaic disease thanks to his research in new cane varieties. Special attention is given to the policies of U.S.-owned South Porto Rico Sugar Company of New Jersey in promoting cane research by hiring Barbadian whites trained by Bovell, whose social outlook was similar to its Louisiana-born-and trained top management. Also highlighted is the role played by reputed sugar technologist and historian Noël Deerr, whose previously unknown report was found by the author. The article concludes that the interregional transfer of biological technology is one dimension of the connections that existed between the U.S. and British sugar circuits in the Caribbean.

RESUMEN

El autor analiza la contribución de John R. Bovell, investigador barbadense de variedades e híbridos de caña, a la industria azucarera de Puerto Rico. Sostiene que la industria azucarera de Puerto Rico sobrevivió a la enfermedad del mosaico gracias a las investigaciones de

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Bovell sobre nuevas variedades de caña. En especial, se analizan las políticas de la South Porto Rico Sugar Company, corporación estadounidense de Nueva Jersey que contrataba alumnos de Bovell, blancos procedentes de Barbados, cuya perspectiva social era similar a la de los ejecutivos nativos y educados en Louisiana. También se hace referencia al papel que desempeñó el respetado investigador de caña e historiador Noël Deerr, cuyo informe al respecto fue encontrado por el autor. El artículo concluye que la transferencia de tecnología biológica es una dimensión de los nexos que existían entre los circuitos azucareros estadounidenses y británicos en el Caribe.

This article discusses the interregional transfer of biological technology in the Caribbean sugar industry at the turn of the century, namely, the introduction of Barbados' cane varieties and hybrids to Puerto Rico. It outlines the history of the sugar industry in Barbados, emphasizing the leading role played by John Redman Bovell under Great Britain's Imperial Department of Agriculture of the West Indies. The latter part of the article focuses on the Spanish colony of Puerto Rico, discussing briefly the use of cane varieties in the fight against cane plant disease in the nineteenth century. The main part of the article deals with the importation of cane varieties and hybrids developed by Bovell and their impact on the eradication of cane diseases in U.S.-dominated Puerto Rico in the early decades of the twentieth century, specifically the mosaic menace, and the subsequent effect of these imports on sugar production. Government-private sector collaboration proved essential for the development of viable sugar industries in both Caribbean islands. This collaboration continued to provide a fundamental link in biotechnology between British and U.S. sugar circuits in the Caribbean.

The sugar industry is organized into two different kinds of activities: agricultural and industrial. The first includes the cultivation and harvesting of sugar cane; the other deals with the extraction of the juice from the cane and its conversion to crystalline sugar. In agriculture, the focus of this article, biological and chemical technology and processes are more central than mechanical technology.[2] Biological and chemical technology attempt to increase crop output per unit of land area. Two important elements in increasing crop production are: *(a)* the modification of the environment by adding organic and inorganic sources of plant nutrients to the soil to stimulate plant growth,

[2] This discussion is taken from Hayami & Ruttan (1971, 50-51).

and implementation of biological and chemical means to protect plants from insect pests and disease, and *(b)* selection and design of new biologically efficient crop varieties specifically adapted to respond to those elements subject to human control.

CANE VARIETY EXPERIMENTATION IN BARBADOS

Previous historical research has established that the main culprits of Barbados' sugar decline in the last 15 years of the nineteenth century were cane diseases, the fall in sugar prices because of the competition of European-subsidized beet sugar, and technological backwardness in sugar manufacture.[3] The sugar crisis led to the appointment of a Royal Commission in December 1896 to study the causes of the depression and the general condition and future prospects of the British colonies in the Caribbean. At that time, Barbados' dependence on sugar was unequivocal; the *Report of the West India Royal Commission*, issued in 1897, said: "In Barbados there is substantially but one industry, one product, and one export —that of sugar."[4] The Commission recommended the organization of a scientific department to assist the sugar industry.[5] The recommendation was immediately put into effect. In 1898, the Imperial Department of Agriculture for the West Indies was established with headquarters in Barbados. Its aims were clear:

> ...the general improvement of the sugar industry and the encouragement of a system of subsidiary industries in localities where sugar could not be grown, or where the conditions were more favourable for the production of cacao, coffee, bananas, oranges, limes, cotton, rubber, cacao-nuts, sisal hemp, rice, nutmegs, pineapples and other crops.[6]

In recognition of his research, the Imperial Department of Agricul-

[3] See Starkey (1939, 124-132); Richardson (1985, 31-44); Galloway (1989, 150-154); and Beckles (1990, 126-132, 136-142).

[4] *Report of the West India Royal Commission* (1897, 29). The industry employed 25.8 percent of the population. See *Report of the West India Royal Commission* (1897, *Appendix C. Part III, Barbados*, 200).

[5] *Report of the West India Royal Commission* (1897, 18-19).

[6] Morris (1911, 234). See also Watts (1920).

ture designated John Redman Bovell agricultural superintendent of cane field experiments in Barbados.[7]

A decade earlier, in 1888, Bovell and Dr. J. B. Harrison, Island Professor of Chemistry and Agriculture, demonstrated both the fertility of cane seed (with actual germination experiments) and the possibility of developing new cane varieties.[8] The confirmation of cane seed fertility came at a time when the old Bourbon variety had become highly vulnerable to fungus diseases. The substitution of the Bourbon by various forms of the Cheribon variety controlled the problem,[9] proving more resistant to the pests and diseases.[10] After the 1838 emancipation of slavery, Barbadian planters implemented several biological innovations, such as heavy application of local and imported fertilizers (particularly guano), planting cane in wide rows, and thrashing or mulching growing plants. Thus, suitable conditions for Bovell's cane research were present because Barbados, in the words of Richard Sheridan, had been "in the vanguard in adopting the new biological technology, [but] it lagged behind the other sugar colonies in introducing mechanical technology."[11]

The discovery of cane seed fertility opened the way for genetic

[7] John Redman Bovell was the eldest of fourteen children. His father owned a sugar plantation, Oxford, in St. Peter's, which he lost. In 1883, Bovell became superintendent of the Reformatory at Dodds and in 1886 he was also superintendent of the Botanical Station. In 1898, he was seconded from his post at Dodds to act as superintendent of Sugar Cane Experiments. In 1908, he was made superintendent of the Department of Agriculture of Barbados, and in 1919 director of the Department of Agriculture of Barbados. Bovell also conducted research on sea island cotton strains. He retired on 31 March 1925. See *Report of the Department of Agriculture*, (1924-1925, 1); *Louisiana Planter and Sugar Manufacturer* [hereafter cited as *LPSM*], 1929, 61; Hoyos (1972, 83-89); and Shepard (1996).

[8] Sugar cane seedlings were actually discovered in 1858, by Aeus Harper, of African ancestry, who pointed them out to J. W. Parris, owner of Highland plantation. Parris wrote an account in the *Barbados Liberal* on February 12 1859, stating that the seedlings were "of several varieties, including the Bourbon, Transparent, and Native" varieties of canes. No attention was paid to Parris' discovery until 1888, when overseer J. B. Pilgrim, following instructions from Bovell, informed him of a grass-like plant he could not identify. Almost simultaneous to Bovell's confirmation of the propagation of cane by its seedlings, Soltwedel of Java had the same results. See Parris (1954).

[9] Bourbon was introduced from Tahiti to Jamaica in 1793 and it rapidly substituted the Creole variety throughout the Caribbean. Bourbon produced higher yields of sugar per unit area of cane-piece than the Creole, its bagasse made a better fuel, and it matured more quickly. See Galloway (1989, 96).

[10] *Report of the West India Royal Commission* (1897, *Appendix C. Part III, Barbados*, 200); Stevenson (1965, 17-19); and R. W. Beachey (1957, 93).

[11] Sheridan (1989, 73-74).

improvement of the crop, starting in Barbados and continuing in British Guiana when Dr. Harrison moved there in 1890.[12] Working closely with sugar planters in Barbados, British Guiana and Antigua, Bovell developed new sugar cane varieties and their seed samples were sent to several experiment stations, including Audubon Park in Louisiana and Mayagüez in Puerto Rico.[13] By the early 1900s, Bovell had covered an ample field in the development of new varieties. He propagated several Barbados cane seedlings and hybrids, some of which, as the B.H.-10(12), proved resistant to cane diseases.[14] Eventually, he transcended cross-breeding for disease resistance and was breeding varieties suited to specific cultivation techniques, disease conditions, and soil and climate.[15] In 1911, Bovell claimed that for one estate in British Guiana, the profit from the introduction of new cane seedlings equalled more than the entire cost of the Barbados experiments over the previous 26 years.[16] That year, the first director of the Imperial Department of Agriculture, sir Daniel Morris, described the experiments as a

> ...great service to the planting community in the West Indies, and they have also been shared by other countries, such as the Southern United States, Australia, Natal and Mauritius. It is estimated that fully one-half of the canes now cultivated in the West Indies are new canes yielding over large areas mean results ranging from 5 to 10 and up to 25 per cent higher than the older varieties.[17]

[12] Dr. Harrison, who arrived in Barbados in 1879, held the positions of Government Analyst and Professor of Chemistry at Queen's College in British Guiana. (*Report of the West India Royal Commission*, 1897, *Appendix C. Part II, British Guiana*, 67, 128.)

[13] Bovell assisted other cane growing Caribbean islands. In 1899, he started the Skerrett's Training School in Antigua, and began cane experiments in Antigua and St. Kitts. In 1910, he was invited by the governor of St. Croix to formulate a scheme for a department of agriculture, which led to the establishment of an experiment station in the Danish colony and the start of St. Croix's own varieties from Barbados seedlings. In 1917, Bovell visited Guadaloupe and Martinique to report on the sugar industry, a service which led to the establishment of an agricultural experiment station in Guadaloupe.

[14] Cane varieties are denominated by a letter, indicating the birthplace of the cane or the name of its breeder and a number, the one from the list. P.O.J. stands for Proefstation Oost Java, H for Hawaii, B for Barbados, S. C. for Saint Croix, Co for Coimbatore, D for Demerara, P R for Puerto Rico, EK for E. Karthaus and so on. B. H. means Barbados hybrid. See Prinsen Geerligs & Prinsen Geerligs (1938, 4).

[15] Evenson, Houck Jr. & Ruttan (1970, 417-422).

[16] Morris (1911, 236).

[17] Morris (1911, 236).

Cane disease and hybrids in Puerto Rico

Sugar planters in Puerto Rico were no strangers to fighting cane diseases with new varieties. In 1870, a disease attacking root systems destroyed entire plantations in western Puerto Rico. The disease was first noticed at haciendas Carmen and Carolina in Mayagüez. Later, it spread to nearby municipalities.[18] Sugar exports through the Mayagüez port fell sharply from 27,511 hogsheads in 1872 to 10,000 hogsheads in 1877.[19]

As the disease ravaged the western area, the colonial government appointed a blue-ribbon commission to investigate. The commission surveyed 15 haciendas in Mayagüez, Cabo Rojo, Hormigueros, San Germán and Añasco in 1878. It found that they had dropped production by 35 percent, despite increases in area under cultivation, new canes planted, and very favorable climatic conditions.[20] The commission, unable to identify the cause of the disease, recommended an "indirect solution to the crisis," namely substitution of "the cultivation of Otaheiti [also known as Bourbon] with those other varieties known to be resistant to the disease and, above all, the immediate importation of new canes already tested in other sugar producing countries."[21]

Puerto Rican planters followed this advice. In 1879, several varieties were imported and sets distributed to the planters. In April 1880, noting the favorable results of cane varieties from the British colony of Trinidad, Mayagüez's provincial assembly approved the importation of varieties of Asian origin grown in the neighboring Antilles. In a 1887 issue of the *Revista de Agricultura*, Dr. Agustín Stahl advertised varieties that he himself had grown, including Creole, Bourbon, Imperial del Brazil or Calancana (Green Ribbon), Salangore rayada (striped Cheribon) and Cavangerie.[22] From 1893 to 1896, the experiment station located in Mayagüez, directed by local agronomist Luis Quintanilla, tested several cane varieties.[23]

In 1899, more than a year after the U.S. military invasion and

[18] See Ruiz Quiñones (1877).
[19] Stahl (1880, 15).
[20] Grivot Grandcourt, Stahl & Acosta (1878, 13).
[21] Grivot Grandcourt, Stahl & Acosta (1878, 53).
[22] See López Domínguez (1927, 84).
[23] Colón (1930, 120-124, 205-211).

subsequent cession of Puerto Rico to the United States, President McKinley's Special Commissioner Henry K. Carroll listened to Puerto Rican planters from western Mayagüez, eastern Yabucoa and southern Arroyo and Guayama who lamented bitterly on the effects of cane disease and pests.[24]

The first Puerto Rican Federal Experiment Station was established in Mayagüez in 1901. In subsecuent years, Director Dr. D. W. May initiated the introduction of new varieties in order to produce hybrids that would yield more tonnage per acre, and thus higher profits.[25] Immunity or resistance to disease and pests, high sucrose yield, good millability, and high adaptability to environmental and soil conditions were qualities necessary for successful new varieties.

The first imported varieties, among these D-74, D-95, D-117, T-77, B-347 and Yellow Caledonia, came to the island in 1904 from Audubon Park in Louisiana, while many came from the British Islands, particularly Barbados.[26] In 1906, the Federal Station started cane breeding, but stopped in 1910 when the Sugar Growers' Association established a sugar experiment station at the urging of sugar magnate Jorge Bird Arias. J. T. Crawley, former director of the Insular Experiment Station of Cuba, was named first director of the station, which was to study all phases of sugar production.[27] Its chief lines of work were soil analysis, the study and control of cane insects and diseases, the development of cultivation methods and finally, the production of new seedling varieties.

The Sugar Growers' Association experiment station did not last long, in part because of the 1913 free sugar menace, a short-lived crisis during which several *centrales* fell into receivership.[28] Others survived in precarious circumstances, but only three were able to maintain experimental farms.[29] In March 1914, the Sugar Growers' Association secured approval by the Legislature of a Joint Resolution transferring

[24] Carroll (1899, 85, 87, 89).
[25] Gardner (1903) and Porto Rican (1907, 364).
[26] May (1921).
[27] Crawley was joined by an entomologist, a pathologist, a chemist, and a station superintendent, all except one connected with the Audubon Sugar School of the Louisiana State University. See Crawley (1911, 31).
[28] See García Muñiz (1997, 127-137).
[29] U.S. Bureau of Insular Affairs, 1913.

the station, with the name "Insular Experiment Station," to the care of the Government of Puerto Rico.[30]

The South Porto Rico Sugar Company of New Jersey and the British Sugar Circuit

As the establishment of the Insular Experiment Station indicates, sugar companies had by this time become extremely interested in conducting scientific research on cane varieties. At that time no company in Puerto Rico was more interested than the South Porto Rico Sugar Company of New Jersey [hereafter referred to as SPRSCO/NJ], a U.S.-owned company with a subsidiary sugar factory, named Guanica Centrale, in the Guánica ward at the municipality of Yauco in southwest Puerto Rico. Guanica Centrale was the largest sugar factory in Puerto Rico from its construction in 1903 until its closing in the 1980s.[31] SPRSCO/NJ proved to be the most resourceful sugar company in Puerto Rico and perhaps in the Caribbean. The company kept abreast of the latest technological innovations in both field and factory, engaging itself at various times in different agricultural and manufacturing experiments. By 1911 it had not only acquired two other *centrales* in Puerto Rico (Pagán in the western town, Añasco and Fortuna in the southern town of Ponce) but had also expanded to the Dominican Republic. From 1913 to 1934, Guanica Centrale milled cane coming from La Romana, the only case in which cane from one sovereign jurisdiction was ever shipped to a colonial territory for milling. In 1918, SPRSCO/NJ built Central Romana in the Dominican Republic, then the largest sugar factory in the world, and in 1926 it purchased Ingenio Santa Fe in San Pedro de Macorís. In the 1950s, SPRSCO/NJ built another sugar factory, this time in Florida, USA, and a furfural plant in La Romana.

[30] Despite initial efforts to incorporate *colonos*, the Sugar Growers' Association was composed mainly of *centrales*, who supported the organization by a tax of so much per ton of cane ground. The transfer required the end of the Sugar Growers' Association, so another organization, the Sugar Producers' Association, was formed immediately. See *LPSM* (1914b, 391).

[31] For a detailed account of the firm from its incorporation in 1900 to 1921 see García Muñiz (1997).

SPRSCO/NJ brought Guanica Centrale's first top managerial personnel from the British sugar circuit. Its first operations manager, Harry Garnett, who served only one year, had been a planting attorney associated mainly with Curtis Campbell & Co. and Quintin Hogg, as well as manager of the Plantation Non Pareil in British Guiana in 1896.[32] Garnett left after one year to manage startup operations at Central Preston in the Nipe Bay, Cuba.[33] Apart from Garnett, it is difficult to locate top employees from the British Caribbean on the management side of sugar manufacturing, though a few held clerical positions, worked in the accounting department, or the factory.[34]

The British-Puerto Rican sugar circuit connection goes further and deeper, however. Puerto Rico's leading sugar central at the end of the nineteenth century, Central Canovanas, was owned by the London-based Colonial Company, which had acquired it in 1881, a year after its founding.[35] The Colonial Company's most important Caribbean investments were in British Guiana and Trinidad and Tobago.[36]

SPRSCO/NJ's connection with the British sugar circuit proved stronger and more continuous in the agriculture phase as "most of the men seemed to come from the British Caribbean."[37] Guanica Centrale's first cultivation manager, P. M. Todd, was born in St. Kitts in

[32] *Report of the West India Royal Commission* (1897, *Appendix C, Vol. 1, Part 1, Minutes of Proceedings*, 35) and Rodney (1981, 158). The *Louisiana Planter and Sugar Manufacturer* wrote he was "one of the best men in the sugar trade, having been a protégé of the late Quintin Hogg, the pioneer sugar operator in Demerara, British Guiana." *LPSM* (1909, 231).

[33] Later Garnett administered Central Trinidad, also in Cuba. He died in New Zealand, as administrator of an important estate in the Fiji Islands. See *The Porto Rico Horticultural News* (1909a, 9).

[34] For example, Douglas Murphy, who attended Combermere School and Harrison College, was employed by SPRSCO/NJ from 1910 to 1954. He started as file clerk and later became chief clerk in the accounting department. Mr. Murphy came to Guanica Centrale to visit Dudley Hutchinson, a Barbadian white working in the factory, and his wife, and was offered a position. See Murphy, D. (1983) and Murphy, I. (1983).

[35] See Giusti Cordero (1994, 445, 459-462).

[36] Starting in late 19th century, Scottish-born William Marr served as resident manager for more than 20 years. After graduating in mechanical engineering from Glasgow Tech, English-born Richard Brown came to work as Assistant Engineer in the 1880s. See *LPSM* (1923), Johnson (1972, 47-50), Haraksingh (1984, 133-145), Rodney (1981, 5, 26, 58, 68, 77), and Brown (1984b).

[37] Brown (1984a). Mrs. Dorothy Brown, born in 1899 in Westchester, New York, lived in the sugar town of Ensenada from 1908 to 1927. Her father, John Royalminns, was in charge of the company's bakery and restaurant, and she married Tom Brown, an engineer who came to work in the factory.

1875. His father, E. G. Todd, was manager of Buckley's Estate, owned by the absentee British peer, Earl of Hugh Mathew-Lannowe, and served as joint attorney of the proprietors of the Molyneux Estate.[38] One of his brothers was also linked to the sugar industry, working first as manager of the Molyneux Estate and later at the Colonial Company's Usine St. Madeleine in Trinidad in 1913. According to the St. Kittian historian Glenn Richards,

> The Todds were not plantation owners but formed part of the managerial class, who managed properties and acted on behalf of absentee proprietors. Consequently, though white, they were not considered fully part of the upper crust of society by the resident proprietary class.[39]

About 1907, Guanica Centrale contracted Charles T. Murphy and Henry Bourne, both white men from Barbados, to work with the U.S. Experiment Station in Mayagüez to breed and distribute new canes for its *colonos* or cane farmers.[40] The work was undertaken at two small experiment stations it had established, one in Santa Rita, midway from Guánica and Yauco, and the other in Hormigueros, south of Mayagüez. Guanica Centrale was also running experiments in the Ponce district. SPRSCO/NJ hoped that it could develop a more resistant cane variety with a higher sucrose content. By 1908, Murphy and Bourne were producing seedlings from several canes imported from Barbados, "among which were B-3412, B-3405 and B-376, exceptionally good canes for rolling canes."[41] In 1913, the Federal Station and Guanica Centrale were, according to Crawley, "producing seedlings, and judging by the success of this work in other countries, we have

[38] E. G. Todd had been appointed to important posts in the crown colony government of the island.

[39] Richards (1984, 2). Dr. Glenn Richards, historian at the University of the West Indies, kindly sent the valuable information above on P. M. Todd. Bryan King, solicitor and contemporary of P. M. Todd, said about the Todds: "They didn't quite count as plantocracy." King (1984).

[40] Guanica Centrale and the U.S. station collaborated continuousl ; not limiting themselves to cane varieties. Initially, they worked together on soil fertility research in Añasco and Yauco. As early as 1906, Dr. May wrote "the elimination of the infestation of the cane borer in new planting in some fields had been done, at the suggestion of Adrian Greif [Guanica Centrale's general manager], by soaking the cane before planting in a solution of lime water for 24 hours." May (1906, 392). Guanica Centrale cooperated also with the experimental sugar station established by the Sugar Growers' Association in 1910 on research to destroy the white grub.

[41] Richardson Kuntz (1930, 24). See also Earle (1921, 81).

every reason to believe that varieties will be found which will be suited to the soil and other local conditions."[42] Tests on cane varieties had significant success:

> ...they obtained practical results in their trials of varieties of sugar cane in the final selection of some of the foreign varieties and the creation in their seedplots of various new seedlings of magnificent qualities.[43]

Other *centrales* and interested parties did not take long to follow suit in the introduction of new cane varieties. In 1911, Ponce's Central Mercedita, a Puerto Rican-owned sugar factory, imported several Barbadian varieties, such as B-1809, B-3750, B-6293 and B-8660. That same year, the Fajardo Sugar Company, at the instigation of Jorge Bird Arias, established a nine-acre private experiment station, which served as a substation of the Insular Station.[44] The station was to study fertilizers, liming and cultivation, conduct planting tests; and study, record and test different foreign and local sugar cane varieties.[45] Harold J. Sewell, a *colono* in the Naguabo district, imported several soon-popular canes from J. W. Caldron, of Antigua. Some were the D-109, B-109 and St.Kitts Seedling, a variety of B-208, to which it reverted when grown in Puerto Rico.[46]

SPRSCO/NJ's connection with Barbados was a direct outcome of Bovell's cane research. Guanica Centrale employed several persons working directly with Bovell, among them Charles T. Murphy and Henry Bourne.[47] The group's expertise became well

[42] Crawley (1913, 289). Crawley stated that the Bourbon cane was practically the exclusive variety planted in former times in Puerto Rico and Cuba. A vigorous, healthy cane, with a fair percent of sucrose and high purity, it required rich, fresh soil and plenty of water. Because most of the land in Puerto Rico was impoverished by long cultivation, Bourbon was largely superseded by the striped cane, which was also common in Cuba, and later a considerable amount of Catalina was grown. Crawley added that many varieties of seedlings, particularly from Barbados, had been extended. These were B-208, B-347 and B-1753 and D-117.

[43] Colón (1923, 477).

[44] Central Plazuela and Central Aguirre established other substations. For an analysis of the experiences of Fajardo Sugar Company and other centrales in research in varieties and pest control see Giusti Cordero (1994, 616-617).

[45] See Veve (1930, 22-23).

[46] Sewell (1915).

[47] No information has been found on Murphy, except that he worked with Bovell in the early 1900s (Bovell & d'Albuquerque, 1902-1904). Bourne came to the employ of Guanica Centrale when he was in his mid-20s on Bovell's recommendation. Bourne

known.[48] But beyond scientific training in sugar cane, there were other clear advantages to hiring Barbadian whites to take charge of SPRSCO/NJ's agricultural divisions in Puerto Rico.[49] Barbadian whites were familiar with Caribbean terrain, climate, and society. As English was their native language, communication with the Louisiana-born and trained top management was easy. In addition, their attitudes concerning class, color and race were closer to those held by U.S. management than to those held by Puerto Rican management.[50]

At the turn of the century, a small white elite controlled Barbados' economic, social and political life. The number of Barbadian whites fell from 15,613 (8.6 percent of the total population) in 1891 to 12,063 (7 percent of the total population) in 1911.[51] In 1912, an American journalist said: "The race domination is frankly acknowledged. The island has always been and still is run for the whites — the 'better class whites'."[52] The "better class whites" were better equipped to withstand the prevailing sugar slump. But not so the white middle class, compelled to migrate due to lack of employment, just as numerous Barbadian blacks had been forced to do since abolition.[53] In the case of Barbadian whites, however, the phenomenon was described as the "compulsory parting" of white families:

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worked initially as assistant cultivation manager in Santa Rita, and later as cultivation superintendent in the Pagán division at the Añasco district. In the 1920s, he took over for a short time the experiment work in Central Palma in Cuba, but returned to work with SPRSCO/NJ, then with Central Romana in the Dominican Republic. Menéndez Ramos (1928, 82). Bourne published an article on varieties. See Bourne (1913).

[48] Louisiana-trained, Edmundo Colón, a Puerto Rican sugar expert, said Guanica Centrale "maintained for a long time competent men in charge of experiment projects which it has considered important for its business". Colón (1923, 477).

[49] SPRSCO/NJ also hired Barbadian whites to manage the agricultural phase of their operations in the Dominican Republic. Their contribution proved valuable as well, and will be discussed in another article dealing with Central Romana. Yet, their hiring proved very advantageous at the early period when a large percentage of black field and factory hands migrated from the British Caribbean colonies in the eastern Caribbean, including Barbados.

[50] For a contemporary description of the racial/color/class attitudes of the Barbadian whites see McClellan (1909, 45-49). A sociological analysis is presented in Karch (1979, 217-233). See also Richardson (1985, 44-52).

[51] Karch (1979, 122).

[52] Edwards (1912, 21).

[53] For an excellent article on the interrelationship of sugar, labor and technology see Engerman (1983).

> It must be remembered that the scarcity of good places for young men of the middle and upper classes is a serious problem, one of which numberless [sic] families come to grief and have to break up and be scattered to the four corners of the earth [...] they left because Barbados has nothing to offer them. They are exiles.[54]

THE MOSAIC MENACE

In 1909, five years before the identification of the mosaic outbreak that almost killed the sugar industry in Puerto Rico, Bovell himself was brought to Puerto Rico by SPRSCO/NJ to examine some diseased canes.[55] Guanica Centrale wanted him to look for "a remedy for a peculiar cane disease noticed among the plantations in the San German Valley."[56] They had reason to be concerned. In 1910, *The Sugar Planter's Journal* noted cane varieties in Puerto Rico were

> ...all at present affected by various diseases, and those that are of a variety hardy enough to resist disease are not sufficiently productive in quantity of cane to the acre or quantity of juice to the cane.[57]

By the 1911/1912 crop season, a general concern had developed among Puerto Rican planters concerning cane disease, pests, and their potential impact on sugar yields. The correspondent of the *Louisiana Planter and Sugar Manufacturer* suggested that greater interest in the subject likely engendered greater notice of the diseases.[58]

Sugar planters forecast a favorable season in 1914/1915 because of low world supplies and high sugar prices caused by World War I. Yet

[54] McClellan (1909, 48, 49).

[55] Bovell published a detailed description of Guanica Centrale. See Bovell (1911, 56-59). In 1903 Bovell was due to visit Puerto Rico to ascertain why Puerto Rican molasses were accorded preference over Barbadian molasses in the U.S. and Canadian markets, but did not travel because the crop season was over. See Commissioner of Agriculture (1903).

[56] *The Porto Rico Horticultural News* (1909b, 13).

[57] Undenburg (1910, 9).

[58] *LPSM* (1912, 246). In 1913, low yield in the experimental plot at Hormigueros led the chemist of the Insular Experiment Station to state that "the injury induced by the continuous cropping has been in its effect upon the biological condition of the soil, in accumulation of organisms causing cane diseases or in disturbing in some way the normal bacterial life in the soil." Gile (1913).

in 1915, an unknown sickness appeared in the northern town of Arecibo, surprising both sugar planters and the Federal and Insular Stations.[59] In November 1916, an Arecibo planter warned that "it is a serious matter and if this trouble is not checked, we shall have no cane within three years."[60]

The Insular Station rejected arguments that the disease was unknown, claiming, rather, that it resulted from the accumulation of infectious matter amid favorable conditions of climate and cultivation. Boom times, they suggested, had led planters to neglect and improperly care for and cultivate their fields:

> ...the high price of sugar has induced the planters to plant with cane all the land which they can count upon, and in this manner it is not possible to give to the land the intensive care which is so necessary for the successful cultivation of the lands which for such a long time have been cultivated in Porto Rico.[61]

Dismissing fears of a new disease or parasites affecting cane yields, the Insular Station issued new cane seed and urged planters to adopt better cultivation methods.[62]

During the middle of the crop season in March 1917, the *Louisiana Planter and Sugar Manufacturer* reported that "considerable losses have been sustained by cane growers in the north coast from Bayamón to Arecibo due to a portion of the cane cut being unfit for grinding [...] due to an unknown disease."[63] The pathologist at the Insular Station, John Stevenson, identified a peculiar mottling of the leaves as the one marked and constant symptom. He recommended experiments with new varieties, and also that planters use disease-free seed of more resistant varieties.[64] In a short note in *The West Indian Bulletin* however, Stevenson repeated the Station's bafflement:

[59] Chardón (1923, 531).
[60] *LPSM* (1916a, 362).
[61] *LPSM* (1916b, 362).
[62] *LPSM* (1913a, 23).
[63] *LPSM* (1917, 184).
[64] The Insular Experiment Station every year distributed about 300 tons of selected seed to cane growers. Among the varieties sought for their preservation qualities and high sucrose content was D-117, which seemed to be perfectly adapted to conditions in different parts of the island, having given excellent results at Guánica. Other varieties commonly requested were B-208 and D-109. See Stevenson (1917, 76-78) and *LPSM* (1916b, 362).

> No cause has been found for the phenomenon, either parasitic or environmental. It is now believed to be a type of degeneration possibly induced by a combination of unfavourable weather and poor agricultural practices.[65]

During dead season in September 1917, the Insular Station did an about-face. A disease of "a type never before described or studied" was reported spreading "for at least three seasons and was probably present for several years previous to the time when it was first reported."[66] The disease was not diagnosed as mosaic or yellow stripe *(matizado)* until 1918. By then, it had overrun almost three-fourths of the island's sugar area.

On December 6, 1918, SPRSCO/NJ General Superintendent T. D. Boyd Jr. told his executive committee that the "Pagan District showed the effect of the Mottling Disease."[67] He forwarded two reports on the disease to headquarters in New York: "Report on Resistance and Immunity, Experiment, Mottling Disease" by Henry Bourne and another on mottling disease by Cultivation Manager P. M. Todd.[68]

The mosaic disease prompted alarm both in government and planters' circles. In 1918, industry losses from the disease were conservatively estimated between $ 8 to $ 10 million.[69] That year, the U.S. Department of Agriculture, in cooperation with the Federal and Insular Stations, commissioned professor Frank Sumner Earle to investigate the mosaic disease.[70] Earle started testing varieties for resistance to mosaic. He undertook an extensive experiment with 171 varieties at Hacienda Santa Rita, in cooperation with Russell & Co., a SPRSCO/NJ cultivation subsidiary in Puerto Rico. Earle reported that Bourbon, Cheribon, Yellow Caledonia and Cavangerie varieties were all suscep-

[65] Johnston, Ashby, Bancroft & Stevenson (1917, 290).
[66] Stevenson (1917, 76).
[67] South Porto Rico Sugar Company (1918a).
[68] South Porto Rico Sugar Company (1918b).
[69] Amount calculated by Carlos E. Chardón, commissioner of Agriculture and Labor for Puerto Rico. This section on cane varieties is based mainly on Chardón (1927). Chardón, an expert in cane diseases at the Insular Experiment Station, had done research on the mosaic. See Chardón & Veve (1922).
[70] In early 1900s, Prof. Earle was director of the Agronomical Station at Santiago de las Vegas, Cuba, consultant agriculturist to the Cuban American Sugar Company, and president of the Cuba Fruit Exchange. After his official visit to Puerto Rico, he became associated with Central Aguirre in 1921, with the General Sugar Company of Sugar in 1923, and with the Tropical Plant Research Foundation in 1925. See Chardón (1930a).

tible to the mosaic disease. He judged "the situation so critical as to amply justify a legal enactment to prohibit [Bourbon] planting."[71]

By 1919, mosaic disease was appearing in Barbados, Cuba, the Dominican Republic, Jamaica, St. Croix, and Trinidad and Tobago.[72] Late that year, Guanica Centrale, in association with the other two large U.S. *centrales* in Puerto Rico, Fajardo and Aguirre, brought one of the world's most recognized sugar cane authorities, Noël Deerr, to investigate mosaic disease and its effects on the sugar cane industry.[73] Deerr's report was awaited eagerly.

Deerr arrived in Ensenada on New Year's eve, met with general manager French T. Maxwell, and was taken by cultivation superintendent P. M. Todd to haciendas at Guánica, San Germán and Yauco. Deerr also visited the fields of *centrales* Cambalache and Los Caños in Arecibo, where the disease was first discovered. He called at the Insular Station and found Earle immersed in his research.

After inspecting a large part of cane areas, Deerr concluded that "nearly the whole island is infected."[74] He suggested the disease was probably imported through infected varieties from the Tucumán Experiment Station in Argentina to the Federal Station in Mayagüez. He found the mosaic identical to a disease in Hawaii and the "Gelestrepenziekte" of Java.

Deerr set out a two-pronged approach to combat the disease, similar to Earle's recommendations: total eradication at the first signs of

[71] Earle (1921, 525).

[72] See Wakefield (1920, 200).

[73] Noël Deerr was born on December 30 1874, the youngest son of Rev. G. Deerr, vicar of Keresley, Warwickshire, England. He was educated at Danstone College, and at the City and Guilds of London Institute, a training college for technologists. From then on, he was employed in Demerara, Mauritius, Hawaii, Cuba, the United States and India. The author of several books on sugar cane, his best known work, *History of sugar* (Deerr, 1949-50), was written during his retirement at Oxford. Deerr had previous Caribbean experience in Demerara, now Guyana, and Cuba. His first engagement in the sugar industry was with the Colonial Company in Demerara from 1896 to 1901. From then, his fame spread worldwide both for his prowess as a sugar expert and for his articles on technical subjects related both to field and factory. After a stay in Hawaii, in 1914, Deerr spent several months in Cuba, appointed directly by President Mario Menocal as government's consulting expert on sugar agriculture and manufacture. Then he resigned to join the Cuba Company. See *LPSM* (1913b, 400), *LPSM* (1914a, 231), and *LPSM* (1914c, 265).

[74] Deerr (1921, 8). Deerr's report has gone unnoticed and was not found by this author in any library, but in the Private Papers of T. D. Boyd Jr., Louisiana State University Archives.

outbreak ("rogueing") and planting of immune varieties.[75] He noted "much progress has already been made in Porto Rico" to find resistant varieties, such as D-117, D-433, G.C.-1313, G.C.-701, G.C.-1.486, P.O.J.-56 and P.O.J.-234, thanks to work by Earle and the Guánica and Fajardo stations.[76] Deerr concurred with Earle that the plant to which "much interest is to be attached is that known as Kavangire and which should be called Uba. This cane is certainly immune." He was aware that Uba was "likely to arouse prejudice" in the milling side because

> It has a high percentage of fiber and its stalk is covered with an excessive quantity of wax. Its juices are hard to defecate and because of the wax trouble arises in the filter press station.[77]

Deerr suggested that Uba be planted in the areas of heavy mosaic infectation and, after the disease had been controlled, more productive varieties be planted.

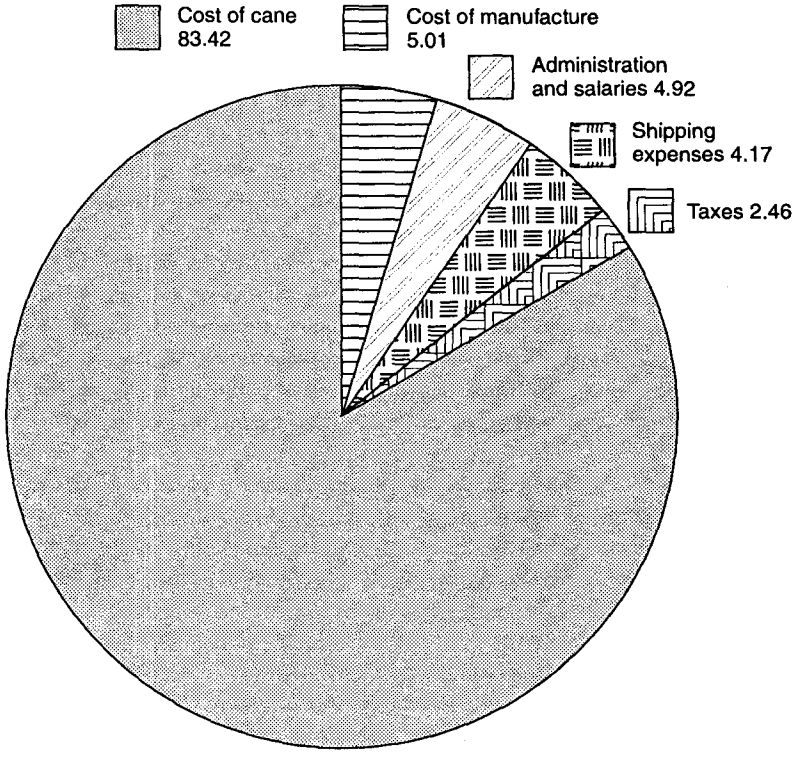
Despite the high sugar prices caused by World War I, Guanica Centrale faced a critical situation. Sugar price increases had been part of more general, spiralling inflation. In reaction, labor demanded and eventually obtained higher wages and bonuses.[78] In November 1918, a memorandum, probably written by Ross L. Page, a new employee in the cultivation department, called for measures to cut costs:

> But now what with increased cost of labor, scarcity of same, high cost of fertilizer, increased cost of fuel per pumping, and the new disease which tends to decrease the yield, I am convinced that it is absolutely obligatory to adopt ways and means to secure the present result with material decrease of costs.[79]

Lower costs for cane supplies were undoubtedly a priority, considering that cane was usually by far the largest production outlay. Cane costs accounted for 83 percent of production expenses in the 1919/1920 crop season. (See Chart 1.)

[75] See Earle (1920).
[76] Deerr (1921, 19).
[77] Deerr (1921, 20).
[78] To forestall field and factory labor stoppages in its fields, SPRSCO/NJ paid its workers a bonus from the 1915/1916 crop year to the 1918/1919 crop year. See García Muñiz (1997, 521-533).
[79] [Ross L. Page] (n.d.).

CHART 1. *SPRSCO/NJ's Total Cost of Producción in Puerto Rico, 1920*
(in percent)



SOURCE: Boycl (1920)

Of the U.S.-owned mills in Puerto Rico, mosaic disease affected only one, Guanica Centrale, whose lands, however, included almost a third of the island's coastal area and were almost all infected. (See Map 1). Disease and drought dramatically reduced the quality and quantity of the cane ground at Guanica Centrale. After testing Guánica mills, Henry A. Nadler, a factory superintendent at Central Romana, said "there is no doubt that the cane that comes into the Guánica mills is some of the worst that is met with throughout the sugar world."[80]

SPRSCO/NJ's Pagan Division in Añasco and the San Germán Valley suffered from severe infection from 1918 to 1922, the Guanica Division experiencing medium scale losses in 1922. Only the Fortuna Division in Ponce was beyond reach of the yellowish mottles. (See Table 1.) By affecting tonnage per acre, mosaic disease hit SPRSCO/NJ where it hurt most:

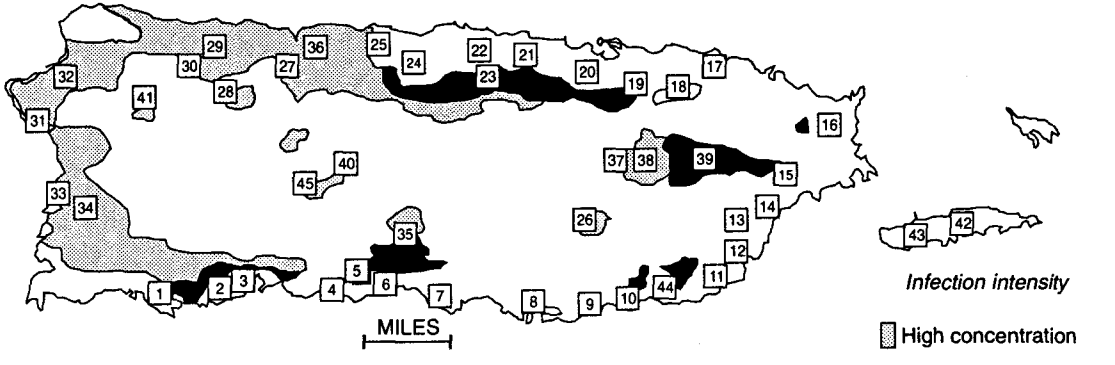
> In Porto Rico the problem is to secure the maximum amount of sugar per acre of land, and for that reason it is found necessary to plant a majority of the land each year, allowing only a very small proportion of the fields to ratoon, and then only for one year.[81]

By 1921, the disease had divided the island almost in half, one heavily infected and the other, less infected. (See Map 1) In 1922, Earle's experiment at Hacienda Santa Rita proved that Uba cane was immune to the mosaic, while other varieties such as P.O.J.-36 and P.O.J.-234 were quite resistant. His timely discovery impeded total disaster in the sugar industry, which also was suffering from a steep fall in prices. At the same time, Russell & Co. was experimenting with several varieties in the Añasco district: G.C.-1486, B-3412, B-6450, BH-10(12), P.O.J.-36, P.O.J.-213 (known as "Egyptian cane"), and Uba. Ross L. Page, Russell & Co.'s field manager, wrote that the future of Uba as a cane variety would ultimately depend on its output after grinding, but

> ...it is here to stay and will play a very important part in reestablishing the sugar industry in very large areas of the southwest portion of the island, where cane growing has been a complete failure in the last five years.[82]

[80] Nadler (1919).
[81] Boyd Jr. (1918).
[82] Page (1922, 25).

MAP 1. *Puerto Rico-mosaic infection at its highest in 1921*



Sugar Mills

1. Guánica
2. San Francisco
3. Rufina
4. Constancia
5. Mercedita
6. Boca Chica
7. Cortada
8. Aguirre
9. Machete
10. Lafayette
11. Columbia
12. Mercedita
13. Ejemplo
14. Pasto Viejo
15. Triunfo
16. Fajardo
17. Canóvanas
18. Victoria
19. Vannina
20. Juanita
21. Constancia
22. San Vicente
23. Carmen
24. Monserrat
25. Plazuela
26. Cambalache
27. Los Caños
28. Bayaney (closed)
29. Alianza (closed)
30. Soller
31. Plata
32. Coloso
33. Rochelaise
34. Eureka
35. Juliana
36. Cayey (closed)
37. Defensa
38. Santa Juana
39. Juncos
40. Pellejas
41. Playa Grande
42. Puerto Real
43. Córsica (closed)
44. Providencia (closed)
45. Santa Bárbara

SOURCE: Chardón (1927)

Thus, despite its relatively low sucrose content and difficult millability, Uba cane practically substituted all other varieties on the western coast starting in 1922. (See Table 1.) SPRSCO/NJ's was familiar with Uba and rapidly replanted.[83] Already by the mid-1900s, Guanica Centrale experimented with Uba seedlings given by the director of the Federal Station:

> It is, of course, a fact that cuttings of this famous cane were also sent by Mr. May to other planters, but with the single exception of Guanica no one gave them any care or attention. Seedling work was begun at Guanica at about the same time I took it up —1908— and they were practically alone in recognizing the value of the new canes.[84]

As the disease subsided by the mid-1920s, planters then began to switch from Uba and P.O.J. canes and to plant B.H.-10(12) and S.C.-12(4), both developed by Barbados' John Redman Bovell.[85] In 1919, Guanica Centrale and the Insular Station jointly imported B.H.-10(12). The Insular Station also imported S.C.-12(4). Bovell's contribution to the sugar industry of Puerto Rico was recognized in one of the leading technical publications of the time:

> Porto Rico has contracted a big debt with the grand old man Bovell for the production of these two new types of cane, with the planting of which our producing capacity of sugar per acre of our fields has improved considerably. Nowadays these two canes are the most popular in the whole island.[86]

Ponce's Central Mercedita, which claimed to have imported B.H.-10(12) as early as 1917, realized first the importance of both varieties. Mercedita boasted that its record for 1920/1921 was

> ...the highest we have been able to obtain and is a matter of some pride to us [...] the cost of planting cane in Porto Rico is so high that it is not profitable to plant any but those varieties giving the highest sucrose content.[87]

[83] Ríos Laviena (1923, 31).
[84] Earle (1921, 79).
[85] S.C.-12(4) bears the name "Saint Croix" instead of the B for "Barbados" because it was a gift given by Bovell to the Danish colonial authorities in a visit in 1912. See Chardón (1927, 19).
[86] Richardson Kuntz (1930, 25).
[87] Giles (1921, 331, 332).

TABLE 1. *Cane harvested in various properties of Russell & Co. and Ground at Guánica Central, years 1917-1926*
(Courtesy of F. T. Maxwell)

	Fortuna Division			*Guánica Division*		
Year	*Acres*	*Total Tons*	*Tons per acre*	*Acres*	*Total Tons*	*Tons per acre*
1917	5,035.81	160,642.34	31.90	3,817.00	137,068.47	35.91
1918	4,962.69	144,712.04	29.16	3,764.25	110.631.31	29.39
1919	5,095.24	144,297.20	28.32	3,706.75	110,349.95	29.77
1920	4,660.13	98,981.16	21.24	3,451.00	84,791.07	24.57
1921	4,994.24	137,041.95	27.44	3,269.25	87,125.51	26.65
1922	4,908.61	114,665.13	23.46	3,385.25	70,616.32	20.86
1923	4,974.15	109,729.75	22.06	2,292.45	51,442.58	22.44
1924	5,265.11	137,366.72	26.09	1,644.50	38,431.97	23.37
1925	5,354.01	197,670.05	36.92	1,451.50	57,581.01	39.67
1926	5,485.35	194,839.63	35.32	1,558.25	60,834.08	39.04
Remarks	Irrigated Area No mosaic infection. Mostly "Cristalina" from 1917 to 1923. B.H. 10 (12) and S.C. 12 (4) the basis for 1925 and 1926 crops.			Irrigated Area Medium mosaic infection in 1920 and 1921. Heavy mosaic in 1922, but vigorous "rogueing" practiced. No disease from 1924 to date. B. H. 10 (12) and S.C. 12 (4) the basis of 1925 and 1926 crops.		

*SOURCE: Chardón (1927, Appendix II).

Pagán Division			*San Germán Valley*		
Acres	*Total Tons*	*Tons per acre*	*Acres*	*Total Tons*	*Tons per acre*
3,168.00	51,448.32	35.91	2,762.97	43,599.67	15.78
2,885.95	36,481.83	29.39	2,681.65	31,348.49	11.69
2,647.85	29,841.27	29.77	2,028.38	21,419.69	10.56
2,264.40	28,350.29	24.57	2,009.96	31,073.98	15.46
2,224.27	27,580.95	26.65	2,384.86	31,551.70	13.23
2,050.55	31,373.42	20.86	1,971.87	19,876.45	10.08
1,724.15	42,552.02	22.44	1,999.54	33,012.25	16.41
2,773.69	82,766.91	23.37	2,242.13	54,964.51	24.51
3,226.82	85,478.46	39.67	2,574.78	75,930.26	29.49
3,192.67	85,308.14	39.04	2,619.01	62,122.92	23.72
Non-irrigated Area Heavy mosaic starting in 1918 clear through 1921. Uban began to be extended in 1922 and was the basis of last four crops.			Non-irrigated Area Heavy mosaic starting in 1918 clear through 1922. Later changed to Uba.		

SPRSCO/NJ was the company best prepared in Puerto Rico to face the mosaic menace. Early in the 1900s, the Barbados connection served to establish experimental fields, where tests were conducted with seed canes, foreign varieties, and chemical and green fertilizers.[88] The importance of this work is attested by the fact that Guanica Centrale was the first Puerto Rican-based *central* to develop its own varieties, classified with the letters G.C.:

> ...they obtained practical results in their trials of varieties of sugar cane in the final selection of some of the foreign varieties and the creation in their seedplots of various new seedlings of magnificent quality.[89]

SPRSCO/NJ also used fertilization extensively and the latest methods of steam and gasoline tractor plowing.[90] E. Graywood-Smith, the entomologist at the Insular Station, acknowledged that Russell & Co.'s "intensive methods of cultivation employed" checked "a very considerable decrease in tonnage."[91]

THE BARBADOS CONNECTION

Barbados-born and -trained white men continued to play an important role in cane biotechnology. In 1920, SPRSCO/NJ employed Ernest H. Barrow, a graduate of Combermere School.[92] Barrow had worked for Bovell during the preceding 14 years.[93] In his recollections, Barrow

[88] Central Fajardo also established its own experimental station; the head was St. Vincent-born R.C. McConnie. See *LPSM* (1916b, 362), and McConnie (1994).

[89] Colón (1923, 477).

[90] A larger proportion of land in Puerto Rico was prepared with power plows than in Cuba. In Puerto Rico, heavy machines were preferred to the lighter, because soils on the north or rainy side of the island were heavy, containing a large percent of clay and on the south side, the need for irrigation also created a preference for heavy outfits. See Crawley (1916, 27).

[91] Graywood-Smith, the entomologist at the Insular Experiment Station, made the investigation at the request of the Guanica Centrale's general manager, French T. Maxwell. See Graywood-Smith (1920).

[92] By the 1890s, Combermere School had become famous as a commercial school. Because of the prolonged economic depression some planters and merchants sent their sons to Combermere. Yet, the school catered mainly to "children of lower middle-income whites but had already begun to provide middle-class black children with secondary education." Sandiford & Newton (1995, 18).

[93] In 1914, Barrow appeared as assistant in charge of nurseries. The next year, he

claims that, while in charge of the Experiment Station at Codrington in 1918, "I produced one of the best sugar cane varieties that Barbados and Puerto Rico have ever grown, B.H.-10(12), a Barbados hybrid."[94] Barrow was put to work in SPRSCO/NJ's cane variety experiments in the Guanica District, where he reduced the mosaic infection from 95 percent to less than one percent.[95] In 1924, another of Bovell's assistants, Merivale Owen Proverbs, who was in charge of sugar cane experiments, resigned his post to accept a field position with SPRSCO/NJ.[96]

Guanica Centrale eradicated mosaic by the mid-1920s and significantly boosted tonnage per acre beyond pre-disease levels. (See Table 1.) The planting of B.H.-10(12) and S.C.-12(4) varieties caused the leap in Puerto Rico's total production from 447,000 tons in 1924 to 866,000 tons in 1930, "with no material increase in acreage."[97] Still, some areas, mainly of Puerto Rican-owned *centrales*, remained heavily infected as late as the 1930s because of delays in planting new varieties. These included fields in north-central region such as Caguas, Juncos, Las Piedras, San Lorenzo and Humacao and from Bayamón westward to Arecibo.[98] During the 1930s, the mosaic was defeated, but the B.H.-10(12) fell prey to the moth borer, and it was substituted by the P.O.J.-2878.[99]

To conclude, both the United Kingdom and United States governments established experiment stations to improve the cane varieties cultivated by planters in their respective colonial territories. Barbados became the Caribbean's most advanced center for cane breeding. Planters throughout the Caribbean — in independent states or under the jurisdiction of other colonial powers — called on Bovell for assistance in times of crisis. Noted Cuban sugar historian, Manuel Moreno Fraginals, sees the discovery of cane seed fertility and the development of cane varieties as "the most significant revolution of the

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moved up to second field assistant, where he remained up to 1918. See Barrow (n.d.a), and *Report of the Department of Agriculture* (1914-1915), *Report of the Department of Agriculture* (1915-1916), *Report of the Department of Agriculture* (1916-1917), and *Report of the Department of Agriculture* (1917-1918).

[94] Barrow (n.d.b).

[95] See Barrow (1921, 6) and Cheesman (1990, 79).

[96] *Report of the Department of Agriculture* (1923-1924, 1).

[97] Chardón (1930b, 6).

[98] Richardson Kunz (1930, 28).

[99] Giusti Cordero (1994, 619-622).

century as far as sugarcane is concerned."[100] Bovell's work served as the foundation for further research in the productivity of sugar cane:

> It is largely this genetic work — though increased use of fertilizers, pest and disease control, and better extraction methods also contributed — which during the century from 1850-1950 caused the yield of cane-sugar obtainable per acre to rise tenfold, an achievement probably not matched by any other crop in the world.[101]

Under U.S. dominance and within the U.S. market, American companies in Puerto Rico, particularly SPRSCO/NJ, led the way in sugar cane research in the Hispanic Caribbean.[102] To be a profitable business, SPRSCO/NJ broke the traditional Caribbean metropolitan colonial arrangements and reached for Barbadian biological technology. It established a Barbados connection, planting Bovell's cane varieties, calling for Bovell's advice, and employing Barbadian whites trained by Bovell to take charge of the company's research and cultivation efforts. The "varietal revolution" dramatically increased yields per acre, offsetting land constraints that had traditionally limited agricultural expansion. Guanica Centrale's production doubled and tripled a decade after the mosaic disease, with a record of one million tons of cane ground attained in three consecutive crop seasons, 1931/1932, 1932/1933, and 1933/1934. This yield increase due to new sugar cane varieties was the result of an intra-regional transmission of biological technology. On spot-research led to disease-resistant, higher yielding seed varieties adaptable to local ecological conditions.

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[100] Moreno Fraginals (1990, 129).
[101] Masefield (1972, 82).
[102] It seems that sugar cane research in Cuba during the early 1800s was limited to experiments carried out in United Fruit Co.'s Central Banes and Edwin F. Atkins' Central Soledad. Atkins sent the reports of the Harvard Experiment Station in Cienfuegos to *The Agricultural News* in Barbados. See Sugar Industry (1905, 146) and (1906, 162). No experiments were conducted in the Dominican Republic until the 1920s.

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