

*NOT* FOR “WANT OF GO-AHEADISM” IN FIELD AND FACTORY:  
THE TECHNOLOGICAL TRAJECTORY OF THE GUYANA (BRITISH GUIANA)  
SUGAR INDUSTRY FROM 1800 TO THE 1930s

A Dissertation

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Allyson Ann Marie Stoll

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Allyson Ann Marie Stoll, Ph. D.

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British Guiana was an anomaly among British Caribbean sugar colonies during the nineteenth century. Annual exports exceeded those of its island counterparts and it became well-known for ‘Yellow’ and ‘Demerara Crystals’, two high-quality specialty sugars. Production rose steadily throughout the century despite persistent setbacks and impediments.

While larger plantations and a more amenable cultivation environment were conducive to relatively higher output, mitigating other geographical limitations demanded more capital and labor than on the islands. The limitations might have constrained British Guiana’s productive capacity more severely had it not been for a culture of technological innovation that is largely unacknowledged in extant literature.

The primary questions underlying this inquiry into the historical technology of the sugar industry of British Guiana are: what were the socio-economic and political underpinnings of its nineteenth century modernization thrust? How were the cane fields and sugar factories transformed and to what extent was technological change conditioned by local innovation and invention?

Fundamentally, despite allegations, there is little evidence of inertia, rampant conservatism and incompetence. Instead, notwithstanding various constraints, the industry showed remarkable persistence and creative variation in its efforts to improve agriculture and factory processing during the period under review.

## **BIOGRAPHICAL SKETCH**

Allyson Ann Marie Stoll was born in Essequibo and educated at Central Preparatory and St. Rose's High schools in Georgetown, Guyana. She gained an undergraduate degree in History at the University of Guyana and received the Elsa Goveia Medal of Excellence for the Best Graduating History Major and the Vice Chancellor's Award (shared) for the Best Graduating Student in the Faculty of Arts, in 1999.

Ms. Stoll was awarded a LOME IV/European Union scholarship and completed the Masters degree in Monument Preservation and Cultural Heritage Conservation at Universidad Nacional Pedro Henriquez Ureña, Dominican Republic, in 2001. She served as Conservation Officer at the National Trust of Guyana prior to enrolling at Cornell.

This work is dedicated to

**Rita Bernadette Stoll**

Who raised me with much love, humor and generosity.

Her attention to history is the foundation of my academic journey.

In memory of

My grandparents

**Joseph Charles Stoll (1901-1987)**

**Emelia Theresa Stoll (née Correia-Cabose, 1906-1992)**

Formerly of Newport's Profit, Pomeroun River

And my aunt

**Romona Philomena Stoll (1942-2006)**

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## PREFACE

As an undergraduate history major I was drawn to material on colonial Guyana—illustrated rare books and maps, especially—all with references to the sugar industry. My graduate research remained focused on the colonial era and I studied eighteenth century fortifications that protected early plantations under Dutch rule.

A stint as Conservation Officer at the National Trust of Guyana nurtured my budding interest in the material legacy of sugar still visible throughout the coastland. I saw, however, that while our historiographical tradition had substantially unraveled socio-economic and political linkages between colony and sugar, the technology story remained untold. Sugar had triggered the movement of thousands—forced, coerced and willing—to Guyana and, though Demerara Sugar and rums are well-known, the history of production remained a mystery to many, including me. While I had studied the plight of sugar-workers and knew the names of the Devonshire Castle and Enmore Martyrs, there were few accounts of the technological accomplishments. I wanted to know, for example, what was going on in the factories and fields when the workers were not on strike.

This dissertation is, accordingly, especially attentive to the built environment of sugar, to the technology housed within the buildings and, particularly, to the manner in which the techniques of converting cane juice into sugar crystals evolved during the nineteenth century in Guyana. As this work is essentially a history of sugar technology, I familiarized myself with equipment and industry jargon by correlating historical and contemporary accounts, mainly the *Cane Sugar Handbook* (Chen and Chou: 1993), *The Sugar Cane Industry* (Galloway: 1989); *The British West Indies in the Late Nineteenth Century* (Beachey: 1957), and *The Practical Sugar Planter* (Wray: 1848), among others. Several key treatises by the eminent sugar historian Noel Deerr—*History of Sugar* (1949 and 1950); *Cane Sugar* (1921); *Sugar and the Sugar*

*Cane* (1905), included—were core readings. Works by nineteenth century residents of the colony— *A Manual of Plantership in British Guiana* (MacRae: 1856), *Demerara After Fifteen Years of Freedom* ([Brumell]: 1853) and *Eight Years in British Guiana* (Premium: 1848), were especially informative as was *Timehri*, the journal forum for sugar planters, scientists and technicians from the 1880s.<sup>1</sup>

Summarily, my intent here is to isolate details of the production cycle initiated by persons resident in or associated with British Guiana. I also sought elements that add to the labor versus technology debate and highlight intersections of technology, ecology, and the international sugar economy. Reconstructing disparate elements of the fast-evolving sugar technology was a tedious but exceptionally rewarding task and I am solely responsible for inconsistencies, omissions or errors in this dissertation.

Throughout this work I employ the terms “Guiana planter” and “Guianese worker” simply to acknowledge subjects who self-identified as residents of British Guiana (often ‘Demerara’ in the case of patentees), and in instances where it was likely that the subject had been born in the colony or survived enslavement and/or indentureship.

Some aspects demand additional research. I have not delved deeply into the linkages between the sugar industry and increased importation of fuel oils such as kerosene at the end of the nineteenth century, nor have I chronicled the factory electrification drive that also began at the end of the century. I summarize rum-making and molasses production as adequate studies of these important by-products would constitute other theses. Comparisons of Guyana’s industrial trajectory with advances in Cuba, Mauritius and Louisiana, for example, would enhance knowledge of how

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<sup>1</sup> Complete bibliographic details are given in the **REFERENCES** and in footnotes.

sugar science and technology diffused worldwide and on the ecological impacts of sugar-making, another aspect of the sugar story that demands further research.

Above all, this study is driven by motives of historic preservation and heritage conservation and the need to articulate a departure point for future studies on the material legacy of sugar in Guyana. I hope that some of my research could be incorporated into a re-telling of our national history that is more inclusive of details of our once-celebrated industrial past.

## INTRODUCTION

### FRAMEWORK AND OVERVIEW

#### **The British Guiana sugar industry to the nineteenth century**

British Guiana entered the world sugar trade during the seventeenth century. Jewish evacuees from neighboring Brazil—with prior experience in sugar-making—established a few plantations along the banks of Pomeroon and the Moruca Rivers in the 1650s.<sup>2</sup> The fledgling Dutch-administered colony flourished, exporting more than 60,000 pounds of sugar to Amsterdam during its heyday in 1661. However, the plantations were destroyed by English privateers between 1665 and 1666 and new settlers confined themselves to the upper reaches of the Essequibo and Berbice Rivers.<sup>3</sup> The colonists focused on trading with the Amerindians and sugar exports became infrequent.<sup>4</sup> Cane was the preferred crop up to the early eighteenth century but the settlers also tried cotton, coffee, cocoa, indigo and rice. Cotton cultivation rose steadily, especially towards the end of the century.<sup>5</sup>

Development was slow owing to repeated raids by the English and French, skirmishes with the indigenous people and neglect and mismanagement by the Dutch authorities in charge of colonization, namely the Dutch West India Company and the Berbice Association.<sup>6</sup> Subsequently, liberal policies adopted by Commander Laurens Storm van's Gravesande—appointed for the Essequibo colony in 1743—fostered

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<sup>2</sup> Mordechai Arbell, "The Jewish Settlement in Pomeroon/Pauroma (Guyana) 1657–1666", *Revue des études Juives*, CLIV (July - December 1995), 343–361; Samuel Oppenheim, "An Early Jewish Colony in Western Guiana 1658–1666 and Its Relations to the Jews in Surinam, Cayenne and Tobago", *Publications of the American Jewish Historical Society*, No. 16 (1908), 57-67; James Rodway, *History of British Guiana* (Georgetown: J. Thomson, 1891), I, 5-6; Alvin O. Thompson, *Colonialism and Underdevelopment in Guyana 1580-1803* (Bridgetown: Carib Research and Publications Inc., 1987), p. 30.

<sup>3</sup> Rodway, I, 6.

<sup>4</sup> Dutch traders bartered for annatto dye, letterwood, balsam copaiba, vanilla beans and hammocks from the Amerindians and gave them iron pots, tools, cutlery, fish hooks beads and other trade goods. Rodway, *History of British Guiana*, I, 50.

<sup>5</sup> Thompson, p. 35.

<sup>6</sup> See Rodway, I, Chapters 1 to 4; Thompson, Chapter 2: El Dorado and Early Colonization.

settlement along the Demerara coast and Dutch colonists were supplanted by newcomers from the Caribbean—mainly British Caribbean planters—after the 1740s.<sup>7</sup>

European rivalry and ensuing wars caused Demerara, Essequibo and Berbice to pass between Dutch, English and French rule in the closing years of the eighteenth century but by the end of the century the potential for profitable agriculture along the Atlantic coast was evident. After final cession Britain in 1814, there was an influx of migrants from Barbados, Antigua and St. Kitts, mainly.<sup>8</sup> Planters from adjoining Essequibo and Berbice were also enticed with favorable settlement terms, the prospect of cultivating virgin soils and importing plantation goods from Britain, duty-free.<sup>9</sup> Between 1824 and 1833, the colony was galvanized by considerable investment from Britain and became its principal colony in South America. Demerara emerged as the leading sugar producer among the three conjoined colonies.

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<sup>7</sup> Rodway, I, Chapter 5; M. Shahabuddeen, *From Plantocracy to Nationalisation A Profile of Sugar in Guyana* (Turkeyen: University of Guyana, 1983), p. 26. Although the colonists had been involved in sugar-making in Brazil, they were unsure what variety of cane would suit local soils. (Shahabuddeen, pp. 10-12) The Barbados sugar industry got its start with cane imported from Dutch-ruled Essequibo in 1626-27 although commercial production dates to the 1640s. (Charles Lucas, *A Historical Geography of the British Colonies* (Oxford: Clarendon Press, 1890), II, 178 and 268; James H. Stark, *Stark's History and Guide to Barbados and the Caribbee Islands* (London: Sampson Low, Marston & Co., Limited, 1903), pp. 62-63; David Watts, *The West Indies: Patterns of Development, Culture and Environmental Change since 1492* (Cambridge: Cambridge University Press, 1987), p. 177. Industrial production began in 1635 on Guadeloupe and Martinique, on St. Kitts in 1643 (by the French), and in 1664 in Jamaica. (*La Sucrière Indigène et Coloniale*, No. 1, LV (1900), 86.

<sup>8</sup> At the end of the Napoleonic Wars in 1814, Britain kept Demerara, Essequibo and Berbice, St. Lucia and Tobago, and returned Suriname to the Dutch in 1816. From the 1740s Dutch Commander of Essequibo Laurens Storm van's Gravesande had actively encouraged British settlers, from Barbados, especially, to come to Essequibo and Demerara. (P. M. Netscher, *History of the Colonies Essequibo, Demerary & Berbice from the Dutch Establishment to the Present Day*. Trans. from Dutch by W. E. Roth (s'Gravenhage: 1888; reprint edition; Georgetown: 1929), pp. 115-18, and 128-30; and Robert H. Schomburgk, *A Description of British Guiana* (London: Simpkin, Marshall, and Co., 1840), p. 76.

<sup>9</sup> New colonists were given land free of charge in Demerara, exempted from paying taxes for ten years and allowed to import enslaved people and personal effects. Rodway, *History of British Guiana*, I, 105; Noël Deerr, *History of Sugar* (London: Chapman and Hall, 1949), I, 161-62. Supplies were ordered through British merchants. North American products—mainly salted fish, beef and pork, construction lumber, staves, shingles, tobacco, flour and rice—came via St. Thomas or from Canada.

## Research lacunae

The labors of the British Guiana (now Guyana) sugar industry to improve its technological practices in the nineteenth century are essentially unresearched and unappreciated.<sup>10</sup> While the stimuli for local expansion—opening up of additional plantations by experienced new migrants, emerging markets and increased competition from other colonies and from beet sugar—are acknowledged, there is insufficient attention to the role of technology in sustaining the colony’s anomalous presence on the world stage as sugar production in other British Caribbean territories declined.

A cursory examination of the statistics confirms that, relative to the islands, Guiana was the primary British Caribbean exporter of sugar from the 1840s onward. Further, the colony’s progress is noteworthy, coinciding with the transition from enslaved to free labor and *moreso* as modernization overlaid periods of trade liberalization and the elimination of imperial trade concessions previously granted to the colonies.

While a few studies have highlighted the atypical trajectory of Guiana’s sugar business amidst regional malaise, the tendency has been to homogenize the colony’s production within a broader ‘West Indies’ story of decline that negates local agency and accomplishment. To date there are no comparative studies that address Guiana’s technological linkages with other colonies and with the wider Atlantic ‘sugar world’, aside from cross-referencing in trade literature. Alternating production surges and lags are explained within purely socio-economic or political parameters that, with few

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<sup>10</sup> Guyana, an independent country since 1966 and a Republic from 1970, comprises three counties, Demerara, Essequibo and Berbice. Formerly the counties were separate but adjoining *colonies* ruled by the Dutch from the beginning of the seventeenth century, ceded to the British in 1814 and united in 1831 as British Guiana. In this work ‘British Guiana’ and ‘Guiana’ apply interchangeably to the colonial period up to 1966. Individual colony names are used when referring to the pre-1831 period.

exceptions, overlook technological factors. Further, few analyses co-relate the combined effect of local climate, topography, and technology on output.

Reasons for the subsumation of the technology story lie partly with the historical divide between labor and the British Guiana planters in the literature. Owners of plantations, their representatives and minions were assigned to a sub-group labeled the ‘plantocracy’, the politically-charged term denoting a historically reviled group, the promoters of the enslavement of Amerindians and Africans and architects of its equally odious replacement, ‘indentureship’, often deemed the ‘new slavery’.<sup>11</sup> Extant scholarship on sugar has dwelled on the sins of the plantocracy and transferred the stamp of tyrannical elitism to its successor - the corporate sugar oligarchy whose domination continued after independence from Britain in 1966 and only waned after privately-owned estates were nationalized in 1976.

The plantocracy and its ostensible control over sugar technology symbolize an obvious but unacknowledged historical counterpoint that is addressed in this dissertation. Summarily, this research seeks to discover whether themes of survival and progress are reconcilable within the purview of an avowed exclusionary and oppressive despotism founded in sugar. Could planter-villains, the enslaved and contract workers all have played decisive roles in stimulating a mode of production that produced world-famous ‘Demerara’ sugars? The argument for which this dissertation seeks some resolution retains another fundamental discontinuity. How did the plantocracy engineer its survival in the face of economic decline and persistent crises that permeated the nineteenth century?

There is a dearth of studies that address longstanding allegations of backwardness prevalent in contemporary assessments of Guiana’s colonial sugar

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<sup>11</sup> ‘Indentureship’ is described in **CHAPTER 1**, this dissertation.

industry.<sup>12</sup> Claims of financial miserliness and scientific apathy on the part of the planter class and its supposedly incompetent enslaved and indentured work force conflict with evidence of progress and modernization. Evidence of achievement and the fact of the colony's long engagement with sugar-making allude to the likelihood that it may have been a hub for agricultural and industrial innovation that prompted world-wide changes in cultivation and manufacturing. These issues invite revisionist attention as do undocumented but significant milestones of the technology story that encompass specific inventions.

Finally, increasing attention to the need for preserving Guyana's sugar patrimony highlight other conspicuous lacunae - the absence of documentation on the legacy of the production sites identified as critical to an emerging heritage tourism.<sup>13</sup> Detailed investigation and analysis of the trajectory of sugar technology therefore fills a significant gap in the history of technology in Guyana, in discourse on technical aspects of sugar production, and as an additional interpretive instrument for re-evaluating Guyana's discordant history.

### **Temporal parameters**

This dissertation assesses over one hundred years of sugar-making in colonial Guyana. I examined the record of field techniques and factory methods between 1800 and the 1930s, the period during which many significant changes occurred. Specific applications of technology are considered for their own merit and as elements of a protracted cycle of introduction, refinement, innovation and diffusion that was a defining characteristic of the nineteenth century and beyond

The chronological parameters enclose other noteworthy transitions, namely, the British takeover of the former Dutch colonies of Demerara, Essequibo and Berbice

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<sup>12</sup> This theme is addressed in **CHAPTER 5, THE CHARGE OF "WANT OF GO-AHEADISM...."**.

<sup>13</sup> Editorial, "Historical Tourism." *Stabroek News*, 22 October 2008.

in 1814, the unification of the three as British Guiana in 1831 and the shift from enslaved to free and indentured labor that lasted from 1807 to 1838, and the beginning of the resistance to imperial rule following the loss of favored colony status in the 1840s. The study ends at the 1930s, the period during which the sugar industry and British Guiana, now wholly dependent on its sugar revenues, suffered the effects of international economic depression that followed World War I and marked the start of a prolonged de-industrialization.

Significantly, expansion of Guiana's sugar industry straddles the interval between the demise of sugar in Haiti after 1800 and the consolidation of Cuba's position as the primary Caribbean sugar producer at the start of the twentieth century.<sup>14</sup> During the period, British Guiana's geographic size, proficiency in making high-grade sugars and adaptability to consumer markets helped it profit from declining production in the British island, especially, and from periodic shortfalls in the Louisiana, Cuba, Puerto Rico, the Philippines, mainly. The industry-wide shift to central factories assumed a variant form that was as productive as the *usines centrales*, *ingenios* and *centrales* of the French and Spanish colonies. These factors and others mark British Guiana as a historical anomaly in the Caribbean sugar business during the nineteenth century and invite a more detailed enquiry into its operations.

### **Theoretical considerations**

A study in colonial Caribbean technological history must necessarily draw on established practice and discourse within European and American history of technology. An acknowledged shift within the science and technology debates from the 1980s accords technology primacy over science. The reversal of views has lifted technology significantly above its pre-modern position of the underling of science and

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<sup>14</sup> Cuba's output was twice as large as Guiana's in 1816 and six times greater by 1850. See **APPENDIX 8 Sugar production, select countries and British Guiana compared, 1800 to 1930.**

accorded the field a new centrality.<sup>15</sup> Nevertheless, technology-based inquiry remains a loosely-defined field served by discourse that characterizes technology as knowledge, as a series of empirical examples, and as relationships between the material and human worlds.<sup>16</sup> Technology is envisaged as not merely referent to machines, tools and related methods of fabrication but as inclusive of the overarching system of procedures within which these operate and are realized.<sup>17</sup>

A focus on technological change is particularly relevant for a study such as this, attendant on a specific manifestation of change—the transformation of sugar production in colonial Guyana—and for which the guideposts are the processes of invention, development (or refinement), innovation and/or diffusion.<sup>18</sup> Theoretically, a history of technological change specific to sugar should examine at least three issues: tracing the invention and development of machines and techniques, their adoption, and the outcomes of their utilization.<sup>19</sup> The abovementioned parameters underpin this study and guide the thematic organization of the findings.

Departing from the usual political and socio-economic foci of Caribbean scholarship, this dissertation is attentive to the evolution of sugar science and

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<sup>15</sup> An outstanding assessment of the shift and its contextualization within the modernity/post-modernity transition is detailed in Paul Forman, “The Primacy of Science in Modernity, of Technology in Postmodernity, and of Ideology in the History of Technology”, *History and Technology*, No. 1/2, XXIII (March-June 2007), 1-152.

<sup>16</sup> Thomas J. Misa, “Theories of Technological Change: Parameters and Purposes”, *Science, Technology, and Human Values*, No. 1, XVII (Winter 1992), 4; Alex Roland, “Theories and Models of Technological Change: Semantics and Substance”, *Science, Technology, and Human Values*, No. 1, XVII (Winter 1992), 79-100. A particular concern has been how to define technology, and what temporal scales are suitable.

<sup>17</sup> Forman defines the science/technology binary. “Technology—which is not, primarily, an ‘-ology’, but simply the collective noun for all the many ways things are in fact done and made—technology is what it is independently, largely, or our conceptions of it. The opposite is the case with science, which is, largely, only what we think it is.” (p. 10)

<sup>18</sup> Roland, pp. 79-100.

<sup>19</sup> Wayne D. Rasmussen, “Technological Change in Western Sugar Beet Production”, *Agricultural History*, No. 1, XLI (January 1967), 31-36, *passim*; Aufhauser favors examining the technologies associated with specific economic activities as well as changes in the mix of economic activities that occurred during slavery. R. Keith Aufhauser, “Slavery and Technological Change”, *Journal of Economic History*, No. 1, XXXIV (March 1974), 37.

technology in British Guiana.<sup>20</sup> It is primarily concerned with describing a localized technology within a given period and discussing the adoption and diffusion of particular techniques and devices, innovations and inventions. Though the nexus of technology, science and society is not an overt topic, specific manifestations of interaction are documented and explored. Another secondary focus highlights certain ecological consequences arising from sugar-making in the nineteenth century.<sup>21</sup> The overall aim is to articulate an empirical base for further study.

### **Organization and themes**

Pursuant to keeping the discussion attentive to the sites of production, the focus rests with the plantations and estates. Save where necessary for clarification there is no partition of the accounts of use of technology by individual site, or management-company as the intent is not to elevate or diminish the achievements of a particular group but to consider a common trajectory of change, mindful of agents and actions suggested by the evidence.

Primary documents constitute the foundation of this study. Official dispatches, government-issued reports such as the annual administration reports ('Blue Books'), British parliamentary records and reports by investigative commissions, and newspapers, letters, manuscripts, pamphlets, maps, plans and photographs are evaluated and compared with data from trade journals and accounts of the industry during the nineteenth century.<sup>22</sup> There is doubt regarding about the accuracy of some

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<sup>20</sup> McCook traces the changing paradigms of agriculture-related development in the Hispanic Caribbean. (Stuart McCook, *States of Nature: Science, Agriculture, and Environment in the Spanish Caribbean, 1760 to 1940* (Texas: University of Texas Press, 2002) Aufhauser's assessment of the pitfalls of the slavery versus technology debate is still relevant. Aufhauser, "Slavery and Technological Change", 36-50.

<sup>21</sup> Reinaldo Funes Monzote, *From Rainforest to Cane Field in Cuba: An Environmental History since 1492* (Chapel Hill: University of North Carolina Press, 2008)

<sup>22</sup> Much of the material referred to in this study is available online through the Google book digitization project.

records—notably official production and export totals and immigration statistics. I have configured the tabular summaries for uniformity of grouping, standardization of measurement units and to reflect, more accurately, the historical record, over time.

For the most part, thematic structure is derived from the evidence. Key routes of enquiry assess the impact of changing technology on the fortunes of the sugar industry and vice versa. I also investigated the extent of geographical and topographical limitations and the scientific and technological responses in factory and field. I assessed factory production techniques to verify if they were concomitant with improvements in cultivation and whether claims of technological and scientific ‘backwardness’ are substantiated.

Chapter One details the socio-political and economic background applicable to the sugar industry of the nineteenth and early twentieth centuries. This section describes the amendments to the labor system on which the industry relied—from enslavement, through Apprenticeship and Emancipation, the shift to paid labor from 1838—and conflicts with the emerging village movement. Financial constraints that impelled the transition from private to corporate ownership, the effects of international trade liberalization from the 1840s and growing competition from beet and other cane sugar producers are also detailed.

Chapter Two, in two sections, elaborates the unique cane cultivation and sugar production environment in British Guiana. Climatic and topographical limitations and mitigation measures dominate the discussion. Coastal Guyana remains a contrived ‘empoldered’ landscape, crisscrossed with canals, trenches, ‘front dams’, ‘back dams’, ‘sidelines’, and ‘middle walks’ and strewn with ‘kokers’, tall chimneys, factories and ‘logies’. The industry fostered a distinctive settlement pattern and gave rise to vernacular building forms that endure to present day. An element of ecological

change and degradation associates with the industry and its historical origins are probed.

Chapter Three outlines principal field-related improvements to the 1930s, tracing public and private research efforts to breed new cane varieties, improve soil fertility and control plant disease and pest infestation. Attempts to enhance traditional cultivation practices and mechanize field tasks are analyzed in the context of related developments worldwide.

Chapter Four assesses factory technology up to the 1930s. Beginning with the introduction of steam engines into Guiana from 1801, I explore external and internal stimuli that revolutionized processing and diversified production. Competition from European beet sugar brought new equipment and techniques and hastened efforts to find more economical power sources so as to increase the competitive edge. Adapting imported machinery was fraught with problems, however, and a plethora of local sugar-related patents evolved to satisfy local needs and conditions.

Chapter Five critiques a persistent historiographical trend that maligns the British Guiana sugar industry as technologically backward and incapable of adopting science-based improvements. The dissertation concludes with a summary and assessment of the main findings of the research.

## CHAPTER 1

### **SOCIO-POLITICAL AND ECONOMIC MILIEU OF THE BRITISH GUIANA SUGAR INDUSTRY 1800 TO THE 1930s**

The export-oriented sugar industry of Demerara, Essequibo and Berbice was subject to extensive socio-economic and political reorganization in the nineteenth century. Sugar became the chief economic engine of the three territories that were combined as a single colony—British Guiana—under imperial rule. As relative latecomers to the sugar business, the colony tapped into modernizing trends concomitant with the arrival of settlers from well-established, ‘older’ colonies in the Caribbean archipelago.

#### **Labor problems and solutions: apprenticeship, indentured immigration and the village movement**

Plantation agriculture initially relied exclusively on manual labor and enslaved men, women and children empoldered the plots, planted, tended and reaped the crop and made sugar. The enslaved ensured a perpetual and immobile labor pool as, once purchased, men, women and children lived in bondage with the planter-owner providing only enough food, clothing and shelter to keep them alive and productive. The enslaved received no wages and endured constant and horrific brutality.<sup>23</sup>

The termination of the British trade in slaves in 1807 signaled the start of the transformation of the system on which the sugar industry depended. In anticipation of Abolition, planters moved to take control of labor.<sup>24</sup> First, they demanded compensation for their “loss of property” in slaves and received £4,494,989—an

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<sup>23</sup> See Thompson, *Colonialism and Underdevelopment in Guyana...*, **passim**.

<sup>24</sup> The Demerara revolt of 1823 caused great anxiety to the planter oligarchy. More than 200 enslaved persons were executed or died as a result of their involvement in the uprising. See Joshua Bryant, *Account of the Insurrection of the Negro Slaves in the Colony of Demerara* (Georgetown: The Guiana Chronicle Office, 1824), pp. 109-11 and **passim**.

average of £50 per enslaved person—from the British government.<sup>25</sup> Next, they instituted Apprenticeship and recruited foreign labor under government-subsidized Indentureship schemes. The planters also sought ways to mechanize their operations to lessen the dependence on manual work.<sup>26</sup>

The Act that abolished slavery, though promulgated in 1833, was not adopted until August 1834 and, even then, ex-slaves remained bound to the plantations under ‘Apprenticeship’ schemes. Apprenticeship was envisaged as a period of transition between enslavement and freedom during which the colonial elite would retain control over its traditional source of labor and avoid financial ruin.<sup>27</sup> ‘Apprentices’—the ex-slaves—were mandated to labor in the fields and factories for three-quarters of each working day without pay, receiving wages only if they continued working for the rest of the day. Field hands (praedials) were required to continue serving on their plantations for six years while a four-year attachment was mandatory for non-praedials. Apprenticeship was to be followed by a system of paid work but as it became evident that it was merely an extension of slavery the scheme was terminated earlier than planned. On 1 August 1838 the enslaved achieved full and unconditional freedom.

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<sup>25</sup> [John Brumell], *Demerara After Fifteen Years of Freedom. By a Landowner* (London: T. Bosworth, 1853), p. 14. Deerr gives the figure as £4,924,989. See Noël Deerr, *History of Sugar* (London: Chapman and Hall, 1950), II, 306. The British Guiana planters were notorious for their influence in the British parliament and many prominent politicians were directly connected to the sugar industry. Sir John Gladstone (1764-1841), a prominent Liverpool merchant, owned plantations in British Guiana and Jamaica. His son, William Ewart Gladstone, was a four-time Prime Minister of Britain. Englishman Quintin Hogg, another prominent Guiana planter, was a well-known philanthropist.

<sup>26</sup> Barton Premium, *Eight Years in British Guiana. Being the Journal of a Residence in that Province from 1840-1848* (London: Longman, Brown, Green and Longmans, 1848), p. 93.

<sup>27</sup> Adamson maintains that “In theory apprenticeship was means to prepare the slaves for freedom. In practice it gave the planters a few years in which to adjust to the loss of their human capital.” Alan H. Adamson, *Sugar Without Slaves. The Political Economy of British Guiana, 1838-1904* (New Haven: Yale University Press, 1972), p. 31. Apprenticeship was instituted in a majority of British Caribbean colonies. Where unoccupied land was readily available as in British Guiana, Jamaica and Trinidad, the schemes kept the workforce bound to the plantations.

On gaining freedom, a majority of ex-slaves were eager to acquire land. Although mainland British Guiana encompassed a relatively large landmass in comparison with the Caribbean islands, much of its arable land was located on the coast and under the control of the planters and colonial government. An independent village movement emerged, nevertheless, and although stifled by circumstance and government policies, helped draw labor away from the plantations.

The village movement was predicated on the desire of the ex-slaves to remove themselves from the places associated with slavery.<sup>28</sup> Soon after Emancipation, a majority left the plantations. Able-bodied free men and women organized themselves into ‘task gangs’, hired themselves out for higher wages, and demanded shorter work days.<sup>29</sup> In retaliation, some planters destroyed the fruit orchards and provision grounds that had fed the enslaved before 1838 and which ex-slaves continued to use.<sup>30</sup> Free people responded by buying their own plots and establishing free villages—‘proprietary’ and ‘communal’—within the plantation zone.<sup>31</sup>

Proprietary villages were formed as some planters, eager to keep labor nearby, subdivided their estates and sold individual plots to ex-slaves. Communal villages resulted from collective land purchases—usually abandoned plantations—afterward

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<sup>28</sup> Marronage was an established form of resistance in colonial Guiana and, while numbers of runaways were smaller than in Cuba, the Dominican Republic, Brazil and Suriname, it was constant. Large maroon settlements were established behind the coastal plantations and among dense forests and inaccessible creeks and rivers in Guiana. Planters lived in constant fear of armed attacks by raiders seeking women and imported goods. A group of maroons established a settlement on Creole Island in the Essequibo River in 1741. (Rodway, *History of British Guiana*, I, 107) Official expeditions were mounted against the hideouts with local Amerindians and a Black Rangers corps employed as trackers in 1744, 1767-78 and 1795. Many were captured and killed but marronage continued until Emancipation. See Alvin O. Thompson, *Maroons of Guyana; some problems of slave desertion in Guyana, c. 1750-1814* (Georgetown: The Free Press. Thompson, 1999); \_\_\_\_\_, *Colonialism and Underdevelopment in Guyana...*, Chapter VII: Slave Resistance.

<sup>29</sup> Adamson, p. 34.

<sup>30</sup> Shahabuddeen, p. 148; and Félix Milliroux, *Demerary, Transition de L’Esclavage a la Liberté* (Paris: Imprimerie de H. Fournier et Companie, 1843), p. 63.

<sup>31</sup> Ibid. In addition to purchasing large plantations such as Northbrook and Orange Nassau, 189 former apprentices bought plots in Essequibo, Demerara and Berbice between 1 August 1838 and 8 April 1840. Great Britain, *Parliamentary Papers*, XVI (1839-1841), pp. 113-14.

sub-divided into separate shares. Proprietary villagers held individual title while communal villages were owned by a few on behalf of a group. Those who could not afford to buy land squatted on abandoned lots and unoccupied ‘Crown’ reserves along rivers and creeks in the interior of the colony.<sup>32</sup>

The ex-slaves bought land intending to enter into the sugar business.<sup>33</sup> However, after expending much of their limited capital on land purchases, little money remained for investing in sugar-making equipment. Moreover, many unwittingly purchased ‘waste land’ – waterlogged plots withdrawn from cultivation by planters unable to maintain the drainage and irrigation infrastructure. The new owners often lacked resources for keeping the land cultivable and were soon bankrupt.<sup>34</sup> Communal villages, especially, relied on voluntary subscriptions from shareholders to subsidize the cost of road-building and maintaining the sea defences, but were perpetually short of funds. Fragmented plots in communal villages were usually too small for profitable cultivation.<sup>35</sup> Further, petty larceny, especially by indentured Chinese, reduced profit margins as did the absence of reliable farm to market transportation.<sup>36</sup> Moreover, the local legislature—dominated by sugar planters—conspired to raise the purchase price of state-owned lands in the effort to close off outlets for free persons wanting to live independently of the plantations. Finally, the Sunday markets at which the ex-slaves sold and traded their cash crops were prohibited by law. Villagers eventually gave up growing cane and cultivated cash crops and raised livestock to supply the urban centers of Georgetown (Demerara) and New Amsterdam (Berbice).

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<sup>32</sup> This ‘creek-and-river movement’ peaked in 1849 but declined afterward as the ex-slaves preferred to live near to schools, churches and other amenities in the plantation zone. (Adamson, pp. 36-37)

<sup>33</sup> Ibid, p. 35.

<sup>34</sup> Premium, p. 60.

<sup>35</sup> Premium, p. 213.

<sup>36</sup> Adamson, p. 57.

Even though the survival of a village was usually precarious, its presence within the sugar-growing zone was viewed as a direct threat to the sugar industry. Believing that an independent peasantry would deprive the sugar industry of its habitual workers, the plantocracy used its influence in the local legislature to force labor back to the plantations. Ordinances in 1852, 1856 and 1861, respectively, prohibited joint purchases by more than twenty persons, imposed monthly charges for infrastructure maintenance on land partitioned among ten people or more, and raised the price of Crown (state-owned) lands from five to ten dollars an acre with a minimum parcel size set at 100 acres. The 1861 regulation was the most restrictive and effectively barred ex-slaves from purchasing land outside the plantation zone. At this time, plantation land was on sale at one-fifth of the cost of Crown land and river estates could be had for an even lower rate.<sup>37</sup> These factors helped to keep a majority of freeholders dependent on plantation wages and in competition with immigrants recruited under indentureship. The enlarged labor pool kept wages low.

### **Indentureship**

As a substitute for ex-slave labor, ‘Indentureship’ brought thousands of workers, mainly from Portuguese-ruled Madeira, India and China, to British Guiana. Contract or ‘bound’ labor also came from the Caribbean islands—the Bahamas, Barbados, Curacao, Martinique, Montserrat, Anguilla, Antigua, Dominica, Nevis, St. Kitts, St. Martin—and smaller numbers from the Azores, Cape Verde, Sierra Leone, St. Helena, Malta, Germany, Ireland, Brazil and the United States.<sup>38</sup> Indentureship

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<sup>37</sup> Ibid. Chapters 2 to 5, especially pp. 57-58.

<sup>38</sup> Great Britain, *Parliamentary Papers* XVI (1839), pp. 59-63. G. W. Roberts and J. Byrne, "Summary Statistics on Indenture and Associated Migration Affecting the West Indies 1834-1918", *Population Studies*, No. 1 XX (1966), 125-134. Wagner statistics are apportioned by number and country of origin. Michael J. Wagner, "Structural Pluralism and the Portuguese in Nineteenth Century British Guiana, A Study in Historical Geography", unpublished Ph.D. dissertation, McGill University, 1976, pp. 41-44. Also see J. F. Williams, "The Development of the Cane Sugar Industry in British Guiana", *Timehri*, No. 26 (November 1954), 10.

contracts were subsidized with public funds and the agreements stipulated that recruits satisfy varying terms of service, between one to five years, in return for rent-free housing and basic food supplies, clothing and fixed wages.

Table 1: Immigration to British Guiana, 1834 to 1917.<sup>39</sup>

Immigration (Indentured and Non-contract) into British Guiana 1834-1917								
Year	Africa	China	Europe	India	Madeira, Malta, Cape Verde, Azores	United States	West Indies	Total
1834-40	91	-	381	396	637	70	8092	1,578
1841-50	10,528	-	-	12,374	15,868	-	4806	38,770
1851-60	1,965	6,655	-	26,187	10,406	-	-	45,213
1861-70	1,476	5,975	-	38,090	1,533	-	10180	47,074
1871-80	-	903	-	51,729	1,954	-	12,264	66,850
1881-90	-	-	-	40,971	398	-	4517	41,369
1891- 1900	-	-	-	36,177	-	-	974	36,177
1901-10	-	-	-	23,769	-	-	-	23,769
1911-17	-	-	-	9,216	-	-	-	9,216
Total	14,060	13,533	381	238,909	30,796	70	12,264	310,016

The migrants were a mixed group - some were experienced agriculturalists and others worked as boatmen and sailors.<sup>40</sup> A few were hired for specialized skills as in

<sup>39</sup> Data collated from G. W. Roberts and J. Byrne, "Summary Statistics on Indenture and Associated Migration Affecting the West Indies 1834-1918" *Population Studies* No. 1, XX (July 1966), 125-134; Dwarka Nath, *A History of Indians in British Guiana* (Edinburgh: Thomas Nelson and Sons, 1950; revised edition; London: self published, 1970), pp. 179-80. There is variance among the categories in each source. Roberts and Byrne employ six points of origin (India, Africa, Madeira, China, Europe and Other) while Nath distinguishes among India, Madeira, the Azores, the West Indies, Africa, England, China, Cape Verde, Malta and the United States of America. Roberts and Byrne counted 73 US Americans while Nath found only 70. The 1,868 persons categorized as 'other' by Roberts and Byrne are presumed to be from the islands named by Nath. Madeirans first arrived in 1835 and official immigration ceased in 1858 although the Immigration Agent General (IAG) continued to report non-indentured arrivals. Immigration from Africa ended in 1867. Indentured Indians arrived from 1838 and the IAG continued to include non-indentured Indians in its arrival statistics even after government sponsorship ended in 1917. No distinction is made between Europeans introduced under indenture and with private sponsorship. A total of 82,834 enslaved persons were freed in 1834. [Brumell], *Demerara After Fifteen Years of Freedom*, p. 14; and Deerr, *History of Sugar*, I, 306.

<sup>40</sup> Non-indentured Maltese immigrants (145 men, women and children) accompanied by a priest, doctor and an interpreter came to Hoop en Vries Estate (Hogg Island, Essequibo River) in November, 1839.

the case of a German sugar-boiler contracted by the Anglican Archdeacon in 1839.<sup>41</sup> Many were, however, unsuited for fieldwork and knew little about farming. Some indentures absconded from their assigned plantations and were accused of non-performance of tasks, neglect of duties and bad behavior.<sup>42</sup> Moreover, recruitment was more successful in some decades than others with more than 66,000 arriving between 1871 and 1880, the period during which indentureship peaked. **(Table 1)** A high mortality rate among the newcomers from overwork, anemia, homesickness and diseases such as Cholera, Malaria (“intermittent fever”) and Yellow Fever—and the tendency to abscond from work—lessened the effectiveness of indentureship, especially in the beginning.<sup>43</sup>

#### **‘Metairie’ (sharecropping)**

Planters also tried Metairie—also ‘Métayer’, ‘Metairé or ‘Métayage’, a form of sharecropping—as a means of labor retention after 1838. Land was leased or allotted rent-free to ex-slaves and laborers who had completed their contracts of indenture. Tenants were normally required to plant cane and turn the harvest over to the landowner who produced sugar and rum production at his expense. Under the terms of the system, farmers did not receive cash wages but were entitled to one half of the produce as payment.<sup>44</sup> Metairie was successful on four of thirty-one estates on which

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Sixty-seven of the indentures were repatriated in January 1841 via New York. Great Britain, *Parliamentary Papers* XVI (1839), pp. 59-60 and 246. See also See Mary Noel Menezes, *The Portuguese of Guyana: A Study in Culture and Conflict* (London: M. N. Menezes, 1994) and \_\_\_\_\_, *Scenes from the History of the Portuguese in Guyana* (London: M. N. Menezes, 1986);

<sup>41</sup> Ibid, p. 59.

<sup>42</sup> Ibid.

<sup>43</sup> Deaths of Madeirans were so high in 1841-42 that the local legislature halted financial support for immigration schemes. (Premium, *Eight Years in British Guiana*, pp. 116 and 130)

<sup>44</sup> [Brumell], pp. 43-44; Adamson, p. 101.

it was tried.<sup>45</sup> The schemes were discontinued after the 1840s, failure blamed on indolence and inconstant work habits of the tenant farmers.<sup>46</sup>

In hindsight, a majority of tenants were unable to work fields that depended on a costly drainage system they could not afford to maintain. With limited capital, they also had to simultaneously provide for their families by maintaining subsistence gardens. Further, Adamson maintains that the African villager had emerged from slavery devoid of experience of successful, small-scale agribusiness and untutored in the practical aspects of cultivation.<sup>47</sup>

Even with Apprenticeship, paid labor after 1838 and Indentureship and Metairie, the labor shortfall was significant and availability erratic during the nineteenth century. Scarcity of hands proved especially detrimental as the sugar industry adhered to a year-round operating schedule premised on a favorable climate and a higher ratio of available land. Unlike Cuba and Barbados where the seasonality of the harvest was anticipated, the British Guiana sugar cycle was, for all practical purposes, continuous and protracted and required a constant pool of hands throughout the year.<sup>48</sup>

The labor shortage worsened as many males, formerly employed on the sugar estates, departed for work in the gold and diamond mines in the interior from the second half of the nineteenth century. Men also went to work on cattle ranches or found employment within the burgeoning timber-industry, as harvesters of balata

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<sup>45</sup> The colony counted 404 individual estates in 1829 but mergers and abandonment reduced the number to 196 in 1849. [Brumell], p. 15.

<sup>46</sup> [Brumell], pp. 43-45. He mounted a scathing attack against the budding agriculturalists opining that “The plain truth is, a poor man has no business with a sugar estate in Demerara” (47) at the same time acknowledging that common drainage was mandatory for the survival of the colony. (94)

<sup>47</sup> Adamson, *Sugar without Slaves*, p. 62.

<sup>48</sup> While the factories were not grinding canes, factory-hands worked as day laborers in the canefields. (Walter Rodney, *A History of the Guyanese Working People, 1881-1905* (Baltimore: Johns Hopkins Press, 1981), p. 105. See also this dissertation, **CHAPTER 2 AN INDELIBLE FOOTPRINT. THE HISTORICAL ECOLOGY OF GUIANA’S SUGAR.**

(*Mimusops globosa*) and as charcoal-burners supplying local and overseas markets.<sup>49</sup> Moreover, as the century progressed, industrial action became a recurrent feature of estate life with free and indentured laborers periodically withholding their services in the struggle for higher wages and improved work conditions. Strikes interrupted the cultivation cycle, delayed the harvest, spoiled the cane in the field and curtailed output to the point where profits were substantially reduced.<sup>50</sup> Episodic outbreaks of Yellow Fever in 1819, 1837 and 1850, and Cholera in 1856 also reduced the worker population. Malaria (“intermittent fever”) was another well-known plague. The multifaceted labor problem was compounded by economic and political changes within and outside the colony.

### **Financial challenges and the transition from private to corporate ownership**

Up to the end of the 18<sup>th</sup> century each plantation in Demerara, Essequibo and Berbice was managed by its slave-holding ‘proprietor’.<sup>51</sup> Proprietors relied on personal wealth and credit from English mortgage houses to finance their operations. Not surprisingly, plantations were often heavily encumbered to offset production costs and shipping to markets overseas.<sup>52</sup>

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<sup>49</sup> Rodney, *A History of the Guyanese Working People*, pp. 90-102. Chinese and Portuguese ex-indentures became well-known as producers of charcoal. West Africans were celebrated boatmen and laborers in the timber industry. Wood from Guiana was exported to the islands for the construction of sugar factories. Bryan Edwards, *History, Civil and Commercial, of the British Colonies in the West Indies* (London: G. and W. B. Whittaker, fifth edition; 1819), IV, 245.

<sup>50</sup> Great Britain, *Parliamentary Papers* XXIII (1848), pp. 88-89. The first post-Emancipation strike occurred in 1842 following a reduction in wages precipitated by a sharp decline in world sugar prices. James Rose, “The Strike of 1842”, *Release*, VIII/IX (1979), 27. The causes and consequences of strikes are given in Peter Ruhoman, *Centenary History of the East Indians in British Guiana 1838-1938* (Georgetown: 1947; reprint edition, Demerara Publishers, 1988) and Clem Seecharan, “*Tiger in the Stars*”: *The Anatomy of Indian Achievement in British Guiana, 1919-1929* (London: Macmillan, 1997); Dale Bisnauth, *The Settlement of Indians in Guyana 1890-1930* (Leeds: Peepal Tree Press, 2000)

<sup>51</sup> Owners in Guiana preferred the title of ‘proprietor’. A proprietor living abroad was an ‘absentee’, and represented by a resident ‘attorney’ or ‘Q. Q’. Henry Dalton, *History of British Guiana* (London: Longman, Brown, Green and Longmans, 1855), I, 318; William Hilhouse, “Agriculture in 1829. II”, *Timehri*, new series, (1897), II, 252-58.

<sup>52</sup> Adamson, *Sugar Without Slaves*, Chapter 5: The Planter, and Chapter 6: Trade and Finance.

Abolition presented proprietors with a new cost - the wage bill. Accustomed to allocating only a pittance for the living expenses of the enslaved, cash wages became a regular and costly recurrent expenditure after 1834.<sup>53</sup> Accordingly, sugar output declined precipitously for want of labor after Emancipation (1838) and by 1846 Guiana plantations were producing only thirty-eight percent of their pre-1838 totals.<sup>54</sup>

New free trade arrangements thrust the colonies into disadvantageous competition with sugar producers worldwide, sugar prices declined and many planters were bankrupt.<sup>55</sup> Between 1838 and 1853, 122 local plantations folded and others, burdened with debt, were abandoned.<sup>56</sup> The demise of the small individually-owned plantation was concomitant with rise of the big 'estate'. By the 1840s, financially stable, usually absentee owners set up joint-stock companies and bought up and combined several small holdings. Following initial mergers in 1829 there were 230 separate sugar estates but by 1849 there were only 180 and the number dwindled to "about 120" between 1877 and 1878.<sup>57</sup> Mergers also altered estate size and by the 1920s the largest estate was Diamond (East Bank Demerara) with 7,209 acres (2917.4 hectares) under cultivation. The majority cultivated from 1,000 to 2,000 acres (404.7 to 809 hectares).<sup>58</sup>

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<sup>53</sup> The end of enslavement also drove up other operating costs. For example, where the enslaved cut wood for boiler fuel the post-Emancipation planter, with fewer workers, had to purchase coal. Adamson, *Sugar Without Slaves*, pp. 162-63.

<sup>54</sup> *Ibid.*, p. 163

<sup>55</sup> *Ibid.*, and p. 216.

<sup>56</sup> Shahabuddeen, p. 89; Adamson, *Sugar Without Slaves*, pp. 160, 163.

<sup>57</sup> Thomas Savage (ed.), *Manual of Commercial and Industrial Intercourse between the United States and Abstracts of the Laws of the Spanish-American Countries for the Year 1889* (San Francisco: The Bancroft Company, 1889), p. 43.

<sup>58</sup> *British Guiana* (Wembley: British Empire Exhibition, 1924), p. 72. In 1922 there were 39 estates under cultivation.

Table 2: British Guiana sugar production by estate size 1841, 1847, 1851.<sup>59</sup>

<b>Sugar Production by Size of Estate: 1841, 1847, 1851</b>			
	1841	1847	1851
Small estates making under 250 hogsheads	178	122	84
Production/hogsheads	21,111	15,128	11,109
Percentage/total production	64	33	24
Medium estates (250-449 hogsheads)	24	60	58
Production/hogsheads	8,179	20,506	17,497
Percentage/total production	25	46	38
Large estates (500+ hogsheads)	7	16	28
Production/hogsheads	3,778	9,626	17,477
Percentage/total production	11	21	38

New owners invested heavily in technology and focused on mechanization resulting in an entirely new range of sugar products that commanded higher prices.<sup>60</sup> Production recovered and output increased an average of twenty-three percent, annually, for the period 1847-54.<sup>61</sup> The recovery also derived from relatively cheap prices paid for plantations bought after the 1840s slump, as well as a decrease in wages that was concomitant with the addition of indentured immigrants to the labor pool.<sup>62</sup> Among the more prosperous firms to emerge were Cavan Brothers and Company, Thomas Daniel and Sons (London and Bristol), Sandbach, Parker, and Company; Booker Brothers, Steele and Loxdale (Liverpool), H.E.C and Alexander Crum-Ewing and Garvin Fullarton (Glasgow). Mergers among several large

<sup>59</sup> Adamson, p. 175. The capacity of a hogshead varied between 1,000 and 2240 Imperial Pounds (lbs.)

<sup>60</sup> The developments are detailed in **Guiana sugars and sugar products, CHAPTER 4.**

<sup>61</sup> Adamson, p. 164.

<sup>62</sup> Ibid., pp. 165-66

companies resulted in conglomerates such as the Colonial Company formed in 1866 and Curtis, Campbell, and Hogg consolidated in the 1870s.<sup>63</sup>

### **The impact of free trade, tariffs and overseas competition**

Up to the 1820s British Caribbean sugar dominated the British market. Favorable tariffs attached to the staple muscovado— unrefined, ‘raw brown’ sugar— kept the colonies in viable production. Levies on sugar coming from Mauritius and India were higher until 1836 when these and other South Asian colonies gained equal tariff status with the Caribbean. Duties on British and other colonial sugars were standardized in 1844 but, following protests, a grade-based scale predicated on quality was offered to the most affected colonies. The concession was of little benefit to territories like British Guiana then producing mostly unrefined muscovado exported to continental refineries. The lone remaining tariff difference was between slave-grown sugar and sugar produced by wage labor.

The 1846 Sugar Duties Act began a phased removal of all tariff distinctions on colonial sugar but its impact on colonial economies was so calamitous that, in 1854, a graduated scale based on color was applied to all sugars imported into Britain, irrespective of country of origin or the labor system that produced it. The duties charged increased according to the lightness of color.<sup>64</sup> Reductions in the rate of duties charged followed until 1874 when all sugar duties were eliminated. Up to that year, vacuum-pan, Yellow Crystals and raw muscovado sugars enjoyed an advantage over sugars from Cuba, Brazil and Mauritius.<sup>65</sup> Guiana planters were accused of deliberately ‘spoiling’ their vacuum-pan sugar to satisfy the lower scale of duties.<sup>66</sup>

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<sup>63</sup> Adamson, p. 174.

<sup>64</sup> J. Russell, *Sugar Duties* (London: Wm. Dawson and Sons, 1862), pp. 1-3. Before polarimetric testing was implemented color was linked to quality - lighter sugars were generally of higher quality.

<sup>65</sup> R. W. Beachey, *The British West Indies Sugar Industry in the Late Nineteenth Century* (Oxford: Blackwell, 1957), pp. 44-45.

<sup>66</sup> *Ibid.*, p. 45.

Despite the ameliorative concessions, British Guiana had to confront the challenge of increased production in Mauritius and Louisiana (except during the United States Civil War, 1861-65), and Puerto Rico after the 1880s.<sup>67</sup> In addition, sugar from Pacific colonies such as Fiji flooded world markets and depressed prices to the extent where the commodity became accessible to a wider cross-section of consumers.

Brief windows of opportunity for increased sales in the United States appeared during the Civil War and from 1871 to 1883 when American import duties favored dark sugars for refining.<sup>68</sup> American producers were protected by the McKinley Tariff Act of 1890 and its subsidies boosted production in the southern states between 1891 and 1895. Planters in Louisiana, especially, refitted their plantations, adopted the central factory system and installed a modern light railway transportation network.<sup>69</sup>

Closer to home, competition from rival Caribbean territories remained a pervasive threat to local viability. Puerto Rico, which retained slavery until 1873, produced sugar at a cheaper cost and in comparable quantities.<sup>70</sup> Cuba, utilizing slave labor until 1886, was the sugar giant of the Caribbean during the nineteenth century. Its exponential expansion resulted in exports that exceeded a million metric tons in 1894 as compared with Guiana's benchmark of approximately 104,000 tons that year. **(APPENDIX 2 British Guiana annual sugar production, 1800 to 1930)** However,

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<sup>67</sup> "Demerara Sugar", *Louisiana Planter*, No. 2, LIII (1914), 20.

<sup>68</sup> Beachey, *The British West Indies Sugar Industry in the Late Nineteenth Century*, Chapter II; Adamson, pp. 217-19. See this work **The 'Dark Sugars' question, CHAPTER 4.**

<sup>69</sup> See Paul L. Vogt, *The Sugar Refining Industry in the United States Its Development and Present Condition* (Philadelphia: University of Pennsylvania, 1908), **passim.**

<sup>70</sup> In 1851 the Guiana legislature lamented that "We are, and must be compelled to continue a struggle for the reduction of wages; for unless we can produce our sugar at rates of wages approaching to the cost of food and clothing of the slaves of Cuba, Porto Rico [sic] and Brazil, and the interest of the money vested in their original purchase, we are borne down by the low prices at which the foreign slaveholder can afford to bring his produce to market." *Parliamentary Papers XXXIX* (1851), p. 3.

civil unrest during Cuba's Second War of Independence (1895-98) almost obliterated its sugar industry and exports declined considerably between 1896 and 1900.

British Caribbean territories took advantage of Cuba's shortfall by increasing production and exports to the United States mainly.<sup>71</sup> The island rebounded after 1900 and an infusion of capital and technology from the United States established more efficient, centralized operations. American investment was also instrumental in expanding production in the Philippines and Puerto Rico after the Spanish-American conflict of 1898.<sup>72</sup> Modern railways drove the changeover from small, inefficient mills to large *centrales azucareros* (central sugar factories) and the United States instituted a system of protective tariffs for its domestic sugars and curtailed imports from other sources. British Caribbean sugar thereafter competed with cheaper sugar exported in ever-increasing quantities from the former Spanish-ruled colonies.

*Centrales*—central factories—were key to the survival and success of the sugar industry in the Francophone Caribbean from the 1850s and in the Spanish-ruled islands as well, especially after influx of United States capital in the late nineteenth century. Large processing units located in industrial enclaves milled cane from multiple plantations, reducing transportation and production costs. The system in British Guiana was slightly different.

Usually a single, large factory processed the harvest of two or three neighboring plantations under common ownership.<sup>73</sup> However, as a possible solution to the financial crisis brought on by the equalization of sugar duties in 1846, the

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<sup>71</sup> See **The 'Dark Sugars' question**.

<sup>72</sup> The conflict lasted from April to August 1898. See Figure 3 and **APPENDIX 8** for production data. For a definitive account of the evolution of the sugar economies of Cuba, Puerto Rico and the Dominican Republic see César J. Ayala, *American Sugar Kingdom The Plantation Economy of the Spanish Caribbean, 1898-193* (Chapel Hill: The University of North Carolina Press, 1999)

<sup>73</sup> Great Britain, *Parliamentary Papers* IV (1871), p. 121.

colony considered the central factory idea.<sup>74</sup> Local planters rejected plans for collective processing arguing that their system of combining cultivation and milling tasks was efficient and economical.<sup>75</sup> Because Guiana estates were large, numerous and in continual, “night-and-day” operation, there was no need for high-capacity, centrally-located factories.<sup>76</sup> Industrialist Henry Davson, comparing British Guiana with the islands, opined that local estates matched their central factories in size and scale of operations. Davson viewed each local estate as a “Central Factory of itself”.<sup>77</sup>

### **The challenge from beet sugar**

Other challenges emanated from outside the Caribbean. Rising incomes and increased access to calorie-rich foods in a rapidly industrializing Europe was contingent on enhanced agricultural productivity. Post-farm processing and advances in transportation technology—railways especially—sustained increased demand for novelty luxuries such as sugar.<sup>78</sup> Higher consumption was concomitant with the restructuring of trading arrangements to accommodate the sale of beet sugar, produced in Europe, on the world market.

Beet, at first, seemed not to pose a significant challenge as its refineries also processed raw cane sugar.<sup>79</sup> However, the Napoleonic continental blockade of 1806-1814 curtailed importation of sugar from the tropics to Europe and impelled the search

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<sup>74</sup> [Brumell], pp. 105-10.

<sup>75</sup> *New Local Guide of British Guiana*, (Demerara: The Royal Gazette Office, 1863), p. 26; Condé Williams, “The Future of Our Sugar Colonies”, *Proceedings of the Colonial Institute*, XXVI (1896), 78.

<sup>76</sup> H. E. Murray, “The Sugar Industry of British Guiana”, *Journal of the Board of Agriculture of British Guiana*, X (1917), 86-87.

<sup>77</sup> Condé Williams, p. 78. Planters working small-scale operations had no measurable data to inform a cost-benefit analysis in favor or against centralization, and Guiana’s persistent interest in the idea was deemed “death-bed repentance” in 1895. (“Sixty Tons of Cane Per Acre”, *Louisiana Planter*, No. 1. XLVI (1911), 4.

<sup>78</sup> David Grigg, “The nutritional transition in Western Europe”, *Journal of Historical Geography*, No. 1, XXII (1995), 250-52 and 255-56.

<sup>79</sup> F. C. Thorpe, “Changes on Sugar Estates from 1865-1894”, *Timehri*, new series, (1894), VIII, 206-07.

for an alternative sweetener.<sup>80</sup> At the onset, beet farmers in France, Germany, Belgium, Russia, Austria and the Netherlands benefited from government subsidies in the form of direct sugar ‘bounties’.<sup>81</sup> They also enjoyed lower factory-to-market charges in comparison with higher freight costs for imported sugar. Beet sugar output surged under protectionism and was bolstered by scientific research that improved farming practices and juice extraction.<sup>82</sup> Increased competition forced sugar prices to a disastrous all-time low in 1884 and many production sites in British Guiana were abandoned.<sup>83</sup>

Britain remained divided between protecting its sugar refining plants at home and sustaining the precarious economies of its colonies overseas. Following pervasive economic slumps during the nineteenth century, Britain safeguarded continental jobs by applying prohibitive tariffs and countervailing duties to sugar from its own and other colonies. The strategies effectively stifled colonial capacity to refine raw sugars into value-added products such as white crystals and loaf sugars.<sup>84</sup>

Disruptions to shipping during World War I added to the problems but the destruction of beet farms in Europe during the conflict stimulated production in the colonies to satisfy the shortfall.<sup>85</sup> Available statistics show, however, that output in British Guiana increased only marginally during the first half of the nineteenth century. Altogether, the combined effects of labor crises, emerging free trade and loss

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<sup>80</sup> Emperor Napoleon offered bounties for beet sugar production in France and promoted beet research. Although the end of the blockade stifled France’s infant industry, cultivation increased in Germany from the 1830s. Despite high labor costs, beet farms close to ports and large urban populations flourished. See David B. Grigg, *Agricultural Systems of the World An Evolutionary Approach* (Cambridge: Cambridge University Press, 1974), p. 175.

<sup>81</sup> Great Britain, *Parliamentary Papers* IX (1830-31), p. 95.

<sup>82</sup> See **Confluences of cane and beet processing, CHAPTER 4**, this dissertation.

<sup>83</sup> Walter Rodney, (ed.), *Guyanese Sugar Plantations in the Late Nineteenth Century: A Contemporary Description from the ‘Argosy’* (Georgetown: Release Publishers, 1979), **passim**.

<sup>84</sup> See **CHAPTER 4**, and **GLOSSARY**.

<sup>85</sup> Trade between the United States (US) and the British Caribbean was suspended from July 1783. Until then, the US had been a major source of plantation supplies, especially salted fish and construction timber. Smuggling was widespread during the blockade.

of preferential markets are reflected in fluctuating export totals between 1814 and 1930.<sup>86</sup>

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<sup>86</sup> See **APPENDIX 2 British Guiana annual sugar production, 1800 to 1930.**

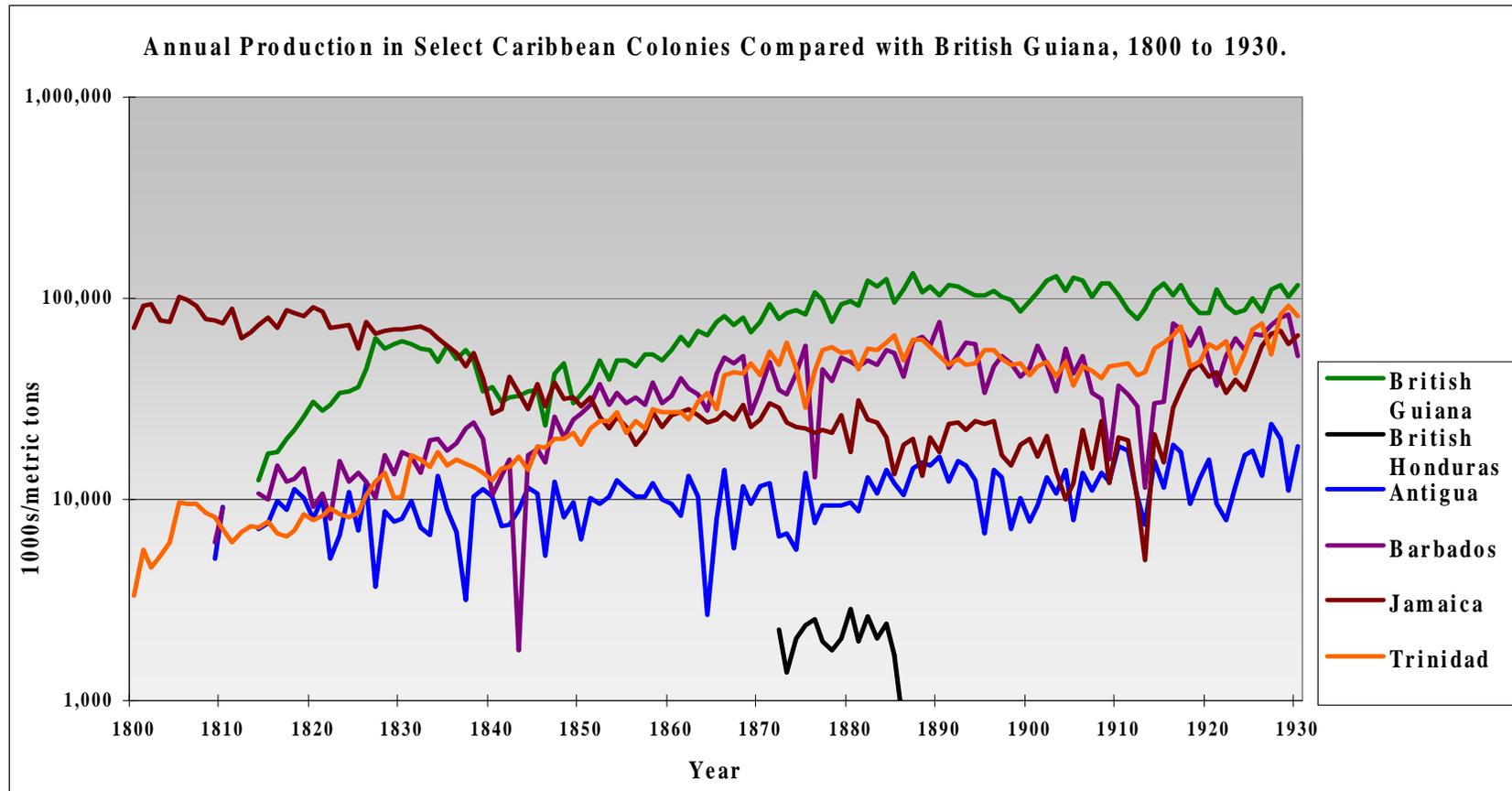


Figure 1: British Caribbean sugar production, 1800 to 1930.<sup>87</sup>

<sup>87</sup> Select Caribbean territories compared with British Guiana. (Deerr, *History of Sugar*, I, **passim**). Deerr's data derive from production (British Guiana, Mauritius, the Philippines, Louisiana and the Hawaiian Islands), and export quantities (Fiji). For comparison, all quantities are converted to metric tons. British Guiana production is detailed separately in **APPENDIX 2**.

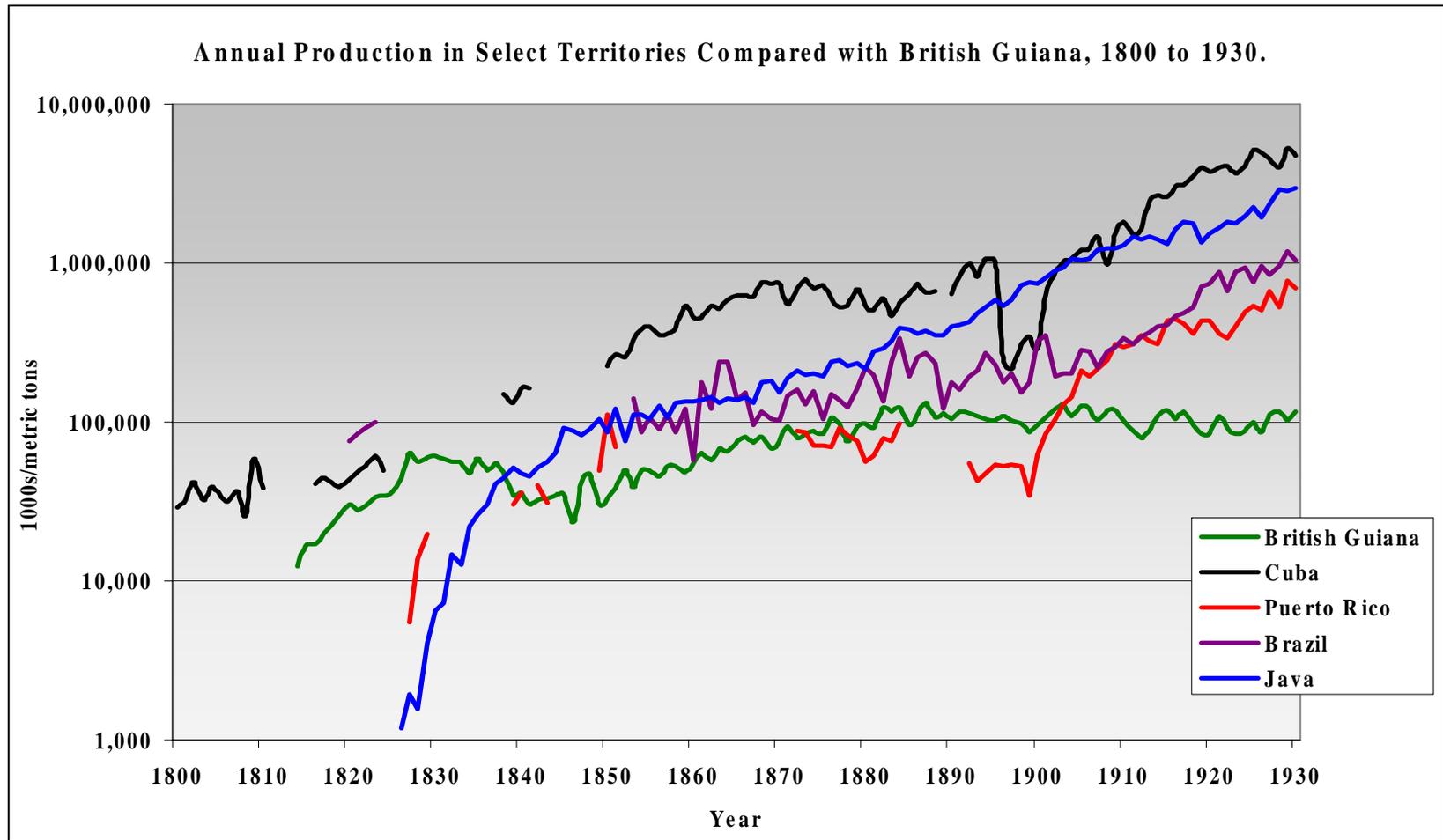


Figure 2: World sugar production: select territories compared, 1800 to 1930.<sup>88</sup>

<sup>88</sup> Ibid.

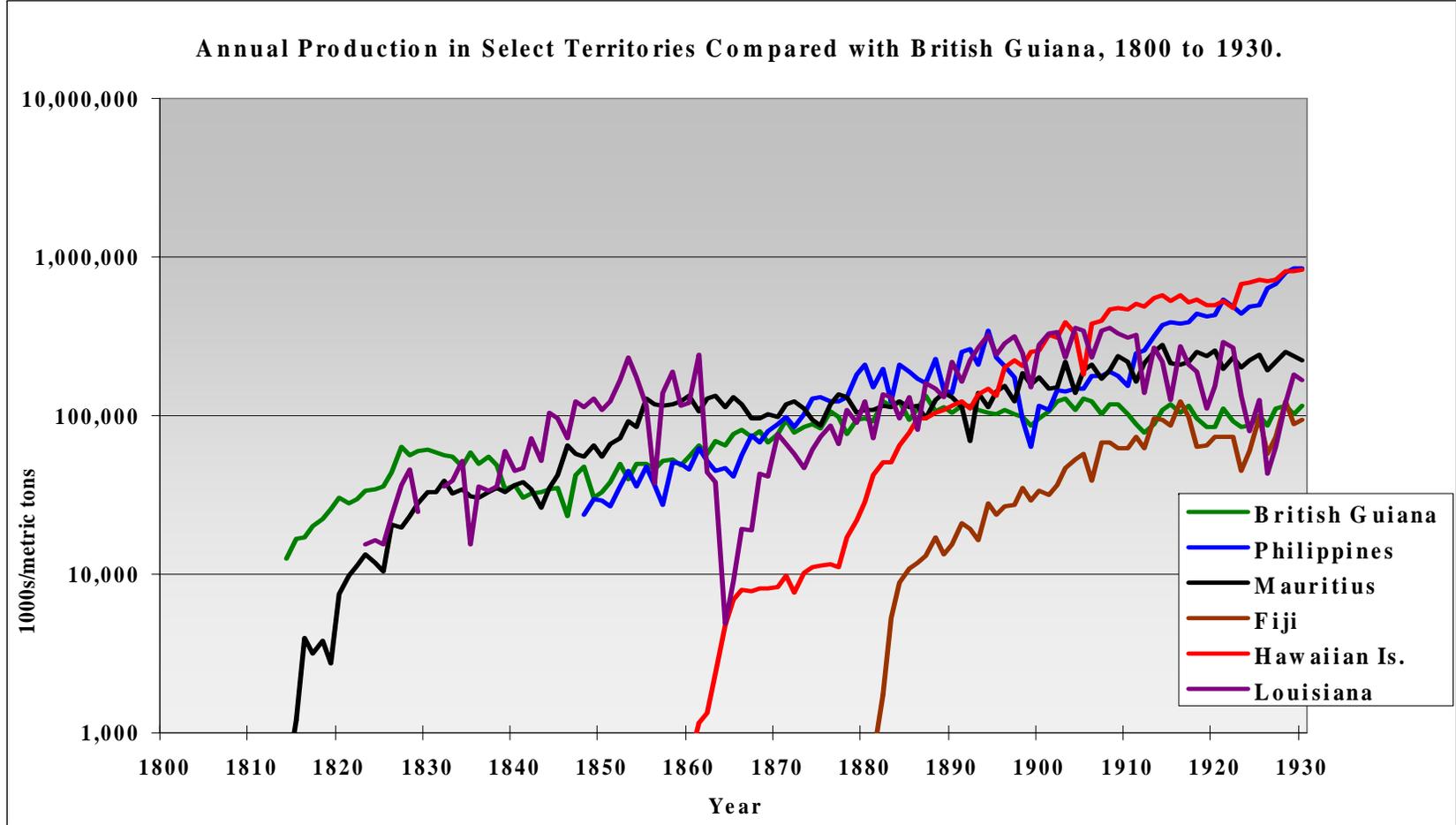


Figure 3: World sugar production: select territories compared, 1800 to 1930.<sup>89</sup>

<sup>89</sup> Ibid.

As with other sugar-producing territories, responses to the challenge of modernization hinged on availability of resources, access to markets and government policies.<sup>90</sup> For British Guiana, the scarcity and rising costs of labor after slavery ended was the main reason for bankruptcy. Although the local legislature adopted protectionist measures and tried to keep labor on the plantations, the financial crisis was made worse by international competition from the Caribbean islands and from the Pacific mainly. The problems were compounded by difficulties associated with the peculiar microgeography of the local plantation zone.

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<sup>90</sup> Jock Galloway, *The Sugar Cane Industry. An Historical Geography From Its Origins to 1914* (Cambridge: Cambridge University Press, 1989; reprint edition, 1991), p. 143.

## CHAPTER 2

### AN INDELIBLE FOOTPRINT. THE HISTORICAL ECOLOGY OF GUIANA'S SUGAR

#### Section One

Commercial sugar production in British Guiana began at inland sites, but shifted to the Atlantic shore at the start of the nineteenth century. Throughout the reclaimed coastal belt cotton, coffee, and other crops were cultivated on large plantations and shipped to overseas markets. Sugar monoculture prevailed from the 1830s and each plantation became a factory-in-field with the processing 'manufactories' adjoining the canefields. Attempts to reserve land for sugar clashed with the evolving needs of human settlement in the plantation zone, irrevocably altering the natural environment.

#### **The geophysical environment**

Guyana is located on the northeastern shoulder of South America, at approximately 0.9° and 8.7° and -56.3° and -61.6°. It shares borders with Venezuela to the west, with Suriname to the southeast, and with Brazil to the south and southwest. Its northeast Atlantic coastline is approximately 270 miles (435 kilometers) long.<sup>91</sup>

Prior to European settlement in the 1750s, the sugar-growing region was a vast unoccupied plain stretching from the mouth of the Pomeroon River in the north to the Corentyne River in the southeast.<sup>92</sup> The belt—covering approximately 1,750 square miles (4,532.5 square kilometers) and between 10 to 40 miles (16 to 64 kilometers)

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<sup>91</sup> The Guyana coast is part of an extended littoral encompassing the Atlantic shorelines of Venezuela, Guyana, Suriname, French Guiana and Brazil. The sugar-production district runs parallel to the coast from the north to south east.

<sup>92</sup> 'Amerindians' are the indigenous people of Guyana. Nomadic groups exploited the varied but seasonal marine food sources of the mudflats, as well as the flora and fauna of the forests.

wide—was substantially altered over time to provide a suitable physical environment for commercial agriculture.<sup>93</sup>

Guyana has many rivers, creeks and smaller waterways. Its largest river, the Essequibo, traverses the length of the country following a course of 600 miles (966 kilometers) The Demerara, the Berbice and the Corentyne—on the border with Suriname—are also of considerable length with numerous tributaries. The district extending northwest from the mouth of the Essequibo to the Pomeroon River is the Essequibo Coast, (formerly the “Arabian”, “Arabisi” or “Arabisci Coast”) Eastward from the estuary of the Essequibo to the Demerara River is ‘West Coast Demerara’. The banks of the Demerara are called the West Bank (right) and East Bank (left) Demerara, respectively. Eastward from the capital Georgetown, (situated at the confluence of the Demerara River and the Atlantic Ocean) to the Mahaica River is ‘East Coast Demerara’ and between New Amsterdam (at the mouth of the Berbice) and the Corentyne River is the Corentyne Coast. **(Figures 4 and 5)**

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<sup>93</sup> Wagner, p. 3. Dalton claimed that coastal clays were alternately blue or yellow in color, the blue type naturally rich in organic matter and more fertile than the yellow clays which were not as productive. Dalton, *History of British Guiana*, 1, pp. 10-11.

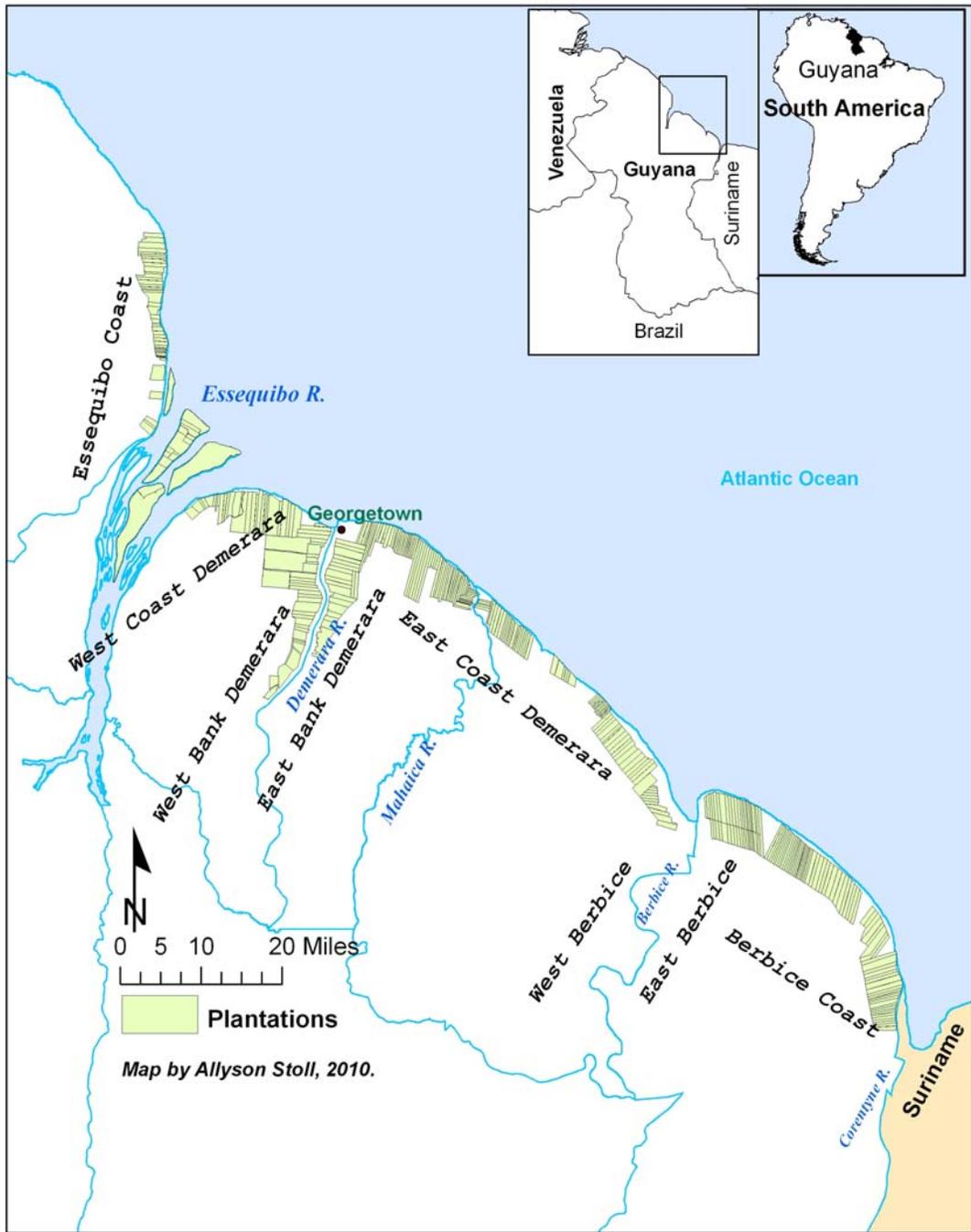


Figure 4: The British Guiana coast circa the 1850s.

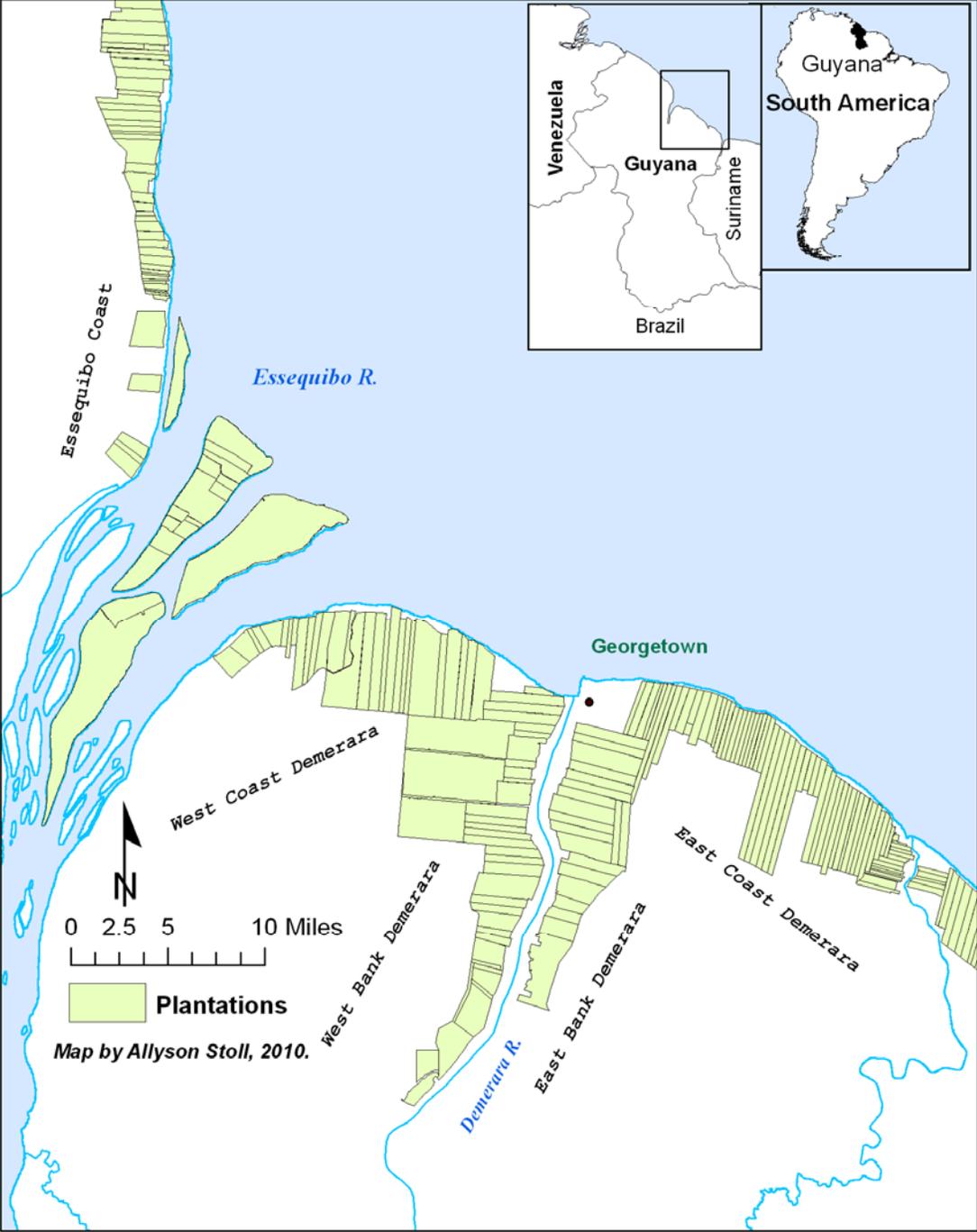


Figure 5: Plantations along the Atlantic coast.

## Climate, rainfall and soils

Sugar cane is a tropical plant requiring warm temperatures and abundant rainfall for maximum yield. Even with ideal climate, cultivation methods vary according to the soil type and availability of resources—human and mechanical—to work the land. Climate is an important variable as the amount of sunshine the cane receives during its growth cycle influences the amount of extractable sugar (sucrose). Excessive rainfall during the harvest delays cutting and causes standing cane to rot.

Climate in Guiana during the nineteenth century was more temperate than other areas at the same latitude.<sup>94</sup> The colony recorded a mean annual temperature of 81° Fahrenheit (27.2° Celsius) with high annual rainfall varying between 70 and 130 inches (1778 to 3302 millimeters) along the coast.<sup>95</sup> A primary (long) wet season that commenced in the middle of April lasted until the beginning of August preceding a primary dry season that extended to November. A secondary (short) wet season followed and continued until January, succeeded by a brief dry spell that prevailed until April. Maximum rainfall occurred during the warmest months.<sup>96</sup>

Wind patterns along the coast varied with the seasons. Northeast trade-winds averaged ten to fifteen miles per hour (16 to 24 kilometers) with occasional higher and destructive gusts and squalls along the shoreline during the wet months of December and January. From March to May the winds were lighter, holding to the northeast and

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<sup>94</sup> Schomburgk, *A Description of British Guiana* (London: Simpkin, Marshall, and Co., 1840), p. 17. The effect of climate on sugar production is discussed in this dissertation, **Land preparation and planting strategies, CHAPTER 3.**

<sup>95</sup> Rainfall data were kept from 1846 until 1857 by Patrick Sandeman. The Government Botanic Station (Georgetown) commenced twice daily meteorological observations from 1899. Arthur Braud of Plantation Mon Repos (East Coast Demerara) kept a record for 20 years from 1864 and by the end of the 19<sup>th</sup> century each estate had its own rain gauge. George D. Bayley (ed.), *Handbook of British Guiana 1909* (London: Dulau & Company, 1909), p. 91; *Timehri*, III (1884), 150-51; “No Drought There”, *Louisiana Planter*, No. 5, IV (1890), 67; Wagner, p. 14 quoting John H. Vann, *The Physical Geography of the Lower Coastal Plain of the Guiana Coast* (Washington: Office of Naval Research, 1959), p. 75.

<sup>96</sup> Bayley (ed.), p. 93.

stronger in June and July when they were accompanied by heavy rain. South-easterly winds prevailed from August to November with frequent long lulls during the dry spell.<sup>97</sup> These winds were usually calmer with speeds of six to twelve miles (9.7 to 19.3 kilometers) per hour.<sup>98</sup>

Soil composition within the sugar belt was of three distinct types. Land closest to the sea featured dense, saline alluvial clays, known as ‘frontland clays’, that extended up the estuarine banks of the largest tidal rivers—Essequibo, Demerara and Berbice—the salinity decreasing where riverain clays began. Inland from the sea coast lies ‘pegasse’, the acid, spongy peat overlay approximately four feet (1.2 meters) deep.<sup>99</sup> Pegasse, not as fertile as the clays on account of its acidity, was the dominant soil on the backlands of many plantations. Elevated sand reefs, the fossilized remains of submerged coastlines—punctuate the sugar belt in places that are useless for commercial agriculture.

The frontland and riverain clays, though fertile and suited to cane cultivation, were nevertheless deficient in organic matter. Highly productive under ideal conditions, habitual oversaturation during seasonal rains promoted leaching of essential minerals into the runoff. These clays also dried out rapidly to the point where surface cracks appeared during droughts. Dry weather also concentrated the alkaline components, an especially detrimental factor as pH levels greater than four stunt cane growth.

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<sup>97</sup> Ibid. Schomburgk, p. 17.

<sup>98</sup> Guiana plantations depended on the constancy of the wind patterns when windmills drove crushing machinery. However, prolonged high winds flattened or uprooted mature canes and reduced yield.

<sup>99</sup> The coastline was the result of geological activity that culminated in the rise in the level of the South Atlantic +6000 B.P and the concurrent submergence of the tidal shoreline between the Orinoco River in Venezuela and the Essequibo River in Guyana. Further tectonic subsidence and rise in the sea level promoted the growth of vegetation and deposition of a layer of peat on top of the clay. See Denis Williams, “The Archaic of North-Western Guyana”, *History Gazette*, No. 7 1989, 1. Also \_\_\_\_\_, *Prehistoric Guyana* (Kingston: Ian Randle Publishers, 2003), **passim**.

## The pre-plantation ecology

Prior to colonization the coast was uncultivated though inhabited seasonally by Amerindian tribes who harvested crabs and other shellfish along the shoreline.<sup>100</sup> At the time of European arrival, the coastal vegetation consisted of a dense line of Black and White Mangrove (*Rhizophora Mangle* and *Langunculariaracemosan*) and brush interspersed with the Courida (*Avicenna nitida*, *tormentosa* and *Conocarpus erectus*).<sup>101</sup> Lofty Silk Cottons (*Bombax Ceiba*) punctuated the tree line as did clusters of palm—the Manicole (*Euterpe edulis* and *oleracea*), the Coconut (*Cocos nucifera* L.), Troolie or ‘Truli’ (*Manicaria saccifera*) and the Ite (*Mauritia flexuosa*).<sup>102</sup> Various durable timber species such as the Mora (*Dimor Phandra Mora*) and Wallaba (*Eperua falcate-Jenmani*) were also present.<sup>103</sup>

A varied and specialized fauna inhabited the region. Snakes exceeding thirty feet long (9 meters) were not uncommon and the swamp fringe bordering the coast was dominated by flocks of Scarlet Ibis (*Eudocimus ruber*), White Egret (*Ardea alba egretta*) and other bird, insect, reptile and mammal species.<sup>104</sup> Although upriver locations were free of mosquitoes, they were a constant plague along the coast.<sup>105</sup>

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<sup>100</sup> Guyana’s prehistoric settlement patterns and cultural sequences are explained in Williams, *Prehistoric Guyana*, **passim**.

<sup>101</sup> Dalton, I, 6-7; Schomburgk, p. 29.

<sup>102</sup> Everard F. Im Thurn, *Among the Indians of Guiana* (London: Kegan Paul, Trench and Co., 1883), pp. 100-02. See also *British Guiana* (1924), pp. 50-58. Troolie is a popular thatching material.

<sup>103</sup> Thomas Staunton St. Clair, *A Residence in the West Indies and America* (London: Richard Bentley, 1834), I, 88-89; [Brumell], pp. 16-17. *British Guiana*, pp. 52. Riparian vegetation is classified by Fanshawe as swamp forest, swamp woodland, arborescent woodland and swamp, herbaceous swamp, semi-aquatic swamp and aquatic swamp. (D. B. Fanshawe, “Riparian Vegetation in British Guiana”, *Journal of Ecology*, XLII (July 1954), 295.

<sup>104</sup> George Pinckard, *Notes on the West Indies* (London: Longman, Hurst, Rees, and Orme, 1806), III, 7; Schomburgk, p. 29.

<sup>105</sup> Edwards, IV, 245; Hilhouse, “Agriculture in 1829. II”, pp. 248-283, **passim**.

## **Agriculture and the transformation of the Guiana coast**

The coast was not the original locale of industry.<sup>106</sup> Early Dutch traders-cum-settlers had confined themselves to the upper reaches of the waterways in order to trade with the Amerindians and escape attacks by privateers which persisted until the late eighteenth century.<sup>107</sup> The first colonists believed that the estuarine swamps were unhealthy and that inland soils were the most fertile until tests in the 1740s proved that the coastland was as productive, especially for cotton.<sup>108</sup> There were also underlying economic reasons for the downriver shift quite apart from the accepted geographic and socio-political motivations.<sup>109</sup>

Initially, cane was not the only crop grown although it might have been the first tried on a large scale.<sup>110</sup> The first planters favored a mixed cultivation tailored to their resources and the microclimate.<sup>111</sup> New land was first cropped with plantains and cotton as the excessive robustness of cane harvested from virgin soils made for a more

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<sup>106</sup> The first downriver plantations emerged on the estuarine island of Wakenaam (Essequibo River) in 1741. Subsequently the Atlantic coast between the Essequibo and Demerara Rivers and nearby islands was empoldered for cane and cotton cultivation. See Dalton, I, 224-45. In 1775 the Dutch began constructing Canals Numbers 1 and 2 on the west bank of the Demerara and another on the eastern bank and new coastal and riverain lands were opened up for agriculture. Plantation cultivation, ongoing since the sixteenth century in the upper Berbice River, relocated downstream to East and West Bank Berbice. New plantations also extended eastward along the coast to the Corentyne River border with Suriname. (See Map 1)

<sup>107</sup> Hilhouse, "Agriculture in 1829. II", p. 263. Essequibo settlements were attacked by the French in 1657 and 1712. Berbice was attacked in 1689 and 2 colonists held for ransom by the French Admiral du Casse. In 1781 Lord Rodney of Britain took Demerara, Essequibo and Berbice which were retaken by the French in 1782. Dutch fortifications date to the 17th century. Ruins exist at Fort Nassau on the Berbice River, at Fort Island and Kyk-over-al Island on the Essequibo. A survey is given in Allyson Stoll-Azaire, *Dutch Contribution to the Built Heritage of Guyana: the Issue of Fortifications from the Seventeenth to the Nineteenth Centuries* (Unpublished M.A. thesis, Pedro Henriquez Ureña National University, August, 2001)

<sup>107</sup> Dalton, I, 224; Pinckard, III (1805), 402; Hilhouse, "Agriculture in 1829. II", p. 250.

<sup>108</sup> Pinckard, III, 402; Henry Bolingbroke, *A Voyage to the Demerary* (Philadelphia: M. Carey, 1813), pp. 66; Dalton, I, 224 and Hilhouse, "Agriculture in 1829. II", p. 250.

<sup>109</sup> Klaas Kramer, "Plantation Development in Berbice from 1753 to 1779: The Shift from the Interior to the Coast", *New West Indian Guide/Nieuwe West-Indische Gids*, No. 1/2, LXV (1991), 51-65

<sup>110</sup> Thompson, *Colonialism and Underdevelopment*, pp. 24 and 35.

<sup>111</sup> See Wagner, *Structural Pluralism...*, **passim**.

profitable conversion to rum rather than sugar.<sup>112</sup> Early plantations exported raw cotton, coffee, cocoa, indigo and tobacco and the enslaved raised subsistence crops of cassava and plantains to feed themselves and their captors.<sup>113</sup>

Cotton was most lucrative for the first ten to twelve years after the initial opening up of a plantation and required few inputs aside from enslaved labor.<sup>114</sup> At the close of the eighteenth century the section of the coast between the Demerara River and Berbice harbored some 116 cotton plantations and only one sugar plantation—Kitty—near the mouth of the Demerara.<sup>115</sup> However, 111 of them were abandoned between 1809 and 1824, in Berbice alone, and production was negligible after the 1820s.<sup>116</sup> **(Figure 6)** The decline was attributed to competition from a cheaper product made with improved technology and slave labor in the southern United States, to ‘blast’ disease which rotted the cotton seeds and butterfly larva which destroyed the plants.<sup>117</sup>

Early colonists also cultivated Arabian (‘Creole’) and Liberian varieties of coffee which were grown together with plantains whose broad leaves shaded the young coffee plants.<sup>118</sup> In 1810 Plantation Le Reduit (Redoubt) on East Coast Demerara counted 150,000 coffee shrubs as well as seventy acres (28 hectares) of cotton.<sup>119</sup> Ruimveldt, Cornelia Ida and Good Hope were coffee plantations in 1816 but

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<sup>112</sup> Edward Bancroft, *Essay on the Natural History of Guiana, in South America* (London: T. Becket and P. A. De Hondt, 1769), pp. 12-13; Hilhouse, “Agriculture in 1829”, *Timehri*, new series, (1897), II, 32.

<sup>113</sup> J. E. Tinné, “Opening up the Country”, *Royal Gazette Sundry Pamphlets XII* (1879), p. 3.

<sup>114</sup> Hilhouse, “Agriculture in 1829”, p. 49.

<sup>115</sup> Pinckard, III (1806), 403; E. F. Im Thurn, “Essequibo, Berbice and Demerara under the Dutch. Part III”, *Timehri III* (1884), 23.

<sup>116</sup> Adamson, p. 25.

<sup>117</sup> *Ibid*; Wagner, p. 27; Schomburgk, p. 103; Hilhouse, “Agriculture in 1829”, 268; [Brumell], p. 12.

<sup>118</sup> Adamson, p. 32. In 1839, Lodge Estate at the mouth of the Demerara grew plantains in between its coffee shrubs. (Henry Capadose, *Sixteen Years in the West Indies* (London: T.C. Newby, 1845), p. 202.

<sup>119</sup> GB0101 ICS 70/8-1, 17 December, 1810. (ICS)

later converted to cane.<sup>120</sup> Meten-meer-zorg, with approximately 130 acres (53 hectares) of canefields in 1817, also grew coffee.<sup>121</sup>

Local coffee—a superior product with a high market-value traded as ‘Dutch coffee’—matured slowly and was less profitable than cane. Competition from British-ruled India, Ceylon (Sri Lanka), the Straits Settlements (now part of Malaysia) and Jamaica also contributed to the demise of coffee cultivation in Guiana. Exports declined precipitously from the 1820s after a brief resurgence in 1831, continued to fall off and ceased altogether in the 1840s.<sup>122</sup> **(Figure 6)**

Cacao was another early staple of the plantations but a sharp decline in prices after 1824 ended cultivation.<sup>123</sup> The crop was restricted to forested upriver zones where natural tree cover provided shade and windbreaks to counter strong breezes.<sup>124</sup> For a time, the prerequisites of growing cocoa effectively forestalled complete denudation of the plantation zone as the plants thrived under the cover of trees.

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<sup>120</sup> SY 30, 12 July 1816. (ICS)

<sup>121</sup> ST 55, 26 November 1817. (ICS)

<sup>122</sup> The Berbice districts, especially, were renowned for a high quality coffee. (Raymond T. Smith, *British Guiana* (London: Oxford University Press, 1962), p. 61. Essequibo, Demerara and Berbice exported nearly 2 million pounds of coffee in 1831. Edward McGeachey, *Irrigation in the West Indies* (Kingston: self-published, 1846), p. 19. Seaforth Bellairs, a Guiana planter, affirmed that cotton was last exported in 1843 and coffee exports ceased in 1846. Seaforth Bellairs, “Sugar-making in Demerara”, *Littell’s Living Age*, CLXXV (October-December 1887), 609.

<sup>123</sup> Great Britain, “The British West India Colonies”, *Parliamentary Papers IX* (1830-31), pp. 104-05

<sup>124</sup> Hilhouse, “Agriculture in 1829. II”, 268; [Brumell], p. 12; James Rodway, *Handbook of British Guiana* (Georgetown: Literary Committee of the Royal Agricultural and Commercial Society, 1893), p. 90. Cacao pods were easily dislodged by high winds.

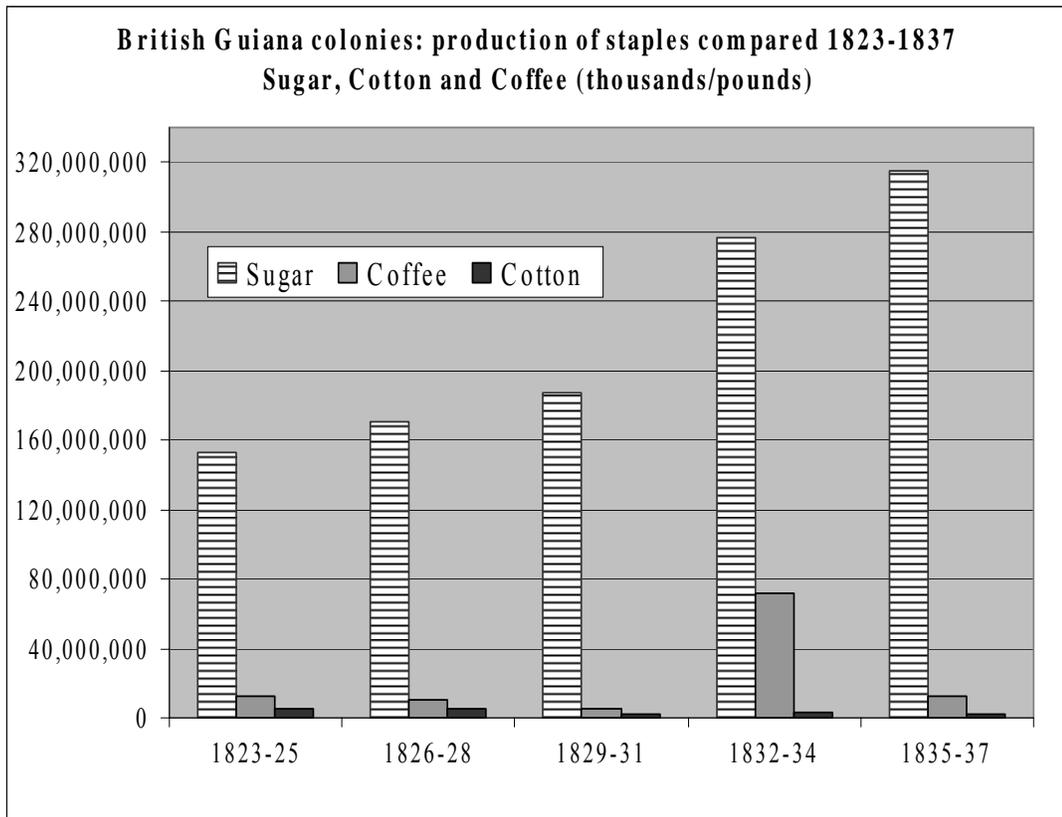


Figure 6: Sugar, coffee and cotton production compared, 1823 to 1837.<sup>125</sup>

Overwhelmingly, early colonists practiced a shifting cultivation which afforded minimal disturbance of the natural environment.<sup>126</sup> They also kept clearance of surrounding vegetation to a minimum, thinning out tree-cover only where buildings were erected and maintaining “greenswards” between the main house and waterway onto which each plantation fronted.<sup>127</sup> Loss of protective cover concomitant with expanding canefields hastened the demise of coffee, cocoa and cotton and was also a hindrance to the plantain, an important food crop that also needed protection from seasonal cold air and high winds.<sup>128</sup>

<sup>125</sup> Ibid. See **APPENDIX 3** for tabulated data.

<sup>126</sup> James Rodway, “Nature’s Triumph”, *Popular Science Monthly*, XLVI (February 1895), 456-57.

<sup>127</sup> Rodway, *Handbook of British Guiana*, p. 88.

<sup>128</sup> Hilhouse, “Agriculture in 1829”, p. 53.

### **Establishing plantations: layout and reclamation**

By the end of the eighteenth century a majority of settlers had relocated to the Atlantic coast. However, as the terrain was flat and below the high-water mark the recovery of land for farming required adequate drainage and protection from tidal surges and water that remained on the land after heavy seasonal rainfall. Correspondingly, a system was needed to import fresh water during drought and for fallowing land to boost productivity.<sup>129</sup>

Tracts of land were laid out perpendicular to the seacoast and, where established along the banks of rivers, fronted onto those waterways. The first plots given out on the coast in the early nineteenth century were approximately 250 acres (101 hectares), and at least 100 rods (0.37 kilometer) wide at the ‘façade’ and extended back for 750 rods (2.8 kilometers).<sup>130</sup> If two-thirds of the plot was successfully cultivated, the owner was entitled to extend his plantation inland and could occupy a further 250 acres and even more as needed.<sup>131</sup> Plots were numbered in ascending order beginning at the estuaries and proceeding upriver and along the coast from west to east.<sup>132</sup>

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<sup>129</sup> Flood-fallowing is discussed in **CHAPTER 3**. Deerr established that irrigation was negligible in Demerara. Noel Deerr, *Cane Sugar A Textbook on the Agriculture of the Sugar Cane, the Manufacture of Cane Sugar, and the Analysis of Sugar-House Products*, (London: Norman Rodger, second revised and enlarged edition; 1921), pp. 110-11.

<sup>130</sup> See the Glossary for an explanation of the term *Façade*. The Dutch *rod* (‘*rood*’ or ‘*roden*’ [pl.]) corresponds to a measurement of 12 feet 4 inches (3.75 meters.) In 1835, a Government circular confirmed that the usual land grant measuring 100 *roeden* at the façade with a depth of 300 *roeden* was the equivalent of a 100-acre plot. (Great Britain, *Parliamentary Papers XXXIX* (1851), 20)

<sup>131</sup> [Brumell], p. 24; Robert Montgomery Martin, *History of the Colonies of the British Empire* (London: Wm. H. Allen and Co., 1843), p. 118; Dalton, I, 227; Robert Tennant, *British Guiana and Its Resources* (London: George Philip and Sons, 1895), p. 16; J. Geoghegan, *Note on Emigration from India* (Calcutta: Office of Superintendent of Government Printing, 1873), p. 108.

<sup>132</sup> Wagner, p. 15. Villages currently bear English, French and Dutch-derived names.



Figure 7: Rudimentary sea defenses in 1902.<sup>133</sup>

Individual tracts were surveyed to establish their boundaries after which the vegetation was cut down and the entire plot burnt.<sup>134</sup> Alternatively, tree stumps and brush were heaped into rows and allowed to decay naturally in situ as some planters felt that mulch was more fertile than ash.<sup>135</sup> This phase comprised the first substantial alteration of the environment marked by substantial denudation of the area intended for growing cane.

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<sup>133</sup> Frank Gray, "The Shore of Demerara and Essequibo, British Guiana, *Geographic Journal*, No.4, XX (October 1902), 408.

<sup>134</sup> [Brumell], pp. 17-18 and 29; Alexander MacRae, *A Manual of Plantership in British Guiana*, (London: Smith, Elder & Co., 1856), p. 18, and Noel Deerr, *Sugar and the Sugar Cane: An Elementary Treatise on the Agriculture of the Sugar Cane and on the Manufacture of Sugar* (Manchester: Norman Rodger, 1905), p. 25.

<sup>135</sup> See this dissertation **Land preparation and planting strategies, Soil enhancement experiments, and Cane disease and pest research, CHAPTER 3.**



Figure 8: A section of improved sea wall circa 1924.<sup>136</sup>

Despite the extreme land clearance methods that accompanied cane monoculture, some natural vegetation was retained as a bulwark against the encroaching sea. Mangrove and Courida were grown along the sea shore as supports for the earthen dams.<sup>137</sup> Until the 1920s some sea-dams were faced with tree branches held together by wooden spars. Stone or brush groynes also helped keep out the sea.<sup>138</sup> **(Figures 7 and 8)**

Each pair of plantations was separated from its neighbors by a ‘Company Path’, a reserve averaging twenty-four to seventy-four feet wide (7.3 to 22.5 meters)<sup>139</sup> Company Paths were formed by excavating double canals—‘Company Canals’—and embanking the earth in the middle. The Paths served as access roads to a second tier of

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<sup>136</sup> *British Guiana*, (Wembley: British Empire Exhibition, 1924), no page. (online)

<sup>137</sup> Rodway, *Hand-book of British Guiana*, 30; Gray, “The Shore of Demerara and Essequibo...”, 408.

<sup>138</sup> Gray, p. 410.

<sup>139</sup> Bancroft, p. 362; Pinckard, III (1806), 389-394; [Brumell], pp. 28-29.

plantations opened up behind the first. The Canals also acted as safety-valves, holding excess water that could not be removed through natural drainage. Conversely, when freshwater was scarce, the dual purpose canals took in sea water at high tide and retained it behind sluice gates. In addition, the force of water released at low tide cleared silt that frequently obstructed the outfalls.<sup>140</sup>

Each plantation was accessed by a substantial path built up just inside its main or ‘front’ (sea or river) dam. As natural stone was unavailable on the coast, the dams were topped with roughly-fired clay brick.<sup>141</sup> Paths were linked and served as the main public thoroughfare for each district. The linked paths evolved into the first public roadway linking the plantations with the capital, Georgetown.<sup>142</sup> Plantations could also be accessed by sea or river. Each had a ‘stelling’—a raised wooden wharf—in its front dam to discharge and receive passengers, rations and produce. Shipping was superseded by a public road and rail system in the late nineteenth century.

### **‘Empoldering’**

None but Hollanders could ever on such a continent, have thought of robbing the sea, or fencing it out from a swampy coast with such intense labour as is found continually necessary to keep up the cultivation. The original Dutch colonists, indeed, seem to have sought, in this country, only another Holland, and they, in a district boundlessly rich and uncultivated, set, at an early period, about gaining land from the sea! They accordingly planted themselves on the muddy land of the sea-shore, where they had the comforting reflection that they must necessarily be drowned by the sea on one side or by the bush water on the other, unless they were protected by dykes.<sup>143</sup>

Physician John Hancock’s commentary confirms the colonial origins of land reclamation in British Guiana but fails to acknowledge the herculean work of the

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<sup>140</sup> William Russell, “Farming and Irrigation”, *Timehri*, I (1882), 87.

<sup>141</sup> J. Geoghegan, p. 108

<sup>142</sup> *The New Local Guide of British Guiana*, p. 3.

<sup>143</sup> John Hancock, *Observations of the Climate, Soil and Productions of British Guiana & c.*, (London: J. Fraser, 1835), p. 6.

enslaved.<sup>144</sup> ‘Task-gangs’ of captive Africans dug trenches, built dams and canals and prepared the land for cultivation.<sup>145</sup>



Figure 9: Nineteenth century cane field with navigation canal.<sup>146</sup>

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<sup>144</sup> There is little evidence of systematic, large-scale enslavement of indigenous people. However, small parties of Amerindians were occasionally hired for land clearance and to remove weeds from canals and trenches in the nineteenth century. [Brumell], p. 29

<sup>145</sup> See Rodney, *A History of the Guyanese Working People*, p. 1. Captive Africans carried out their tasks so ably they many were purchased specifically for hiring out as work teams, garnering substantial profits for the enslavers. See J. E. Alexander, *Transatlantic Sketches Comprising Visits to the Most Interesting Scenes in North and South America and the West Indies with Notes on Negro Slavery and Canadian Emigration* (Philadelphia: Key and Biddle, 1833), I, p. 29; Rodney, *A History of the Guyanese Working People*, pp. 2-3.

<sup>146</sup> J. Siza (Photographer), Plate 56. *Views of British Guiana*, [1900], Schomburg Center for Research in Black Culture/Photographs and Prints Division, New York Public Library. (Online) Workers are laying harvested cane on a dam in preparation for loading onto the punt in the background.

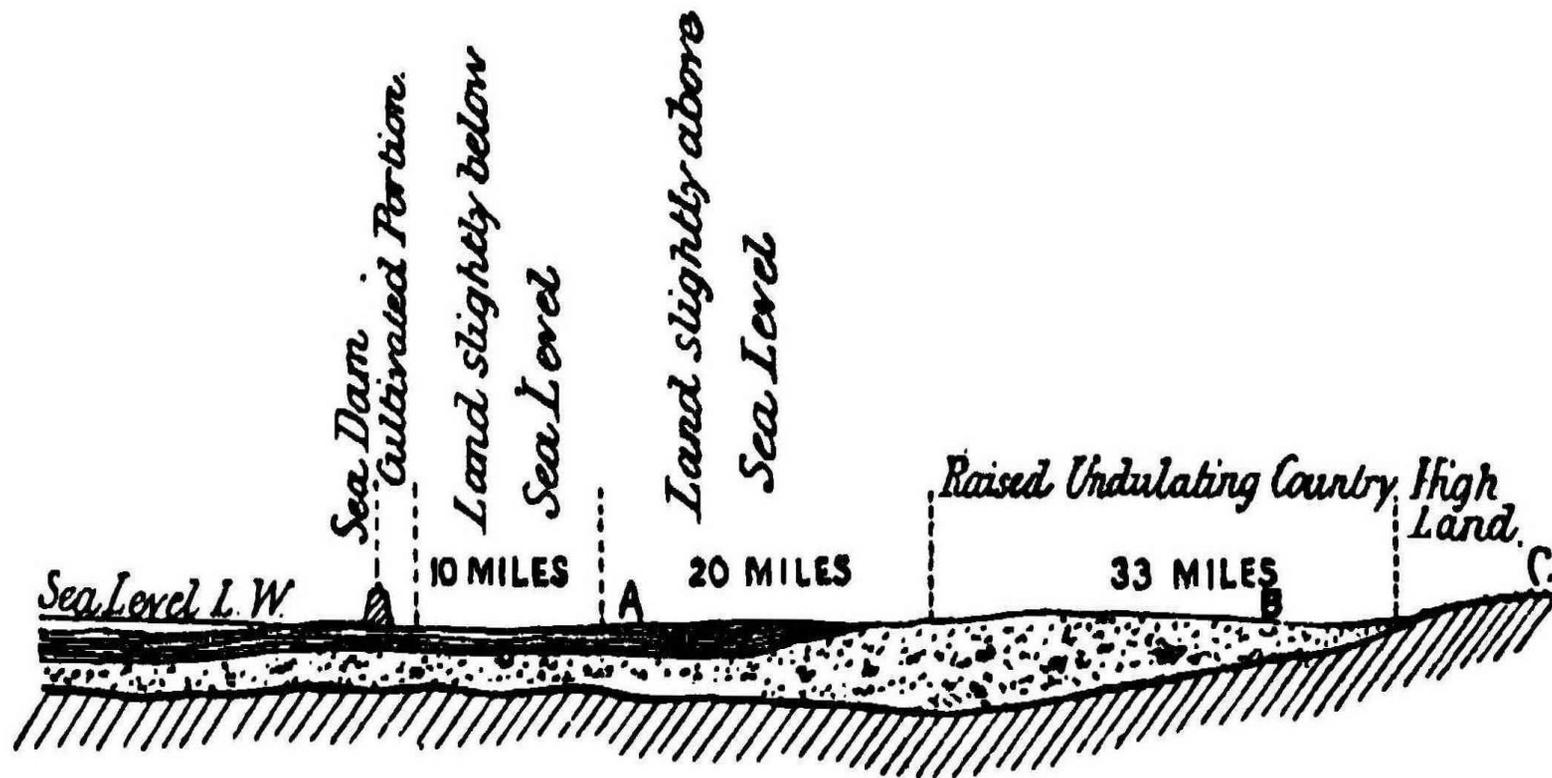


Figure 10: Section through the Demerara coast.<sup>147</sup>

<sup>147</sup> John Scott, *Draining and Embanking* (London: Crosby, Lockwood and Co., fourth edition; 1883), p. 88. The diagram shows relative levels of land and sea at low tide.

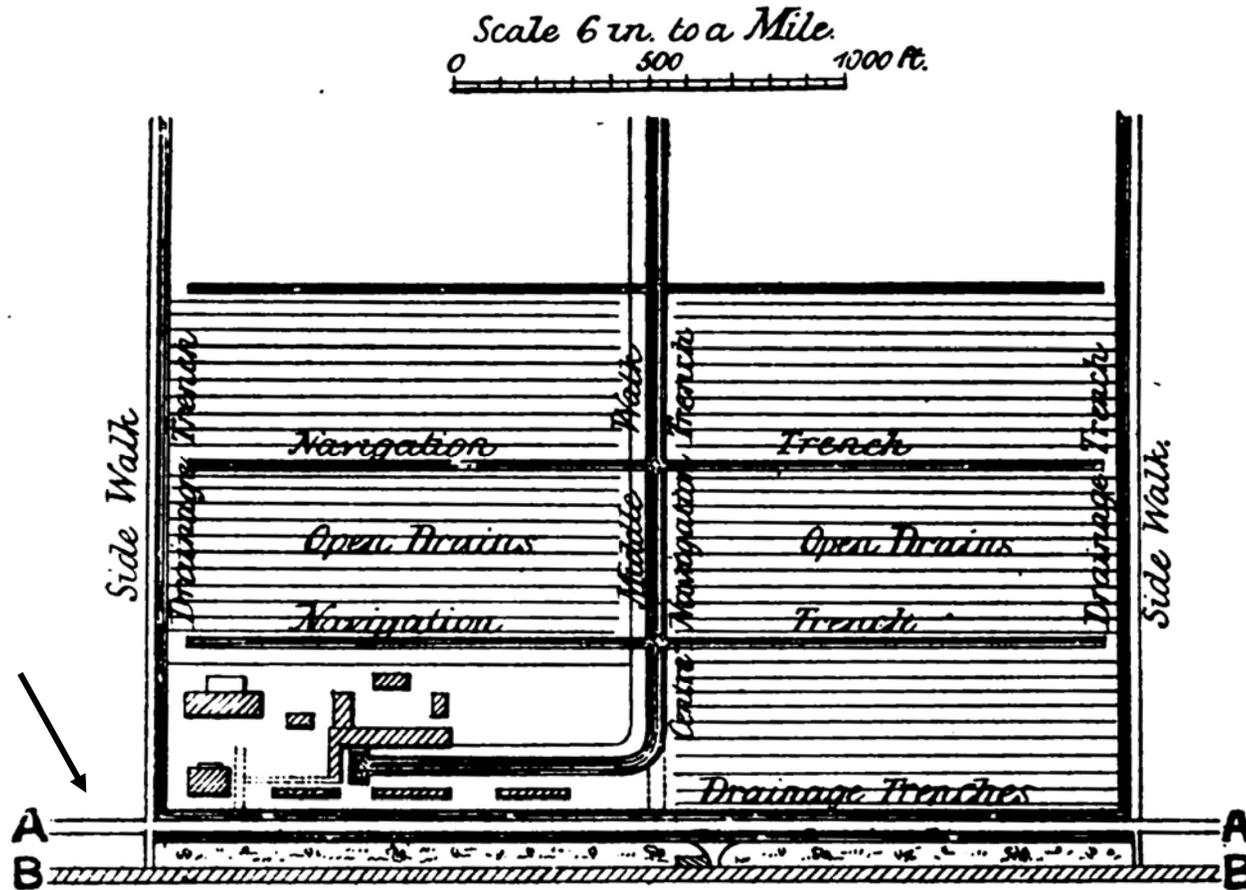


Figure 11: Nineteenth century sketch of a typical empoldered plantation.<sup>148</sup>

<sup>148</sup> John Scott, *Farm Roads, Fences and Gates: A Practical Treatise on the Roads, Tramways, and Waterways of the Far* (London: Crosby, Lockwood and Co., 1883), p.78. (A) is the front-dam and (B) the sea-wall. The middle walk diversion to the processing complex is at bottom, center and left.

Installing the water management infrastructure was the most important phase in setting up a plantation. The process—called ‘empoldering’—reclaimed land by keeping out the sea in front and containing rain run-off in the rear.<sup>149</sup> Empoldering isolated a usable plot of land—a *polder*—retained fresh irrigation water and drained away the excess. A distinctive facet of the *polder* is the separation of irrigation and drainage functions within its interconnected canal system.



Figure 12: Aerial view of Skeldon Estate, Berbice.<sup>150</sup>

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<sup>149</sup> The tasks of empoldering are detailed in [Brumell], pp. 23-29, **passim**. Deerr, *Sugar and the Sugar Cane*, p. 26; \_\_\_\_, *Cane Sugar...*, Chapter VIII: The Husbandry of Cane, 126-128; W. Gresham Nicholson, “On Empoldering Land, Planting, Growing, and Reaping the Sugar Cane; giving Particulars of the Cost of the Different Operations in Detail”, *Sugar Cane*, VIII (1 September 1876), 467-476.

<sup>150</sup> [http://www.guysuco.com/about\\_gsc/gscoday/geog\\_layout/default.asp](http://www.guysuco.com/about_gsc/gscoday/geog_layout/default.asp). The punt dumper is left of center.

On Guiana plantations, the waterways served many functions – ‘navigation’ canals held fresh water for irrigation purposes and doubled as transportation conduits. Another set of ‘trenches’ discharged waste water into the sea or river than ran in front of the plantations. Within the empoldered plot, the excavation of two freshwater canals—‘center navigation canals’— generated an intervening dam or ‘middle walk’. A small koker in the back dam brought in irrigation water from the savannahs behind the plantations or from small creeks nearby for use during droughts.<sup>151</sup> The navigation canals also doubled as transportation waterways in which punts (small barges) carrying the harvest were floated to the factories, a section of the center canals and middle walk diverting to the ‘punt dumper’ or receiving dock of the mill. The middle walk served as the bridle path for draught animals harnessed to the punts. (**Figures 11, 12 and 13**)

After empoldering, the area to be cultivated was divided up into discrete fields called ‘cane-pieces’ ten to twenty acres drained by a grid of small trenches spaced at between twenty-five to thirty feet apart, (7.6 to 9.1 meters) The smallest units of cultivation in the field were the ‘beds’—averaging thirty-six feet long by nine feet wide (11 by 2.7 meters)—on which the cane was grown. Small wooden bridges provided access to the fields.<sup>152</sup>

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<sup>151</sup> J. Crabtree, “British Guiana Sugar Industry. Present Conditions and Future”, *Sugar*, no. 5, XXIV (1922), [Part Two], 270; United States Special Consular Reports, *Canals and Irrigation in Foreign Countries*, (Washington: Government Printing Office, 1891), pp. 59-59

<sup>152</sup> Deerr, *Sugar and the Sugar Cane*, p. 26; \_\_\_\_\_, *Cane Sugar...*, Chapter VIII: The Husbandry of Cane, 126-128, **passim**.

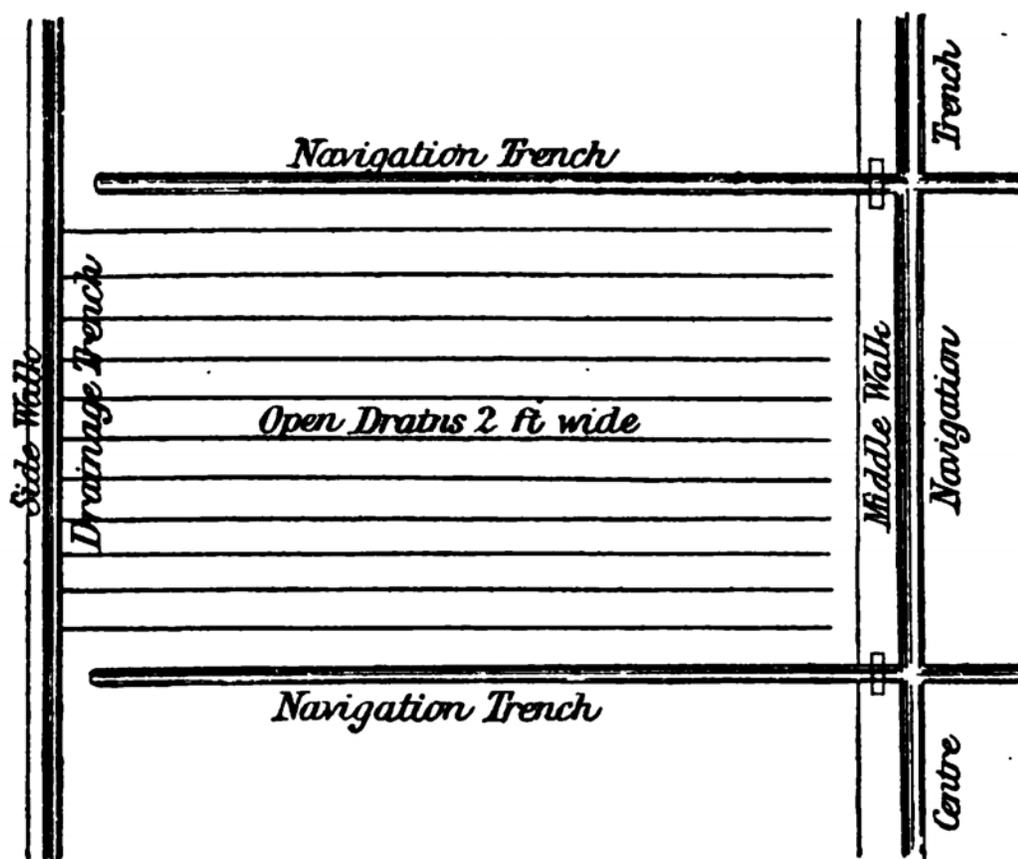


Figure 13: Detail of the drainage system of a typical canefield circa the 1880s.<sup>153</sup>

### The drainage problem

Sections of the Guiana coast are subject to natural phenomena that present recurrent problems for the sugar industry. From the mid-nineteenth century coastal plantations were afflicted by a thirty-year cycle of accretion and erosion that periodically wore away the sea-defenses, internal water-management infrastructure, roads and buildings and forced a constant and costly “daily struggle against the waves”.<sup>154</sup>

<sup>153</sup> Scott, *Farm Roads, Fences and Gates...*, p. 47.

<sup>154</sup> [Brumell], p. 23; Gray, p. 410.

The shoreline was fundamentally unstable and an observer summarized the dilemma:

The crux of the country's water-control difficulties lies in the fact that earth movement is continually taking place along the shore lines, and it is movement of a kind that is not constant in direction and effect, but consists of alternating periods of severe erosion and considerable accretion, creating the need for strengthening or rebuilding the local sea defenses or clearing the drainage outlets as the case may be.<sup>155</sup>

Plantation drainage was often compromised and the fields either perpetually waterlogged or too dry. Water control failure brought flooding that could destroy the cultivation. Breaches in the back-dams were more destructive as water entering from the rear remained on the land while sea or river overflow could be discharged through the kokers at low tide. In addition, naturally high ground water levels along the coast compromised plantation drainage as did periodic neap tides which caused overtopping of sea dams. Further, a natural thirty-year cycle of erosion and accretion generated shifting sandbanks that blocked outlets and internal waterways were often obstructed by aquatic weeds.<sup>156</sup>

An ominous change in the rainfall pattern was evident by the 1830s. Severe droughts occurred in 1826 and early in the 1830s and were followed by a devastating calamity from July of 1845 to August 1846 that caused irrigation canals to dry out. Another dry spell followed in 1852 and estates resorted to using salt water for irrigation during the exceedingly dry stretch from 1868-69. Another significant drought lasted from 1877 to 1879. **(APPENDIX 7)**

Droughts alternated with floods often within a single year or planting season. By the 1880s the biannual wet and dry seasons were occurring later than expected and, while the long dry season remained constant, the short dry spell had practically

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<sup>155</sup> J. A. E Young, *Approaches to Self-Government in British Guiana* (London: self published, 1958), p. 5. Soil specialists later identified natural bacterial activity that promotes the formation of an aerated honey-comb effect that predisposes the foreshore clays to erosion. (Shahabuddeen, p. 1)

<sup>156</sup> [Brumell], p. 23; and Gray, "The Shore of Demerara and Essequibo, British Guiana", p. 410.

ceased.<sup>157</sup> Where the average annual rainfall for the period between 1864 and 1889 was 79.25 inches (2012.95 millimeters), it rose to 109.38 inches (2778.25 millimeters) between 1889 and 1894.<sup>158</sup> Increased rainfall extended the drainage problem by raising the cost of maintaining the waterways and keeping the fields weed free. ‘Sour grass’ (*Paspalum conjugatum*), ‘wire grass’ (*Scirpus*) and ‘busy-busy’ (*Cyperus laxus*) bloomed uncontrollably and only persistent battles by ‘weeder gangs’ checked the choking growth that threatened to overwhelm the cultivation.<sup>159</sup> Natural drainage strategies were inadequate and artificial means were adopted.

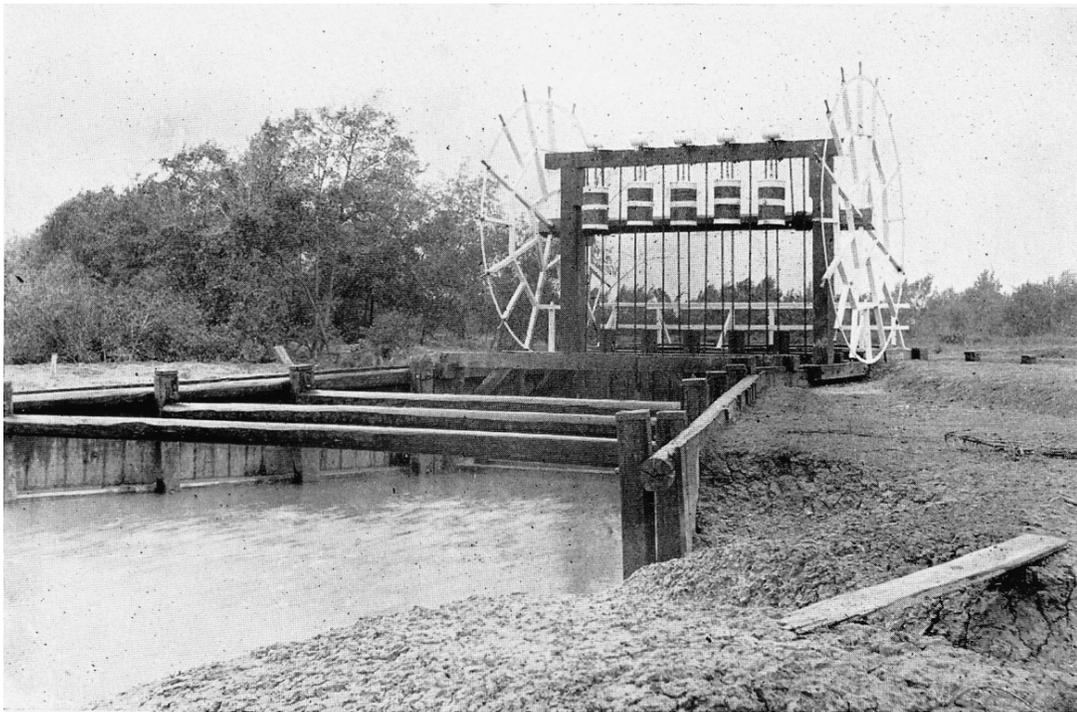


Figure 14: A nineteenth century koker.<sup>160</sup>

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<sup>157</sup> Schomburgk, pp. 17-18; James Gillespie, “Late Rainfalls; some of their Effects”, *Timehri*, new series (1894), VIII, 88-89.

<sup>158</sup> Gillespie, pp. 91-93.

<sup>159</sup> *Ibid.*, pp. 91-92.

<sup>160</sup> Edith A. Browne, *Peeps at Industries Sugar* (London: A. & C. Black, second edition; 1918), p. 16. The koker’s wheel, counterweights and pulleys and revetment to its outfall channel are visible.

### Natural and forced drainage

Natural drainage was aided by kokers (sluices) through which surplus water from the plantations drained to the sea or river at low tide. Kokers comprised two wooden columns or brick posts sunk into the reinforced sides of a drainage trench.

**(Figure 14)** The posts were connected by lintels over the canal and topped with a large wood-spoked wheel rigged with counterweights and pulleys that controlled a heavy, wooden door across the bottom of the canal.



Figure 15: Lily infestation in a freshwater canal in the 1890s.<sup>161</sup>

Koker ‘doors’ were either sliding or self-activated float valves. Self-acting valves opened outward as the tide fell below the level of the water in the canal and sliding doors were opened manually by a ‘koker operator’ turning the wheel. As the

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<sup>161</sup> Rodway, *Handbook of British Guiana*, facing page 77.

tide rose, the float valve closed automatically from the pressure of water rising outside, and an operator returned to lower the sliding door.<sup>162</sup>

Koker drainage construction was premised on the principles of drainage by intertidal gravity. The overflow normally discharged at low tide into outfalls which channeled it to the sea or river. However, the Atlantic coastline was frequently blocked by shifting banks of shell, sand and mud aggregate that accumulated in the channels outside the kokers.<sup>163</sup> In addition, weeds accumulated in the internal waterways and obstructed natural outflow. **(Figure 15)** Large, densely-packed, floating mats of water lilies and aquatic weeds were a frequent problem and laborers up to their necks in water clearing weeds was a common sight on plantations during the nineteenth century.<sup>164</sup> The blockages caused a buildup of water that could destroy the entire cultivation.<sup>165</sup> Coastal estates, most susceptible to problems with drainage, were the first to experiment with mechanized drainage.

A mechanical pump was tried, though unsuccessfully, at Haag's Bosch, East Bank Demerara around 1840.<sup>166</sup> A steam-powered scoop wheel tried at George Booker's Cane Grove estate also failed.<sup>167</sup> Finally, a scoop-wheel driven by an eighteen horse-power engine at Turkeyen, East Coast Demerara, in December 1843 was declared such a success that the Manager, John King, immediately shut off the natural drainage outlets on the estate.<sup>168</sup> Scoops were also used successfully at

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<sup>162</sup> MacRae, pp. 14-15.

<sup>163</sup> In Guyana, this notoriously sticky accretion is called 'sling mud'.

<sup>164</sup> [Brumell], pp. 25-26. The most common were the Water Hyacinth (*Eichhornia caerulea* and *E. azurea*), the Water Lettuce (*Pistia stratiotes*), Lotus (Nelumbium) and various lilies (*Nymphaea*)

<sup>165</sup> Ibid, p. 25.

<sup>166</sup> "Drainage in Demerara", *Mechanics' Magazine*, XL (January-June 1844), 190.

<sup>167</sup> Ibid.

<sup>168</sup> Ibid. King's wheel was still working some forty years after installation. (William Russell to W.A.G. Young, Government Secretary, 4 July 1882, (ICS). Russell's letter is a historical essay on the problem of coastal drainage and irrigation up to the 1880s.

Haarlem, West Coast Demerara, and at Hampton Court Estate on the Essequibo Coast.<sup>169</sup> (Figure 16) Local scoop wheels were described by ‘Argonaut’:

The axle or gudgeon is of cast-iron, wrought iron or steel, on which are keyed cast-iron bosses, which have sockets cast in to receive radial arms which are cotted to same; these radial arms, terminate in a rim, which has sockets cast in to receive the wood arms, which in their turn carry the scoops or boards—the outer edge of arms being braced together by means of a wrought-iron ring. The scoops thrash the water from the lower to the upper side, the upper side having a koker which is shut when the wheel is not working. The great thing is to get the angles of the scoops at the ingress and egress exactly right; otherwise a great loss of efficiency takes place, the wheel carrying a great quantity of water over at egress side and lifting it some feet, throwing it back to the ingress side; this of course means a great loss of power.<sup>170</sup>

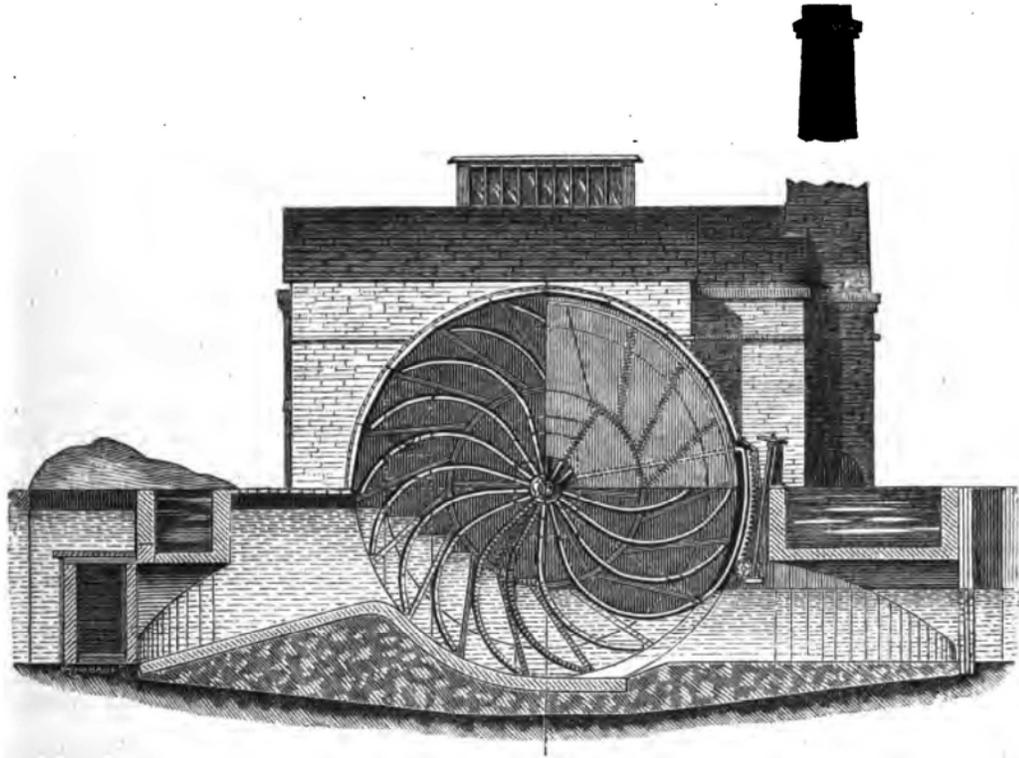


Figure 16: A scoop-wheel installation.<sup>171</sup>

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<sup>169</sup> Russell to Young. Ibid.

<sup>170</sup> [‘Argonaut’], “Drainage of Sugar Plantations in Demerara”, *Louisiana Planter*, No. 19, IV (1890), 338.

<sup>171</sup> *Appleby’s Illustrated Handbook of Machinery*. Section III-Pumping Machinery (London: E. & F. N. Spon, third edition, 1878), p. 49.

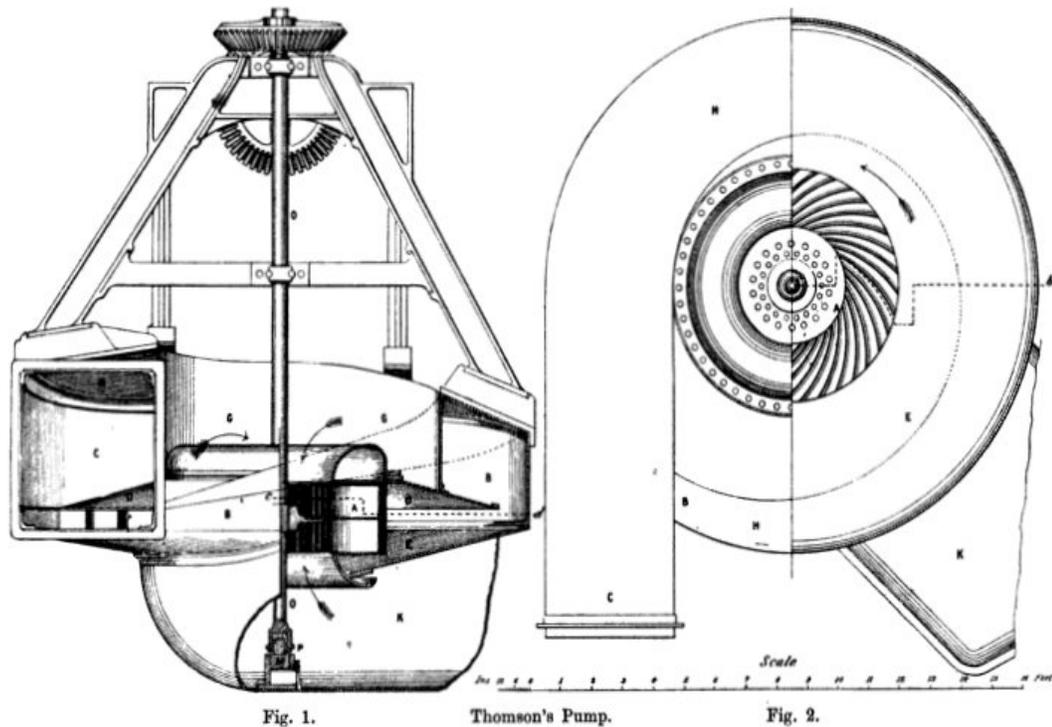


Figure 17: James Thomson's 'Centrifugal Pump with Exterior Whirlpool'.<sup>172</sup>

Centrifugal pump technology was introduced in 1850, Mon Repos was the first to use the “extra powerful” machinery fabricated by Bessemer, Appold and Gwynne that outperformed scoop wheels.<sup>173</sup> In 1857 James Ewing and Company ordered a “centrifugal pump with Exterior Whirlpool” for their Demerara plantations. The pump, designed by James Thomson and fabricated by W. & A. McOnie and Company of Glasgow, was driven by a twenty-five horse-power steam engine.<sup>174</sup> **(Figure 17)**

<sup>172</sup> The pump was fabricated in 1857 for James Ewing’s estates in British Guiana. See James Thomson, “On a Centrifugal Pump with Exterior Whirlpool, Constructed for Draining Land”, *Collected Papers in Physics and Engineering* (Cambridge: The University Press, 1912), p. 22.

<sup>173</sup> MacRae, p. 10.

<sup>174</sup> James Thomson, pp. 18-24, *passim*. In 1853 a similar device was installed by James Ewing at an estate in Jamaica with a windmill driven pump “...the costliness of fuel and the habitual use of windmills in that island having led to the selection of the windmill in this case as the source of power.” (p. 16)

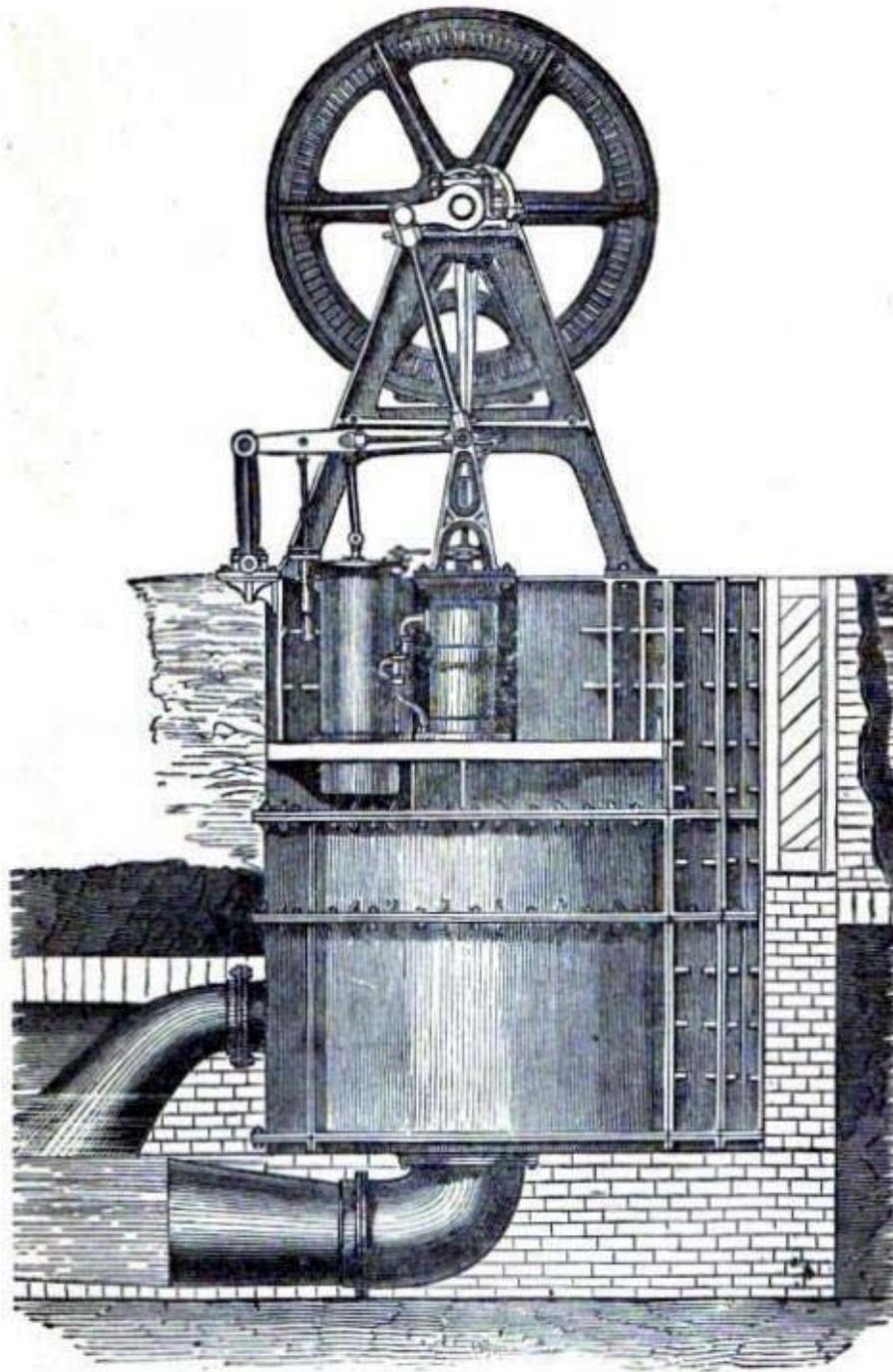


Figure 18: Section through an Easton, Amos and Son centrifugal pump.<sup>175</sup>

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<sup>175</sup> John Bourne, *Recent Improvements in the Steam-Engine* (London: Longmans, Green and Co., new edition; 1880), p. 107. The drawing is of a pump used in British Guiana.

Planters preferred compact equipment and by 1882 there were twenty-four centrifugals and only thirteen scoops.<sup>176</sup> By the 1890s vertical Appolds manufactured by Easton and Amos were most popular.<sup>177</sup> **(Figure 18)** A few horizontal pumps made by Fletchers and Company to Lawrence and Porter’s patent were also used.<sup>178</sup> At the onset, pumps discharged water directly over the front dams into the sea or river. This method changed, however, as the accretion problem became more acute and the flooded frontlands of plantations reverted to swamp.

### **Water-control and the restructuring of the plantations**

By the 1850s, scarce labor and fluctuating sugar prices had reduced profits substantially. The vital water-control system was collapsing from lack of maintenance.<sup>179</sup> Concomitantly, a natural cycle of erosion and deposition along the coast was forcing the abandonment of frontlands bordering the sea.<sup>180</sup> Planter Brumell explained:

When the land begins to wash away on any part of the coast, considerable labour and expense are entailed upon the proprietor, who is then compelled to retreat more inland, and to make new sea-dams, sluices, and roads; and even, sometimes to erect new buildings, as the sea swallows up the old one, or else, at immense cost to maintain a daily struggle against the waves, in which he is certain to be eventually defeated.<sup>181</sup>

Mechanized drainage prompted an intensive reworking of the layout of the estates. Scoop wheels and centrifugal pumps were housed in small pump houses—called ‘drainage-engine’ houses—constructed on the estate’s frontlands. Excess water from heavy rains and ‘bush water’ runoff, formerly drained by gravity from internal

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<sup>176</sup> Russell to Young.

<sup>177</sup> [Argonaut], “Drainage of Sugar Plantations in Demerara”, *Louisiana Planter*, p. 338.

<sup>178</sup> Ibid.

<sup>179</sup> Russell to Young.

<sup>180</sup> [Brumell], pp. 25-28 and **passim**; Gerald O. Case, *Coast Erosion Protection Works on the Case System in British Guiana* (New York: Tidal Engineering Corporation, 1920), p. 32.

<sup>181</sup> [Brumell], p. 23.

trenches through the kokers to the sea, was redirected to the pumps that discharged it directly onto the frontlands.<sup>182</sup> Under the new system, the frontlands-cum-reservoirs were isolated from cultivated areas by secondary dams and kokers where the water was held until the tide fell.<sup>183</sup>

At first, the pumps seemed to solve the drainage problems but the complexity of adapting to the new technology surfaced. Canals and trenches required redigging to channel the water to the pump-houses and reinforcement to accommodate the increased volume of water passing through them. Kokers had to be opened and closed at specific times to avoid backup and flooding. Further, failure to clear the outfalls resulted in water accumulating in the reservoirs and overflowing into the cultivation with disastrous results. Moreover, the high costs of fuel oils for the scoop wheels and centrifugal pumps rendered the equipment too costly for many plantations.<sup>184</sup> In addition, villages established in the plantation zone after Emancipation strained the interdependent water-control system as only the largest villages—Buxton, Friendship, Plaisance and Beterverwagting—could afford mechanical drainage.<sup>185</sup>

Planter John Brumell proposed in the 1850s that a loan be sourced from the British government to establish a collective drainage scheme comprising four or five powerful engines serving at least twenty estates. He argued that the combined power of the engines would clear clogged outfalls while cutting channels deep enough to augment natural drainage. As the engines would only be worked for an average of fifty days per year and only during the heaviest rainfall, Brumell felt that the scheme would

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<sup>182</sup> ‘Bush-water’ is the term for runoff originating in the highland region behind the plantations that drains through the plantations to the sea.

<sup>183</sup> [‘Argonaut’], “Drainage of Sugar Plantations in Demerara”, *Louisiana Planter*, p. 338.

<sup>184</sup> Adamson, p. 169.

<sup>185</sup> Alan H. Adamson, “Monoculture and Village Decay in British Guiana: 1954-1872”, *Journal of Social History*, No. 4, III (Summer 1970), 390.

prove economical.<sup>186</sup> His proposal was apparently ignored as no changes occurred before the 1880s when construction of a continuous sea wall along Atlantic Coast of the Demerara began.<sup>187</sup>

Tiled drainage was mooted as a way to fortify the earthen trenches to accommodate the increased volume of water pumped through them. An experiment with subsoil drainage, subsidized by the local legislature, began at Plantation La Penitence in Demerara in 1846. Three inch (7.6 centimeters) tube tiles were placed in drains spaced fifteen feet apart (4.5 meters) linked to the plantation's central drainage. The trial was hampered by silt accumulating in the tubes especially after continuous rain and regular clearance was needed to avert flooding.<sup>188</sup> Despite the prohibitive costs of subsoil drainage, a few owners adopted it mainly to facilitate mechanized ploughing and especially after sea-wall construction began in the 1880s. James Crum-Ewing and the Colonial Company introduced the system on Better Hope and Montrose Estates, East Coast Demerara, circa 1893 with "happy results".<sup>189</sup> Plantation Highbury in Berbice also installed subsoil drainage.<sup>190</sup> Bricks and piping used were made and fired on site.<sup>191</sup>

As the sea advanced wealthy owners altered the layout of their plantations to reduce flooding. The original frontlands of the estates—"old fields"—were withdrawn

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<sup>186</sup> [Brumell], pp. 102-03.

<sup>187</sup> Wagner, p. 20.

<sup>188</sup> William J. D. Hill, "Following Land in British Guiana", *The Russell Prize Essays 1877-78, Seven Essays on Agricultural Subjects*, Pamphlet 3 (1878), p. 31. Tiled drainage had also been tried in Louisiana and had failed owing to silting up of the drains. "Cane Culture in British Guiana", *Louisiana Planter*, No. 11 XLIII (1909), 162-63.

<sup>189</sup> William Hill, p. 22. See also "Report of the Commission of Enquiry into the Treatment of Immigrants", *Parliamentary Papers* IV (1871), 378-79; E. C. Luard, "Steam Husbandry with Open Drainage in Demerara", *Timehri*, new series, (1894), VIII, 97.

<sup>190</sup> Great Britain, *Parliamentary Papers*, XXXIX (1851), p. 177.

<sup>191</sup> Edward Jenkins, *The Coolie: His Rights and Wrongs* (New York: George Routledge and Sons, 1871), p. 67. Another factory on the Essequibo Coast made "bricks, flooring-tiles, draining-tiles...of good quality". "Enclosure 8 in No. 29: Stipendiary Magistrate's Half-Yearly Report ending 30<sup>th</sup> June 1841, from District G in the County of Essequibo", *Parliamentary Papers*, XXIX (1842), p. 71.

from cultivation and new defensive dams built up further inland. The vacant frontlands, up to a mile wide on some estates, became pasturage for the estates' draught animals. With the installation of pumps, the pastures doubled as reservoirs for excess water pumped from the canefields that was drained to the sea at low tide. Where owners could not afford pumps, the waterlogged frontlands were abandoned or sold to prospective villagers.<sup>192</sup> Planters who could afford mechanized drainage installed pumps in new dams built up behind the pastures. Canefields now began behind the new dams and extended a further mile to the industrial and residential areas. (Compare **Figures 11, 19** and **20**) The rearrangement functioned effectively at first but was undermined by other problems.

Mergers of estates worsened the drainage crisis. When two or more plantations were combined, the common practice was to shut down the secondary factory and relocate the processing equipment to the primary estate. Owners often diverted the drainage canals of secondary lands to the main estate and closed off the kokers.<sup>193</sup> The reconfiguration placed new burdens on existing dams, canals, sea defenses and reserves and extended the threat of constant flooding to the people of the newly-established villages. Public responsibility for drainage and sea defenses was not realized until the 1880s and only after much suffering on the part of villagers.<sup>194</sup> By the 1920s, frontlands that could not be reclaimed were utilized for rice and coconut cultivation.<sup>195</sup>

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<sup>192</sup> See **Labor problems and solutions, CHAPTER 1**, this dissertation. A visitor concluded that the extreme difficulty with land reclamation and water management demanded a system of forced labor rather than freeholding and that the high costs of outfitting a plantation could only be met by capitalists. (W. T. Veness, *El Dorado; or, British Guiana as a Field for Colonisation* (London: Cassell, Petter, and Calpin, 1866), pp. 3-4.

<sup>193</sup> British Guiana, "Report of C.H. Massiah, Government Medical Officer, May 28<sup>th</sup>, 1902", *Annual Administration Reports, 1901-02*. (ICS)

<sup>194</sup> Wagner, p. 20.

<sup>195</sup> *British Guiana* (1924), p. 72.

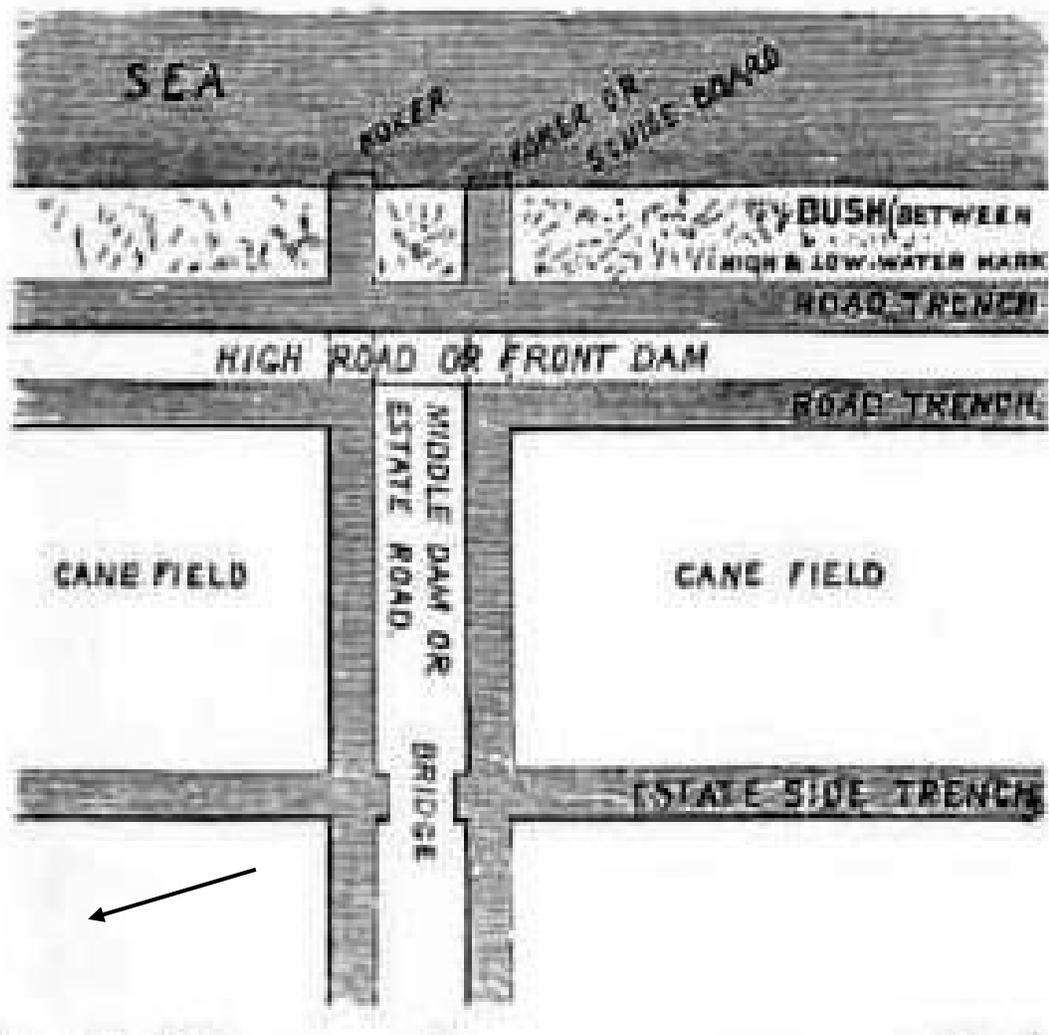


Figure 19: The frontlands of Windsor Forest in relation to the sea circa 1871.<sup>196</sup>

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<sup>196</sup> Jenkins, p. 41.

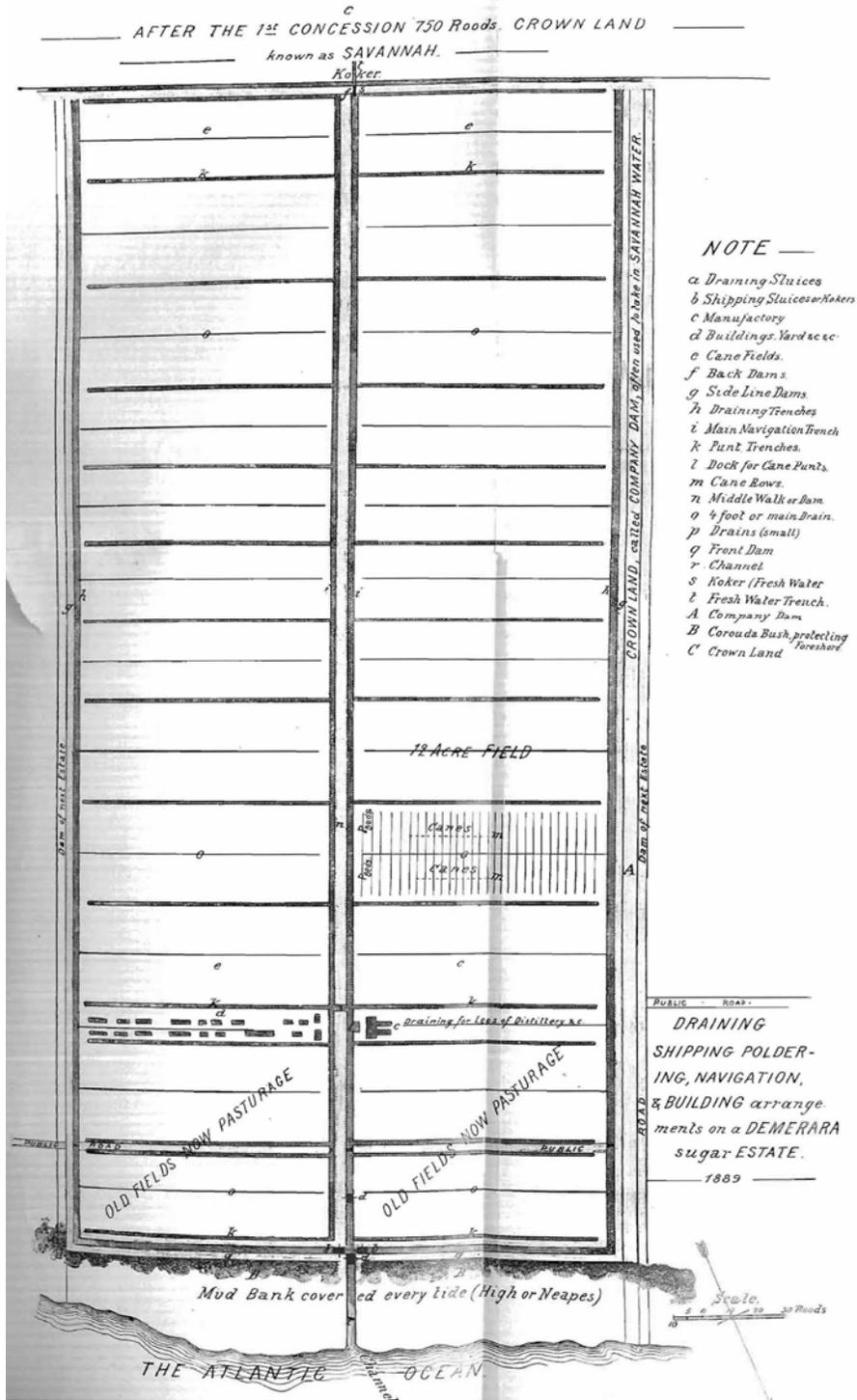


Figure 20: Plan of a Demerara sugar estate, 1889.<sup>197</sup>

<sup>197</sup> The plan shows “old fields” converted into pasturage, bottom. United States Department of State, Special Consular Reports, *Canals and Irrigation in Foreign Countries* (Washington: Government Printing Office, 1891), between pp. 328-29 (CUL)

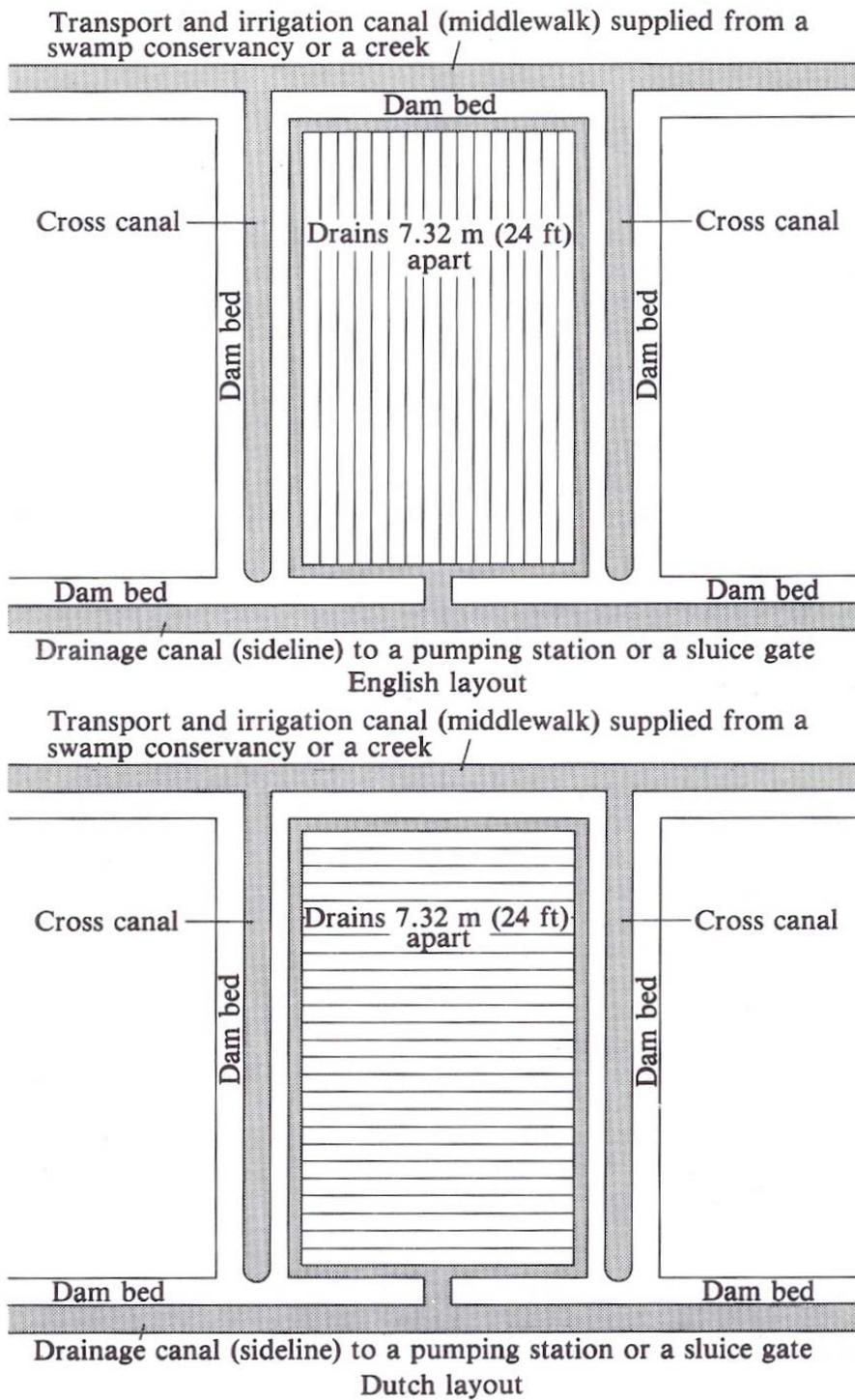


Figure 21: Dutch (top) and English Bed (bottom) layouts compared.<sup>198</sup>

<sup>198</sup> Glyn James, (ed.), *Sugarcane* (Oxford: Blackwell Publishing, second edition; 2004), p. 105.

### **The field system: ‘Dutch’ versus ‘English’ layout**

Each estate or plantation comprised individual fields from five to ten acres (2 to 4 hectares).<sup>199</sup> Layouts adhered to either the ‘Dutch’ or ‘English’ plan. ‘Dutch’ fields (‘beds’) measured, on average, thirty-five feet wide (10.6 meters) and ran parallel with the main navigation canal and the Middle Walk. **(Figure 21)** ‘English’ beds were configured to lie at right angles to the principal navigation canal although, in some instances, a single bed called a ‘dam bed’ ran parallel with a ‘four-foot’ in front of it. Behind the dam bed the plot was bisected by another ‘four-foot’, and by smaller drainage trenches. Each field was networked with small drainage trenches that discharged into a secondary trench called the ‘tracker’ or ‘four-foot’. The tracker then connected with the plantation’s main drainage outlet.<sup>200</sup> Both layouts were later reconfigured to facilitate implemental and mechanical tillage.

## **Section Two**

### **The built environment of the plantation**

There are few historical diagrams of British Guiana plantations but narratives provide adequate detail on their layout and building forms. Plantations combined residential and industrial functions at a single location although the factory complex was preeminent in the spatial hierarchy.<sup>201</sup> Factories processed the cane crop while residential units housed administrators as well as the estate’s labor force, *moreso* during slavery. The residential complex comprised a commodious Great House, a hospital for the workers, laborer’s cottages called ‘ranges’ or ‘logies’, the manager’s

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<sup>199</sup> [Brumell], p. 29.

<sup>200</sup> Deerr, *Sugar and the Sugar Cane*, pp. 26-28.

<sup>201</sup> The evolution of the village movement is discussed in **CHAPTER 1** and earlier this chapter.

and overseers' quarters and, especially after the 1850s, a small shop run by a Portuguese or Chinese merchant.<sup>202</sup>

Sheller's finding that sugar monoculture fostered a romanticized, pastoral view of the Caribbean landscape apply easily to nineteenth century Guiana.<sup>203</sup> Visitors remarked on the swamp-like appearance of the colony's Atlantic coast and the similarities between water-bound plantations and the landscape of Holland and Flanders.<sup>204</sup> The web of drainage and irrigation canals surmounted with dams and sluices seemed like defensive "ramparts", while the contrast of cleared fields and encroaching sea seemed like a mirage of islands in a vast sea.<sup>205</sup>

Plantations radiated grandeur and opulence and seemed entirely "European" to visitors. Grounds were ornamented with a variety of fruit trees and vegetable gardens, trim walks, avenues and well-kept roadways carried a stamp of Britishness or, depending on the observer, Dutch influence<sup>206</sup> The carefully contrived ambience at Plantation was apparent at "Golden Tent" [sic] where there were "square grass-plats before the door"—presumably rudimentary lawns—and decorative touches simulating

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<sup>202</sup> Madeiran Portuguese first came to British Guiana in 1835 as contract labor. However, they created a niche for themselves as petty merchants and established retail shops in villages and on estates. See Mary Noel Menezes, *The Portuguese of Guyana: A Study in Culture and Conflict* (London: M. N. Menezes, 1994) and \_\_\_\_\_, *Scenes from the History of the Portuguese in Guyana* (London: M. N. Menezes, 1986); Trev Sue-A-Quan, *Cane Reapers Chinese Indentured Immigrants in Guyana* (Vancouver: self published, revised edition; 2003)

<sup>203</sup> Mimi Sheller, *Consuming the Caribbean: from Arawaks to Zombies* (London: Routledge, 2003), p. 37 and **passim**.

<sup>204</sup> St. Clair, I, 91; Montgomery Martin, p. 118; Hilhouse, "Agriculture in 1829 II", p. 271. Knight declared Guiana "a tropical Holland" (E. F. Knight, *Overseas Britain* (London: John Murray, 1907), p. 311) Allen also noted the similarities. Nellie B. Allen, *South America* (Boston: Ginn and Company, 1918), p. 68.

<sup>205</sup> David P. Chalmers, "British Guiana", *Scottish Geographical Magazine*, XII (1896), 125. See also John Purdy, *Memoir, Descriptive and Explanatory, to Accompany the Charts of the Northern Atlantic Ocean* (London: R. H. Laurie, ninth edition; 1845), p. 91; Edwards, IV (1819), pp. 244 and 246-47. Dr. George Pinckard wrote that, on approaching the coast from the sea, land was invisible unless one came very close to the shore. To him, the tops of trees appeared to be growing out of the ocean. Pinckard, III, 388.

<sup>206</sup> Veness, p. 3; William Bingley, *Travels in South America* (London: John Sharpe, 1820), pp. 74-75; St. Clair, I, 91.

an European environment. By 1806, Lusignan on the East Coast of Demerara had gardens, orchards and ornamental shrubbery.<sup>207</sup> Plantation Reynestein had a “walk of fruit trees nearly a mile long” that included citrus, soursop and wild cherry. There were orchards of shaddock (pomelo or *Citrus grandis*), granadilla (*Passiflora quadrangularis*), pomegranate (*Passiflora edulis* and *ligularis*) and the “marrow pear” (avocado or *Persea Americana*) grew next to stands of guinea corn (millet).<sup>208</sup> Schoon Ord’s manager’s garden had oranges, limes, pawpaw, bananas and coconuts in addition to decorative shrubs and flowers.<sup>209</sup>

During slavery, land was allotted for growing subsistence crops to feed the enslaved and their enslavers.<sup>210</sup> Under the Dutch, plantation dams were covered in fruit trees intended to supplement the meager diet of the enslaved. Adjoining fields were cropped with plantains (*Musa paradisiaca*) and eddoes (*Colocasia esculenta* or *C. antiquorum*), yams (various species of the family *Dioscoreaceae*), cassava (*Manihot esculenta*), and ochroes (*Abelmoschus esculentus*), lettuce (*Lactuca sativa*), French beans (*Phaseolus vulgaris*), spinach (*Amaranthaceae* family), and asparagus (*Asparagus officinalis*).<sup>211</sup> Stands of plantain, called ‘plantain walks’, were characteristic during Dutch rule but discontinued by the British who ordered the walks cleared and canefields enlarged so as to deprive the ex-slaves of free food.<sup>212</sup>

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<sup>207</sup> Pinckard, III, 278 and 381. This estate was likely ‘Good Intent’ on the Demerara River.

<sup>208</sup> Bolingbroke, p. 24; St. Clair, p. 130-132.

<sup>209</sup> Jenkins, p. 56.

<sup>210</sup> During slavery, owners maintained the captive population by forcing them to grow their own food. As Emancipation approached, plantations were required by law to allow half an acre of ‘good land’ for each captive aged 15 and older, within two miles of the residence of the captive. Enslaved children under 15 were allowed a quarter acre. (J. E. Alexander, *Transatlantic Sketches*, p. 70) An Ordinance passed in 1825 stipulated that one acre of provision grounds be allotted for every five slaves. (Great Britain, “The British West India Colonies”, *Parliamentary Papers*, IX (1831), p. 40.

<sup>211</sup> Schomburgk, p. 76.

<sup>212</sup> Shahabuddeen, p. 148; and Milliroux, p. 63.

Twentieth century reviews tend to emphasize the idiosyncrasies of the historical cultivation pattern. Geographer Michael Wagner deemed the coast “an exasperating landscape” owing to the extreme effort required to drain the land and maintain a supply of fresh water.<sup>213</sup> For this reason Alfred Chapman Barnes, a sugar scientist, viewed conditions in Guyana as “unusual” when compared with other territories.<sup>214</sup>

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<sup>213</sup> Wagner, p. 10.

<sup>214</sup> A. C. Barnes, *The Sugar Cane* (New York: John Wiley and Sons, second edition; 1974), p. 120.

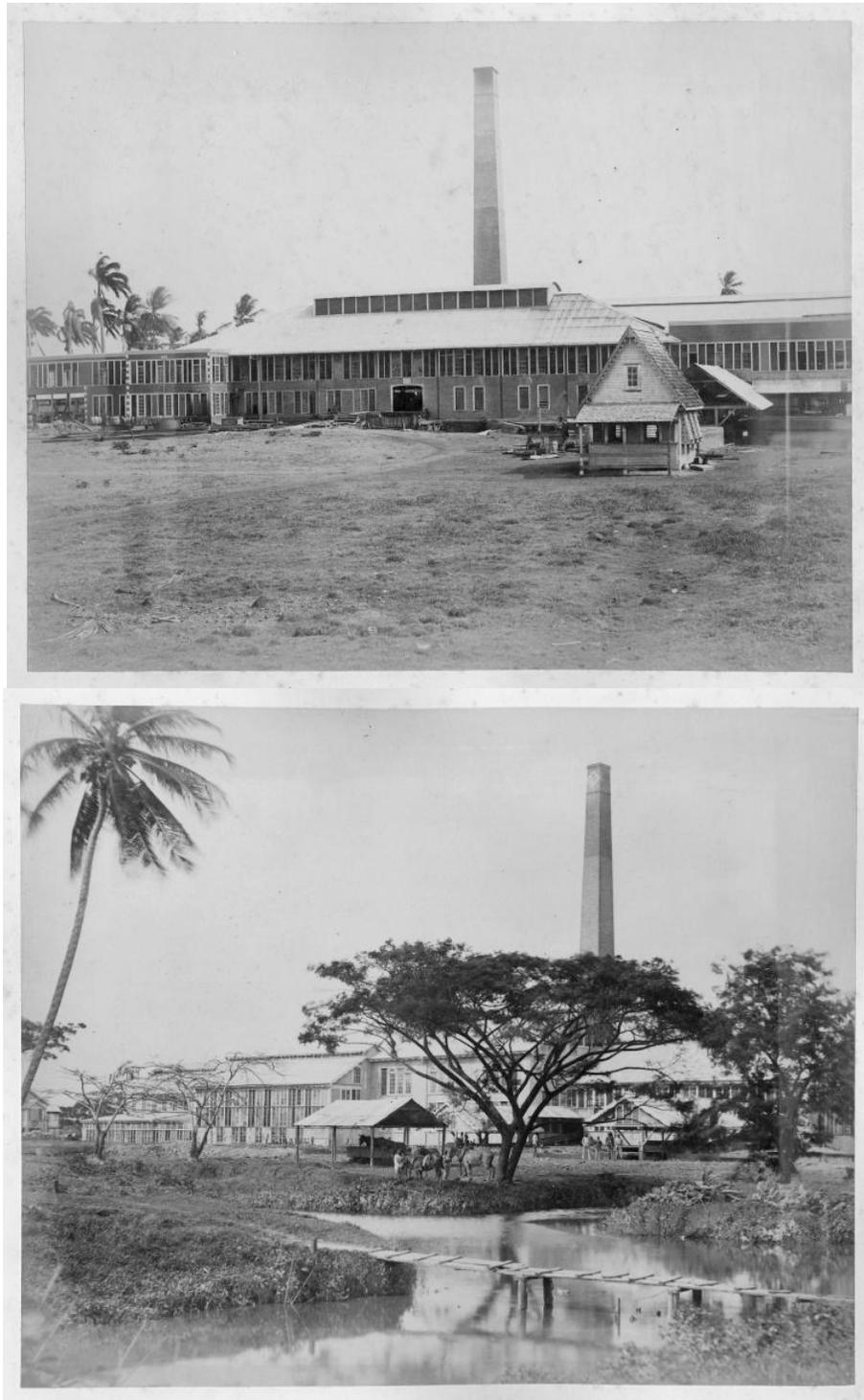


Figure 22: Two views of a factory circa 1900.<sup>215</sup>

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<sup>215</sup> J. Siza (Photographer), *Views of British Guiana*, Plates 30 (top), Plate 31 (bottom)

## **The industrial complex**

Plantation buildings—industrial and residential—were surrounded by canefields. Positioning sugar factories close to the cultivation ensured that the cane could be milled immediately after harvesting. At another level, the predetermined layout followed the norms of economic manipulation and social control begun during slavery.<sup>216</sup> Planters were able to monitor the sugar-making operations directly from their houses and were instantly alerted to labor uprisings and mill breakdowns. Despite the excessive noise, they preferred the proximity to field and factory.<sup>217</sup>

Each plantation had several characteristic buildings. Sugar buildings, or ‘manufactories’ enclosed the processing areas and protected machinery from the elements. The main structures were the ‘mill-house’ (also known as the ‘engine house’), the ‘boiling-house’, ‘curing-house’, rum distillery, fuel sheds (called ‘trash-houses’ or ‘megass logies’), stables and assorted outbuildings. A majority were made of brick imported as ballast or made on site.

### **‘Engine’ or ‘mill-houses’**

Engine houses enclosed the crushing mills and apparatus that powered them. At mid-century, mill-houses were spacious to accommodate large horizontal, multiple-roller mills and steam engines with large boilers. They measured between 300 to 400 feet long (91.5 to 122 meters), and were lofty, well-lighted and ventilated. Mill-houses adjoined the ‘mill-docks’ that received punts filled with cane from the fields. A moving platform, a ‘cane-carrier’, brought the cane to the milling floor and connected

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<sup>216</sup> James Delle, *An archaeology of social space: analyzing coffee plantations in Jamaica’s blue mountains* (New York: Plenum, 1998), pp. 8, 9, and 21.

<sup>217</sup> Manager Eccles of Blairmont admitted to being so used to the noise that when it ceased he immediately summoned the engineer on duty for an explanation as “money was being lost”. Chris Curtis (ed.), *Demerara Doctor An Early Success Against Malaria: The Autobiography of George Giglioli 1897-1975* (London: Smith-Gordon and Co. Ltd., 2006), p. 129.

the two structures. The mill-house was usually connected to the megass logie in which the cane trash was stored until needed as fuel for the furnaces. (**Figures 22 and 23**)

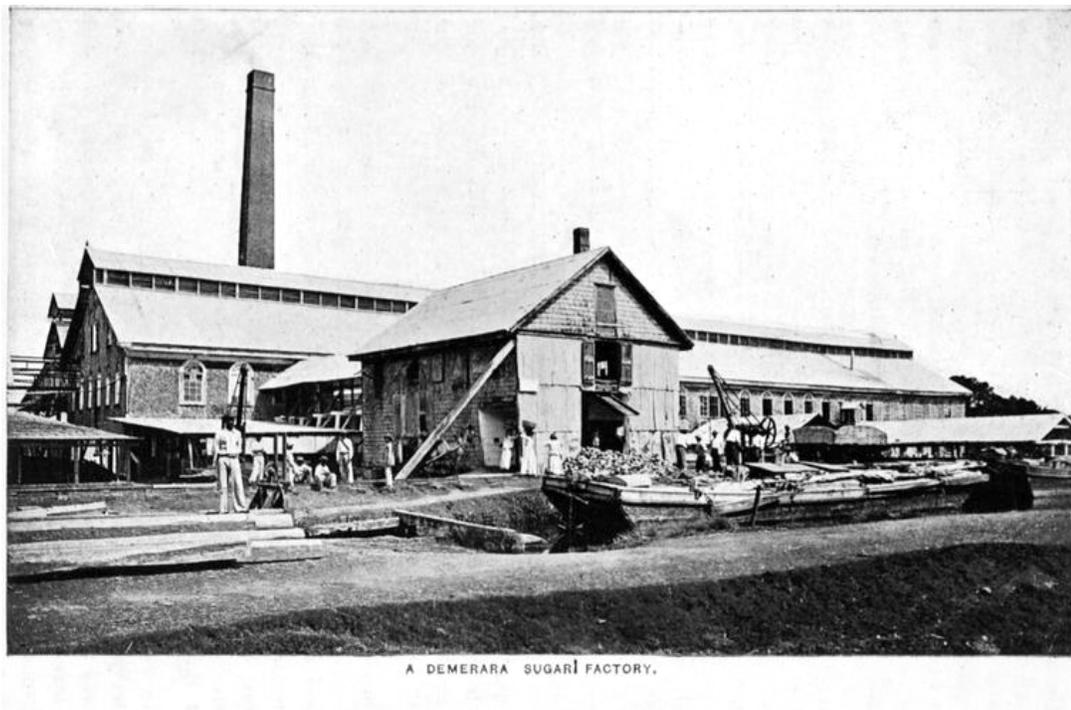


Figure 23: A nineteenth century Demerara sugar factory.<sup>218</sup>

### **The ‘Boiling House’**

The ‘boiling house’ was the most important building on the estate. Boiling houses were the largest structures and constructed around the tasks of boiling the cane juice and evaporating the syrup to sugar. Early boiling houses housed open batteries set in refractory brick and were partially open-sided.

### **Megass logies**

The ‘megass logie’ was a tall, barn-like structure constructed for drying megass, the cane stalks left over after the juice is removed. ‘Megass’ (or ‘bagasse’)

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<sup>218</sup> Samuel A. Richardson, *A Brief Sketch of the Early History of British Guiana* (Georgetown: The Daily Chronicle Limited, 1916), facing page 33. The megass logie is in the foreground) and ‘punt-dumper’ at right. The factory was probably Chateau Margot (East Coast Demerara)

was the main furnace fuel in nineteenth century factories.<sup>219</sup> A Demerara megass logie is described in an 1833 American sugar manual:

The bagasse houses at Demerara are high one story buildings, 30 to 35 feet wide, and from 100 to 200 feet long. The walls consist of brick columns about eight feet apart, which are larger at bottom, where they are hollow. These columns are perpendicular on the inner side, but slant outwards as they approach the ground. The roof rises from a wooden frame, supported by these columns, and is traversed its whole extent on both slopes with "cow-mouth" openings, to allow of the escape of air, and to prevent the access of rain. There are doors also at the end of the roof. These buildings are placed endwise to the direction of the prevailing winds of the country, and at a distance of about 200 yards to the leeward of the mill. There are two rails laid down from the mill room, which lead through the bagasse house, upon which cars move for the transportation of the wet bagasse. A laborer is stationed in the house, who unhitches the loaded car, and attaches the unloaded one to return for a new load, while he unloads that which has just arrived. In unloading it, he throws the bagasse quite into the roof. In about ten days, it undergoes fermentation and becomes much heated, sometimes pressing the walls outward with great force; and in about twenty days it is ready for use. They commence using from the end of the house first filled. The dry bagasse is carried to the furnaces in bundles on the heads of two laborers, where the fire is fed by a third. When pressed for fuel, they dry the bagasse in the sun, where it becomes cured in six days.<sup>220</sup>

Early logies were thatched with Troolie palm ('Truli' or *Manicaria saccifera*) by Amerindians hired for that purpose.<sup>221</sup> Logies had roofs but were partially open at the sides and large enough to store at least six months of fuel. They were expensive to build, costing between £1000 and £1500 sterling in 1858, but indispensable.<sup>222</sup> Their simple frames were easily lengthened and normally 500 feet long and at least thirty-

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<sup>219</sup> The word 'logie' may derive from a Scottish term *logie* referent to the holding-place for fuel located at the front of a furnace. Megass logies are currently called 'bagasse houses'.

<sup>220</sup> Benjamin Silliman, *Manual on the Cultivation of the Sugar Cane, and the Fabrication and Refinement of Sugar* (Washington: United States Department of the Treasury, 1833), pp. 64-65.

<sup>221</sup> British Guiana Boundary Commission, *Arbitration with the United States of Venezuela, Appendix to the Case on Behalf of the Government of Her Britannic Majesty*, VI (1812-1892), p. 127.

<sup>222</sup> *Supplement 1 to Eighth Report from the Select Committee of Sugar Planting*, p. 122; Hy Mitchell, "On the Desiccation of Fuel in the Manufacture of Sugar", *Journal of the Society of Arts*, VI (19 March 1858), p. 287.

five feet wide (30.5 by 10.6 meters)<sup>223</sup> Some plantations had multiple, conjoined logies with a combined length of 800 feet (244 meters)<sup>224</sup> The majority were two-storeyed although an 1813 account described a three storeyed building on a Demerara River plantation.<sup>225</sup>

By the 1870s logies were upgraded and small boxcars with collapsible sides ran on elevated rails bringing megass directly from the crushing mills into the logies.<sup>226</sup> Logies were targets of sabotage during periods of worker unrest. During the first six months of 1848 two logies on Plantation Palmyra and one at Zorg (Essequibo) were razed. An entire range of megass logies at Montrose (East Coast Demerara) and one on Plantation Melville were lost to fires of unknown origin.<sup>227</sup> For this reason, logies were built in the lee of other buildings to lessen the risk of fire. Towards the end of the century an important change occurred in the way megass was used. New furnaces utilizing ‘green’ or fresh megass made pre drying and large logies obsolete.<sup>228</sup>

### **Windmills and chimneys**

Windmills and chimneys were ubiquitous on early plantations. Windmills drove the crushing apparatus and were lofty landmarks in the eighteenth century.<sup>229</sup> A pair of windmills on plantations Kitty and Thomas at the confluence of the Demerara River and the Atlantic Ocean doubled as beacons that guided ships into the Georgetown harbor; one carried a flag during the daytime as an additional marker.<sup>230</sup>

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<sup>223</sup> *Proceedings of the Literary and Philosophical Society of Liverpool*, No. 29 (1874/75), 56; Mitchell, p. 287.

<sup>224</sup> MS 677/115. (SHL)

<sup>225</sup> Bolingbroke, p. 22.

<sup>226</sup> William Walker, *On the Social and Economic Position and Prospects of the British West India Possessions* (Self published, 1873), pp. 86-87.

<sup>227</sup> Eighth Report from the Select Committee of Sugar Planting, Supplement 1”, p. 122,

<sup>228</sup> See **The cane megass furnace, CHAPTER 4.**

<sup>229</sup> Windmills were used to drive crushing equipment but not for drainage equipment as in Holland or the Caribbean islands.

<sup>230</sup> St. Clair, I, 86-88.



Figure 24: Demolishing an Essequibo chimney.<sup>231</sup>

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<sup>231</sup> Author's collection. The exact date of the photograph is unknown but estimated at early in the twentieth century.

Chimneys marked the furnace and boiler areas of the factory were beacons for incoming ships. Hampton Court's two tall chimneys of nearly equal height were the principal nautical markers of the Essequibo Coast in 1894.<sup>232</sup> Local chimneys were sized to accommodate the specialized evaporating apparatus present in Guiana factories.<sup>233</sup> **(Figure 24)**



Figure 25: Single-family workers' cottages at Tuschen de Vrienden circa 1860s.<sup>234</sup>

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<sup>232</sup> United States Boundary Commission, *Report and Accompanying Papers, (Geographical)*, VIII 1897, p. 282.

<sup>233</sup> A Jamaican planter described the chimneys in British Guiana: "Their large chimneys are the great cause of their intense draught; they are so capacious that one of ours would go bodily into the flue of theirs, and they are also very lofty. (W. F. Whitehouse, *Agricola's Letters and Essays on Sugar Farming in Jamaica* (London: Simmonds & Ward, 1845), pp. 341-42.

<sup>234</sup> Rodway, *Hand-book of British Guiana*, facing page 29,



Figure 26: Two-storeyed logies on Diamond Estate in the 1950s.<sup>235</sup>

### **Worker housing: the ‘logies’**

Placement of residential buildings on a colonial plantation reinforced historical race and class divisions. Well-established manifestations of social segregation dictated that worker housing be separated from the owner-manager hierarchy and screened from public view. Details on the dwellings of the enslaved are vague but visitors routinely commented on the style and contents of owners’ houses.

Prior to Emancipation, the enslaved lived in logies or ‘ranges’ partitioned for individual families.<sup>236</sup> In 1833 a visitor noted rows of “neat negro houses” surrounded

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<sup>235</sup> TNA, UK.

<sup>236</sup> Although the term *logie* first applied to wooden storage sheds for megass (dried cane trash), it was also applied to the type of rudimentary housing built for enslaved and indentured populations. Logies also housed soldiers if accommodation at the forts was insufficient. Pinckard, III (1805), pp. 61-62.

by vegetable gardens and livestock pens near to building where sugar and rum were made.<sup>237</sup> “[H]umble huts” seen in the 1810s were made from the Manicole palm “twisted and beautifully worked together” and shaded by the leaves of the plantain.<sup>238</sup> At the start of Apprenticeship in 1834, a new law required each enslaved family be given their own “comfortable, separate” house.<sup>239</sup> Logies vacated by ex-slaves—the majority refused to live on the plantations after gaining their freedom—were allotted to the indentured immigrants as they arrived but were invariably dilapidated and unsafe.<sup>240</sup> By the 1840s plantation owners were required to provide adequate improved housing for incoming indentures.



Figure 27: Nineteenth century estate yard with ‘logies’ in the foreground.<sup>241</sup>

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‘Range’ is synonymous with logie and both terms imply a substandard form of housing found on estates up to the 1950s. (Figure 27)

<sup>237</sup> Alexander, *Transatlantic Sketches*, I, 95.

<sup>238</sup> St. Clair, I, 126.

<sup>239</sup> St. Clair, I, 71.

<sup>240</sup> Jenkins, p. 44.

<sup>241</sup> Browne, p. 22.

Old ranges with dirt flooring and leaky, thatched roofs were replaced with “detached cottages elevated on brick pillars, floored and shingled”.<sup>242</sup> Maintenance was erratic, however, and up to the 1870s logies were surrounded by fetid drains into which all household effluent discharged. Although the waste flowed into the main drainage of the estate it remained stagnant in the trenches until the kokers were opened, usually at low tide.<sup>243</sup> **(Figures 25, 26 and 27)** The housing environment of plantation workers, romanticized by itinerant visitors, was appallingly insanitary and the cramped, ramshackle structures contrasted sharply with the spacious, well-kept dwellings of the estates’ elites.

### **The ‘Great House’**

Each plantation had its version of the Great House where the proprietor or his representative lived.<sup>244</sup> In colonial times, a Great House embodied the high social status of the plantation owner. His house, also known as the ‘Manor House’, was intentionally imposing and designed to reinforce an appearance of wealth, prominence and respectability, important social markers in Caribbean colonial society.<sup>245</sup> **(Figures 28 and 29)**

Centrally positioned within the plantation, the symbiosis of flat land and sea caused an early visitor to remark that the planter’s house seemed built on water as the land on which it stood was invisible from an approaching ship.<sup>246</sup> On river plantations, the dwellings were located close to the bank and opposite the stelling (dock).<sup>247</sup>

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<sup>242</sup> *Parliamentary Papers*, XVI (841), p. 235.

<sup>243</sup> Jenkins, pp. 44-46.

<sup>244</sup> In some cases, both roles were performed by a single individual, a man, as women managers do not appear in the historical record. If the owner was in residence, the manager lived separately but usually dined at the Great House.

<sup>245</sup> Pinckard, III (1806), p. 11.

<sup>246</sup> St. Clair, I, 86.

<sup>247</sup> Montgomery Martin, *History of the West Indies* (London: Whittaker & Co, 1837), II, 9.



Figure 28: The Great House of former Aurora Estate (Essequibo Coast).<sup>248</sup>

A typical nineteenth century Great House was a one or two-storeyed, commodious wood structure, perched on tall brick pillars or wooden stilts to avoid flooding and the perpetual damp of the surrounding clay.<sup>249</sup> Open verandahs called ‘galleries’—approximately eight feet wide (2.4 meters)—encircled the house.<sup>250</sup> Invariably, windows overlooked the area where the harvest was unloaded from the punts and moved into the factory.

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<sup>248</sup> Collection of the National Trust of Guyana. The house is on brick pillars and features an observation belvedere.

<sup>249</sup> Descriptions vary but references to the spaciousness, location and ambience are typical.

<sup>250</sup> Bancroft, p. 363; Premium, p. 12. “A Glimpse of Overseeing in Demerara”, *Chambers’ Journal of Popular Literature, Science, and Art*, fourth series, No. 804 (24 May 1879), 325.



Figure 29: Refurbished Great House at Blairmont Estate, 2005.<sup>251</sup>

A visitor described the house at Blairmont Estate:

The manager's house stood a little way back from the public road, close to the factory. It was a typical, two-storeyed, old-fashioned plantation-house, which stood on the tallest brick pillars I have ever seen in Guyana, not less than 18 feet high; a rather elaborate and very steep staircase let to the front door.<sup>252</sup>

Early windows lacked glass panes but had heavy, wooden 'Demerara shutters' that kept rain out and the interiors cool.<sup>253</sup> Rain run-off was channeled from the roofs into large vats at the side.<sup>254</sup> Well-adapted to the tropical climate, steep, hip roofs without ceilings allowed air entering through open eaves to circulate freely through

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<sup>251</sup> Collection of the National Trust of Guyana.

<sup>252</sup> Chris Curtis (ed.), *Demerara Doctor*, pp. 127-28.

<sup>253</sup> The shuttered interiors were "very dull" in wet weather. Rodway, *History of British Guiana*, II, 94.

<sup>254</sup> Early houses were thatched with Trootie, ('Truli' [*Manicaria saccifera*]), the thatch intentionally concealed by climbing foliage. Rodway, *Ibid.*, p. 94.

the rooms. During British rule a majority of the estates' buildings were painted white, also "the favorite color of Dutchmen", with green shutters.<sup>255</sup>



Figure 30: Avenue of palms at the entrance to a Demerara plantation.<sup>256</sup>

Great Houses contained from four to eight separate spaces.<sup>257</sup> Where there were two storeys, the first floor had kitchen and a dining room as well as a 'planter's room' or den. A corridor extended from the main door to a secondary opening in the rear. The second floor was partitioned into at least six bedrooms accessed by an inner

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<sup>255</sup> Bingley, p. 75. However, James Rodway saw planters' houses with "gaudy yellow and red paint". Rodway, *History of British Guiana*, II, 94.

<sup>256</sup> J. Siza, *Views of British Guiana*, Plate 10. The caption on the photograph reads "Cabbage Palms, West Bank Demerara". Guianese Historian James Rodway gave the location as Plantation Houston, East Bank Demerara. See Rodway, *Hand-book of British Guiana*, facing page 74.

<sup>257</sup> "A Glimpse of Overseeing in Demerara", p. 325.

staircase. The backyard contained various low, wooden buildings, often a kitchen and servant quarters, stables and storage sheds.<sup>258</sup>

The substantial elevation and layout of the Great Houses permitted an aerial view of the surrounding landscape. From these and other vantage points, owners and managers monitored critical processing sites especially during unrest and worker agitation in the pre and post-emancipation periods.<sup>259</sup> Many plantations had ‘Avenues of Palms’, a double line of Royal and Cabbage Palms (*Oreodoxa*) on either side of the path leading to the Great House.<sup>260</sup> The carefully-tended corridor helped maintain the desired atmosphere of wealth and high status. **(Figures 30 and 31)**



Figure 31: Remains of a palm avenue, 2005.<sup>261</sup>

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<sup>258</sup> St. Clair, I, 123-24.

<sup>259</sup> Curtis, p. 129. Megass logies were prone to ‘suspicious’ fires. See **Megass Logies**, earlier this chapter.

<sup>260</sup> Premium, pp. 12-13.

<sup>261</sup> Collection of the National Trust of Guyana.

### **Foremen and overseers' cottages**

The number of overseers on a plantation varied according to its size and scale of production. Overseers supervised factory and field tasks and comprised a group of from three to eight men.<sup>262</sup> Initially, overseers resided communally in a barrack-styled logie (range) gradually replaced by individual cottages. Bungalows were erected for the overseers at Blairmont Estate in the 1930s after their barracks were destroyed by a freak storm.<sup>263</sup>

Living quarters allotted to the resident engineer was close to the processing unit and the Great House. This arrangement allowed him to work a twenty-four shift—a regular work day during the grinding season—and to communicate quickly with the owner or manager during emergencies such as fires, mechanical breakdown or labor unrest

### **Hospitals**

The first plantation hospitals were 'sick-houses' for enslaved persons who were too ill for work. As Emancipation approached plantation owners were ordered to provide medical care for their Apprentices. Improved hospitals were "lofty, spacious and well ventilated", two or three-storied buildings on brick pillars seven to eight feet high (2.1 to 2.4 meters). The upper floors were reserved for pregnant women and divided into labor and delivery sections.<sup>264</sup> Some large hospitals had kitchens and wash-houses attached. Plantations Providence and Nismes (Demerara River) and at Hope (Essequibo Coast) each had large hospitals.<sup>265</sup>

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<sup>262</sup> The tasks and responsibilities of overseers are described in "A Glimpse of Overseering in Demerara", 325-27, **passim**.

<sup>263</sup> Curtis, *Demerara Doctor*, p. 156.

<sup>264</sup> "The British West India Colonies", *Parliamentary Papers*, IX (1831), p. 41.

<sup>265</sup> Bryant, p. 114.

## CHAPTER 3

### FIELD TECHNOLOGY

#### Section One

Nineteenth century expansion was predicated on improvements in field and factory. An early goal was to lessen dependence on manual labor, a defining feature of the local industry for centuries. Private and government-sponsored researchers collaborated on strategies to enhance soils, breed new cane varieties, mitigate the scourge of disease and pests and improve cultivation practices. Local trials focused on increasing plant viability and the quantity and quality of juice yield.

#### **Land preparation and planting strategies**

A unique microgeography allowed coastal estates to harvest ripe cane after fourteen or fifteen months while riverain operations required a sixteen-month growth period.<sup>266</sup> Accordingly, there were two or three annual crops with the main harvest occurring between September and December.<sup>267</sup> A shorter harvest lasted from May to June and, occasionally, another cutting was done in March.<sup>268</sup>

Prior to the use of seedlings, cane was propagated by ‘ratooning’ or replanting the tops of viable stalks, called ‘setts’.<sup>269</sup> Ratooning was viewed as a cost-cutting measure that eliminated seasonal replanting. ‘Plant canes’ yielded an initial

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<sup>266</sup> John Davy, “The West Indies before and since Emancipation”, *London Quarterly Review*, VIII (April-July 1855), 496; Deerr, *Sugar and the Sugar Cane*, p. 8 and Chapter IV: The Cultivation of the Cane; \_\_\_\_\_, *Cane Sugar*, Chapter III.

<sup>267</sup> Jamaica had a ‘spring crop’ and a ‘fall planting’. Thomas Roughley, *The Jamaica Planter’s Guide* (Longman, Hurst, Rees, Orme, Brown, and Green: 1823), p. 247.

<sup>268</sup> Adequate sunshine during the growth cycle increases the amount of extractable sucrose in mature cane while excessive rainfall precipitates the reverse. Noel Deerr, sugar scientist and historian who worked in British Guiana at the end of the nineteenth century verified that an annual total of 65 inches (1650 millimeters) was considered low and resulted in poor yields while an average between 90 to 100 inches (2290 to 2540 millimeters) gave heavy crops but with low sucrose content. Deerr, *Sugar and the Sugar Cane*, p. 8 and \_\_\_\_\_, *Cane Sugar*, Chapter III: Range and Climate.

<sup>269</sup> Setts were also called ‘stem cuttings’ or ‘seed-pieces’. [Galloway, p. 13] In Guiana, setts comprised ten-inch lengths which normally sprouted grass-like leaves or “eyes” at every joint. [Brumell], p. 30).

crop and 'first ratoons' during the second year of cultivation. Successive crops—'second', 'third' or 'fourth' ratoons—gave diminishing yield until replanting. Ratoons matured earlier than plant canes and could be cut after approximately twelve months.<sup>270</sup>

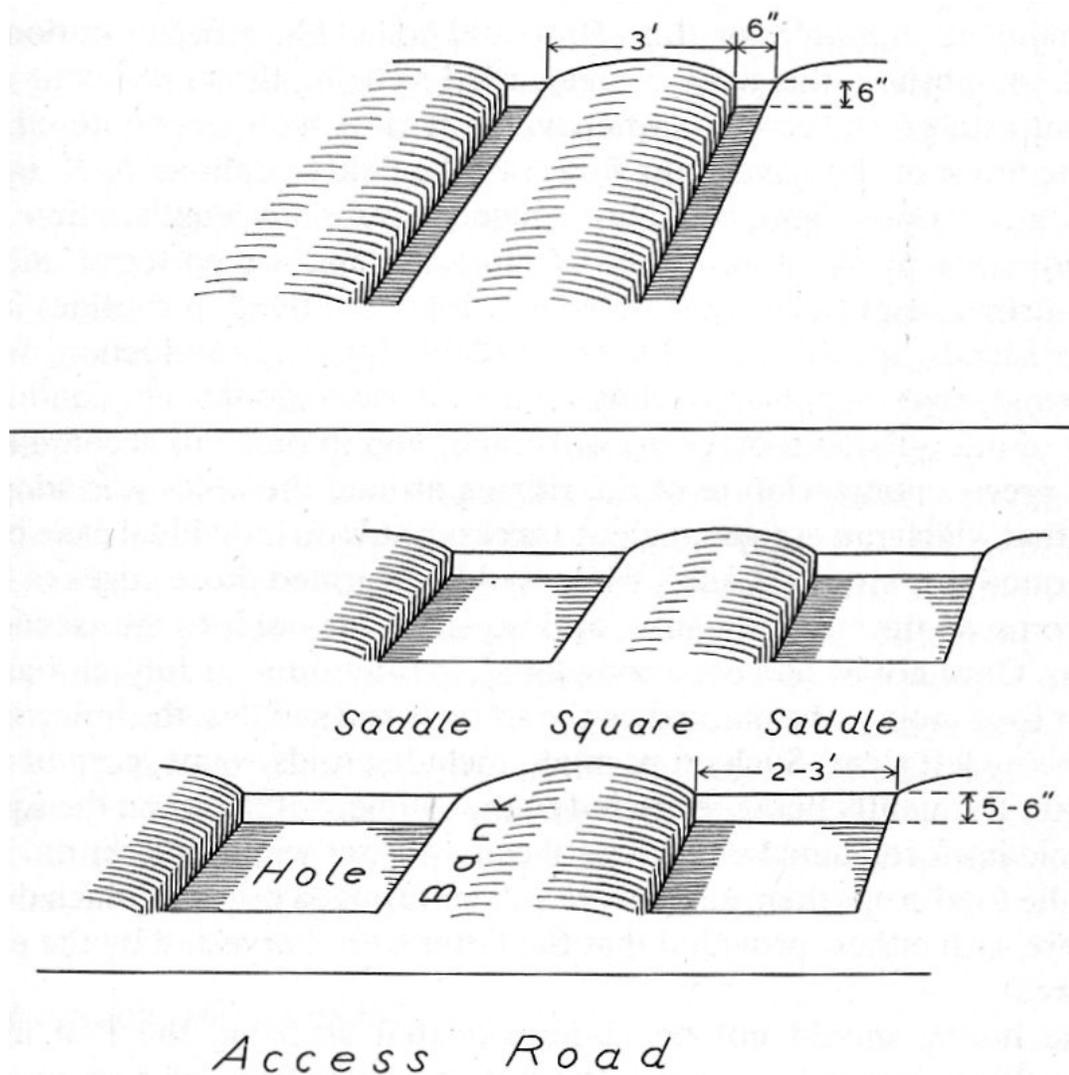


Figure 32: Cane 'trench' (above) and 'hole-and-bank' (below)<sup>271</sup>

<sup>270</sup> Deerr, *Sugar and the Sugar Cane*, pp. 32-33; J. Crabtree, "British Guiana Sugar Industry. Present Conditions and Future", *Sugar*, No. 4, XXIV (1922), 212-13.

<sup>271</sup> David Watts, p. 403.



Figure 33: Mould-board ‘holing’ on an island plantation.<sup>272</sup>

By the 1850s a majority of estates subsisted exclusively on ratooning and, even as seedlings became available after the 1890s, the consensus was that ratooning reduced replanting costs and yielded more robust plants relative to seedlings.<sup>273</sup> British Guiana adopted a variation of the planting technique used in the islands. Island ‘holing’ consisted of digging a line of evenly spaced openings, throwing the soil to one (‘banking’), and planting setts in the opening called ‘holes’.<sup>274</sup> **(Figure 33)** Although form-boards helped contain soil within the holes and forestalled erosion on mountainous terrain, the higher worker-to-land ratio in the islands favored labor-

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<sup>272</sup> TNA, UK. The island is identified as Antigua.

<sup>273</sup> Great Britain. “Select Committee on Sugar and Coffee Planting. Minutes of Evidence,” *Sessional Papers XXXVI* (1847-48): 1-3, **passim**.

<sup>274</sup> David Watts, pp. 402-05. Holing and banking is also described in Bryan Edwards, *History, Civil and Commercial, of the British Colonies in the West Indies* (London: John Stockdale, 1807), pp. 246-50.

intensive holing. In contrast, labor was scarce and expensive in Guiana even after immigration supplied a larger pool.<sup>275</sup>

Mould-boarding was also impractical on dense Guiana clays. Up to mid-century local planters employed a modification known as ‘trenching’ or ‘drilling’. Drilling involved digging lines of furrows (trenches) across a cane-piece and mounding the excavated soil into banks between the trenches.<sup>276</sup> The space between two furrows was a ‘bank’ and two adjacent banks constituted an ‘opening’.<sup>277</sup>

**(Figure 34)**



Figure 34: MacRae's transverse section of a canefield after drilling.<sup>278</sup>

Drilling, though adapted to local conditions, was not the ideal solution. Setts were also planted in the bottoms of furrows risked destruction by floods during

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<sup>275</sup> Jamaican agriculturalist W. F. Whitehouse wrote that in Demerara [British Guiana] “The usual method of making cane holes is with a shovel or long handled spade; few cane holes are now dug in consequence of the scarcity of labour ...”. Whitehouse, p. 17.

<sup>276</sup> MacRae, p. 21. ‘Drilling’ was called ‘holing’ in William Hilhouse’s account: “A field to be prepared for sugar must be first carefully leveled, [sic] spaces are then marked off of 3 and 1/2 feet alternately from the first space, a shovelfull [sic] of ground is dug and piled up one on the second, so as to make a bank and shallow trench across the bed, this process is called cane holing.” (Hilhouse, “Agriculture in 1829”, 34) Hilhouse’s description is consistent with Watts’ ‘ridging and trenching’. (David Watts, pp. 402-05) Campen, recommending holing to the members of the Royal Agricultural and Commercial Society in 1895, likened it to ‘Cassava holes’ a Guiana term for the individual mounds on which Cassava (*Manihot esculenta*) was grown. (F. Campen, “Cane Cultivation in the Straits Settlements”, *Timehri*, new series, (1895), IX, 95. Clearly, the writers were acknowledging changes in local cultivation technique although, save for Campen’s, the details are unclear.

<sup>277</sup> Crabtree, “British Guiana Sugar Industry”, p. 212.

<sup>278</sup> MacRae, p. 21.

biannual rains.<sup>279</sup> Shortage of hands and the recurrent floods forced a change in planting methods and by mid-century ‘cambering’ was reintroduced.

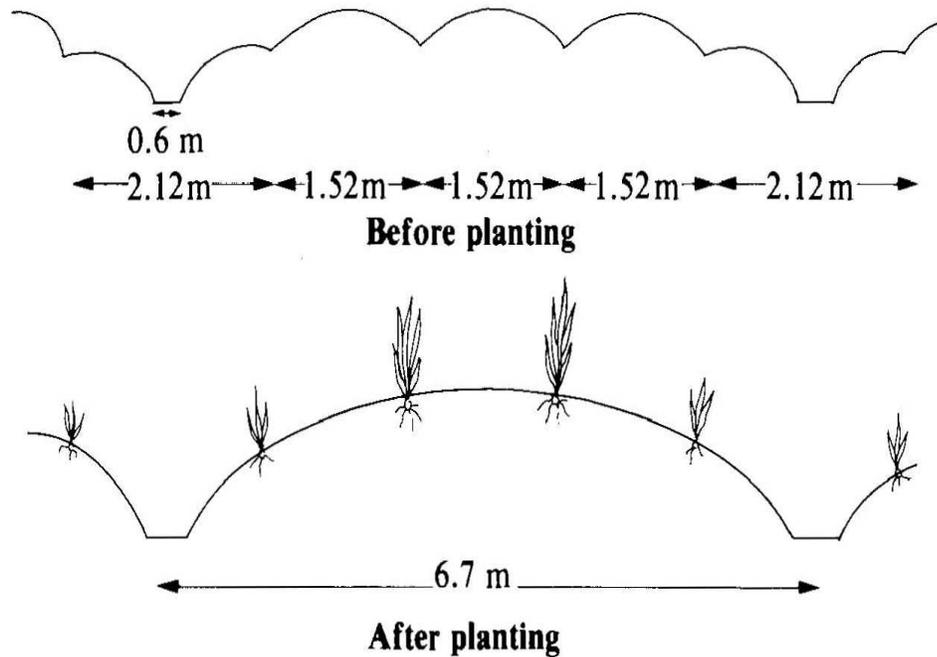


Figure 35: Section through a cambered bed.<sup>280</sup>

Cambering required shovel or fork-ploughing the soil which was mounded into large beds elevated above the natural ground-line.<sup>281</sup> Setts were planted on the cambered beds, inserted into the soil at a forty-five degree angle in rows spaced at

<sup>279</sup> Ibid, p. 22.

<sup>280</sup> Glyn James, (ed.), *Sugarcane*, p. 104.

<sup>281</sup> Cambering was observed in the British Guiana colonies during the eighteenth century. N. Ahmad and A. Mermut, *Vertisols and Technologies for their Management*, *Developments in Soil Science* 24 (Amsterdam: Elsevier Science, 1996), 384-85. MacRae recommended cambering in the 1840s. (p. 22) Dalton included ‘holing’, ‘banking’, and ‘rounding beds’ in his list of field tasks. (*History of British Guiana*, I, 485) Davy restated John Shier’s description of the “open drain and round-bed method” of planting in Guiana. John Davy, *The West Indies, Before and Since Emancipation* (London: W. and F. G. Cash, 1854), p. 358.

nine to ten inches (23 to 25 centimeters) apart.<sup>282</sup> (**Figures 35 and 36**) Cambering was a further adaptation to the sub sea-level coastland with its dense, sticky soils. Larger planting beds used labor more economically than traditional holing and banking.<sup>283</sup>

### **‘Supplying’, ‘trashing’, ‘moulding’ and ‘relieving’**

Cane plants required constant attention to ensure vigorous growth and maximum ripening. Keeping the canefields free of weeds, disease and insect pests were year-round, manual tasks in British Guiana. The main field interventions were ‘supplying’, ‘trashing’, and ‘moulding’ or ‘banking’.

‘Supplying’ viable setts to replace those that failed to thrive was generally done before the cane was two months old.<sup>284</sup> Intermittent removal of weeds and superfluous leaves—‘trashing’—was also customary. Defoliation relieved the plants of the burden of dead or decaying leaves, exposing them to the full effects of the sun that encouraged sucrose production.<sup>285</sup>

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<sup>282</sup> MacRae, p. 23.

<sup>283</sup> Ibid. The new practice was an improvement but not entirely trouble-free. Mechanical harrows used from the twentieth century created bands of soil of the same curvature as the cambered surfaces and worsened flooding in the furrows. (Frank Blackburn, *The Sugar-Cane* (London: Longman Group Limited, 1984), p. 138.

<sup>284</sup> MacRae, p. 26; Premium, pp. 62-63.

<sup>285</sup> Roughley, p. 220; Leonard Wray, *The Practical Sugar Planter* (London: Smith, Elder and Co., 1848), pp. 25-26; Thomas Kerr, *A Practical Treatise on the Cultivation of the Sugar Cane and on the Manufacture of Sugar* (London: John J. Griffin and Company, 1851), pp. 46-47; Edward Hawtrey, “Trashing Cane in Demerara”, *Sugar Cane*, (January 1 1874), 41.



Figure 36: Replanting a canefield in British Guiana circa 1900.<sup>286</sup>

The combined waste was deposited on either bank of the planting furrow, allowed to decompose and re-used in the moulding process. In British Guiana, one bank—the ‘trash bank’—received the waste gathered during the growth cycle while the alternate ‘clean bank’ was reserved for post-harvest trash.<sup>287</sup> ‘Relieving’ the fields after the harvest was customary; the trash was heaped on the clean bank and the process repeated for the ensuing crop. In this way, a permanent reserve of rich compost was easily accessible for manuring purposes. **(Figure 36)**

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<sup>286</sup> J. Siza, *Views of British Guiana*, Plate 53. Alternating trash-banks and rows with newly-planted setts are visible.

<sup>287</sup> Crabtree, “British Guiana Sugar Industry”, [Part One] pp. 212-13.

Judicious trashing hastened ripening and removed weeds from around young ratoons. Leaving some waste in the fields helped to provide cover for the plants and soil especially during drought.<sup>288</sup> Some planters removed green leaves from the lower joints of stalks to force ripening but the practice was viewed as harmful.<sup>289</sup>

Regular trashing was paired with ‘moulding’ which compacted soil around the roots and kept the cane upright. Moulding recycled green manure and brought subsoil nutrients to the plants. It improved drainage, curbed the growth of weeds and produced robust ratoons.<sup>290</sup> Local field conditions favored an initial weeding, moulding and banking at the time of planting.<sup>291</sup> Another moulding and weeding occurred when the plants were about six weeks old, and at the three and five-month benchmarks. The number of weedings and mouldings during the growth cycle was limited to four as opposed to the average of six cleanings for island plantations.<sup>292</sup>

British Guiana earned the reputation of being a territory where “non-banking” and “non-trashing” was normal and cane was allowed to fall over and run along the ground.<sup>293</sup> In fact, the favorable climate and rain-fed alluvium supported year-round cultivation and cane matured early with tall, heavy stalks atypical of the islands. Plagued at times by scarce labor but compensated by fertile soils, there was little incentive for planters to waste time and labor propping up the plants. Further, as field

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<sup>288</sup> *Three Essays on the Cultivation of the Sugar-Cane in Trinidad* (Port of Spain, 1848), p. 69; Thomas Roughley claimed four cleanings for Jamaica. (229-232) MacRae confirmed that some planters allowed “the ratoons and plants to grow up together for a time”. (25)

<sup>289</sup> *Three Essays...*, pp. 181-82 and 255.

<sup>290</sup> *Ibid.* See also *Eight Practical Treatises on the Cultivation of the Sugar Cane* (Jamaica: Jordon & Osborn, 1843), pp. 59-61.

<sup>291</sup> Moulding drew compost from the trash banks hence the interchangeable use of ‘moulding’ and ‘banking’.

<sup>292</sup> Dalton, I, 485; Bolingbroke claimed three or four weedings. (*A Voyage to the Demerary*, p. 68) Hilhouse confirmed that the second weeding occurred when the cane was about three or four months old. (“Agriculture in 1829”, p. 35) Adamson summarized that regular weeding and moulding was needed for the first six to eight months of the growth cycle. (Adamson, *Sugar Without Slaves*, p. 169) During the 1840s Trinidadian planters customarily performed three cleanings, the last primarily to hasten ripening. (*Three Essays...*, p. 16)

<sup>293</sup> Whitehouse, p. 8; Wray, pp. 122-23; *Eight Practical Treatises...*, p. 109; Campen, p. 93.

fertility declined, planters resorted to shovel-ploughing the trash back into the soil.<sup>294</sup> This strategy required more labor and by the 1840s trashing was simply heaped on alternate rows and left to decompose.<sup>295</sup>

Pre-harvest defoliation by burning was another labor-saving measure adopted in British Guiana. Burning also eliminated the characteristic heavy undergrowth that concealed rats and poisonous snakes. Moreover, leftover ash was recycled as field fertilizer. Burning also reduced the amount of trash entering the factory where the high silica content in cane leaves routinely wore down the crushing rollers.<sup>296</sup> Opponents of field burning argued that useful mineral constituents of trash—nitrogen, phosphoric acid and potash—were neutralized and valuable green components needlessly destroyed. Burning also destroyed the ratoon stools.<sup>297</sup> As pest infestations increased burning was also blamed for destroying natural bio-control organisms such as ants.<sup>298</sup>

### **Soil enhancement experiments**

New plantations were cleared and the debris burnt or left in the fields as compost. Worn-out fields were usually abandoned and new plots cleared as needed. Casual abandonment ended as the costs associated with land clearance and field preparation rose and rotating cultivation among various fields ensured that some land was held in fallow while other sections were in use.<sup>299</sup> Manuring was usually

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<sup>294</sup> Premium, p. 63.

<sup>295</sup> Whitehouse, p. 18.

<sup>296</sup> James C. P. Chen, Chung-Chi Chou, *Cane Sugar Handbook* (New York: John Wiley and Sons, , eleventh edition; 1993), p. 6.

<sup>297</sup> MacRae, pp. 30-31; Whitehouse, p. 18; C. G. Warnford Lock, G.W. Wigner and R.H. Harland, *Sugar Growing and Refining* (London: E. and F. N. Spon, 1882), pp. 66-67; Francis Watts, *An Introductory Manual for Sugar Growers* (London: Longmans, Green, and Co., 1893), p. 53; Crabtree, “British Guiana Sugar Industry”, [Part One] p. 213.

<sup>298</sup> “Insect Pests”, *Kew Bulletin*, No. 90 (June 1894), 173. Burning was also practiced in Mauritius. See Alfred North-Coombes, *A History of Sugar Production in Mauritius* (self-published, 1993), p. 61.

<sup>299</sup> Hilhouse, “Agriculture in 1829. II”, p. 248. This ended as the costs associated with land clearance and field preparation rose. Luke M. Hill, “On the Fallowing of Land in British Guiana”, *The Russell Prize Essays 1877-78*, p. 20 (ICS)

unnecessary on newly-opened fields and unmanured cane often grew to heights of 20 feet (7 meters)<sup>300</sup>.<sup>301</sup> Soils found too ‘rich’ were first cropped with plantains or cotton, the fibrous root systems loosening the dense clays in preparation for cane.<sup>302</sup> Cane grown on unseasoned land reportedly produced “rank and watery” juice that gave a dark-colored, poor quality sugar.<sup>303</sup>

Despite the acknowledged fertility, some soils were detrimental to cane. Pegasse was acidic and toxic as pH levels below four produced stunted plants.<sup>304</sup> Rudimentary green manuring from trashing and moulding supplied nutrients at regular intervals but, significantly, there was no intercropping with legumes during the nineteenth century as occurred on the Caribbean islands or Mauritius where there was less arable land.<sup>305</sup>

Continuous cropping eventually depleted essential nutrients that were replenished by ploughing ‘shell-lime’ and Peruvian *guano* directly into the soil.<sup>306</sup> Although neither improved the nutrient component, planters felt the additives rendered the stiff clays more porous and friable.<sup>307</sup> Intermittent and haphazard application of

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<sup>300</sup> Hilhouse, *Ibid*; Whitehouse, p. 18. MacRae saw diminished fertility after twenty successive years of cultivation. (*Manual of Plantership*, p. 31) An exception was Plantation Thomas at the entrance to the Demerara River that needed no manuring after fifty years of continuous cultivation. (Davy, “The West Indies ...”, p. 359) Others held that a 10 to 12 year fertility period was normal. (Adamson, p. 183) while others put the limit for well-drained soils at between 10 to 15 years. Lock, Harland and Wigner, p. 34.

<sup>301</sup> Whitehouse, *Ibid*.

<sup>302</sup> MacRae, pp. 21 and 29; “Reports from Committees on Sugar and Coffee Planting”, *Parliamentary Papers* XXIII, Part 2, (1848), p. 88; Pinckard, (1806), 402; Bolingbroke, p. 66; Dalton, 1, 224; and Hilhouse, “Agriculture in 1829”, p. 32. Plantains were sometimes grown for ten to twelve years before cane was introduced (Hilhouse, *Ibid*.) Bolingbroke wrote that at least two or three crops were needed to prepare the soil for sugar. (p. 67) Bancroft stated that at least two or three years of plantains were mandatory and, even then, the first and second cane crops were more suited to rum-making. (p. 12)

<sup>303</sup> By the 1840s the industry was aware that the sugar content of local cane juice was lower than juice from Barbados. “No. 1 Sugar Manufacture”, *De Bow’s Review of the Southern and Western States*, No. 6, VI (1848), 425.

<sup>304</sup> H. Evans, “Field Research in British Guiana Past, Present and Future”, *Bookers Sugar 1954*, p. 39; Blackburn, *The Sugar Cane*, pp. 44 and 46.

<sup>305</sup> See North-Coombes, *passim*.

<sup>306</sup> MacRae, p. 29. ‘London Lime’ came from Liverpool, England. ‘Barbados Lime’ and ‘shell sand’ was also imported.

<sup>307</sup> Luke M. Hill, “On the Fallowing of Land in British Guiana”, p. 26.

organic additives such as livestock dung and rotted cane trash were found to be useless and scientific intervention was eventually proposed.

In 1845, the Royal Agricultural and Commercial Society (RACS) of British Guiana, with support from the local legislature, hired chemist Dr. John Shier to research strategies for improvement.<sup>308</sup> At the same time, individual planters experimented with organic manures and tried new cane varieties such as the Mont Blanc Transparent imported from Jamaica.<sup>309</sup>

The RACS later co-sponsored another study of 134 soil samples in the early 1880s. Testing at several estates revealed significant deficiencies in essential minerals. While iron and silica levels were adequate, soils lacked phosphates, potassium and sulphuric acid and the deficiencies were assessed as the main causes of reduced plant yield. The study also found that intermittent application of high-priced commercial mixes hindered assessment of the value of each ingredient in the compounds.<sup>310</sup> Based on the findings, gypsum in the form of sulphate of lime and lime phosphate were proposed as fertilizers.<sup>311</sup> Sulphate of ammonia, in particular, was credited with bringing back exhausted Schoon Ord on the West Bank Demerara from the brink of

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<sup>308</sup> Shier, a Scottish Agricultural Chemist, researched ways to improve canefield operations and factory processes. He traveled throughout the colony, collecting data and giving public lectures on the merits of proper drainage, conducted tests to determine the efficacy of subsoil drainage and explored using artesian well water for residential and commercial use. Shier promoted fertilizers and is credited with improving juice clarification. He headed the first chemical laboratory that was staffed by an English assistant and four attendants. The British Guiana legislature funded his Caribbean tour to observe cotton and cane cultivation and sent him to Holland to report on drainage methods used there. Shier consulted with specialists on the cotton needs of the Manchester (England) mills. His tenure lasted from 1845 until his death in the colony in April 1854. See Alexander Bain, "Biographical Memoir of Dr. John Shier", *Transactions of the Aberdeen Philosophical Society*, I (1884), 116-132.

<sup>309</sup> "Select Committee on Sugar and Coffee Planting", p. 17; *Parliamentary Papers*, XXIII (1847-48), pp. 62-63. John Osborn tried 'artificial guano, Alexander MacRae and J. H. King applied shell lime and guano separately and in combined quantities. Alexander Winter (Berbice) reported on his experiments with "temper lime". ("The Action of Lime on the Clay-soils of the Colony", *Timehri*, II (1882), 300-01.

<sup>310</sup> Ernest E. H. Francis, "On British Guiana Cane Soils and Artificial Manures", *Timehri*, II (1882), 283-293.

<sup>311</sup> *Ibid*, p. 290 and *passim*.

abandonment.<sup>312</sup> Initially, fertilizer use was popular and expenditure per acre rose from \$2.09 in 1861 to \$7.61 by 1884.<sup>313</sup> Despite the increase in spending, application routines were haphazard and resultant improvements negligible. Superphosphate of lime, especially, was widely but improperly used to the extent where it reduced cane yield.<sup>314</sup>

Institution-led manorial experiments recommenced in the 1890s with John Burchmore Harrison and George Jenman leading research at experimental plots at the central Botanic Gardens as well as on the estates.<sup>315</sup> The focus of their research was the marked alkaline condition of coastal soils. Samples from Albion, (Berbice Coast), Friends (Berbice River), and Hampton Court (Essequibo Coast) showed that high proportions of magnesia were present in cane juice as uncrystallizable compounds absorbed from the soil. This ‘ash’ proved difficult to separate from the sucrose and was a factor in reduced factory output.<sup>316</sup>

Organic remedies were also tried and farm-yard dressings, dried blood and residual vacuum-pan molasses were applied directly to the fields. Molasses, paired with ammonia, phosphates, potash in individual and combined applications, aided the growth of bacteria in the soil but, ultimately, manured fields were not significantly

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<sup>312</sup> Jenkins, *The Coolie, His Rights and Wrongs*, p. 329.

<sup>313</sup> Adamson, *Sugar Without Slaves*, p. 183.

<sup>314</sup> *Ibid.*, pp. 184-85.

<sup>315</sup> George S. Jenman, F.L.S. (Government Botanist and Superintendent of Botanic Gardens 1879-1902) collaborated with Ernest E. H. Francis (Professor and Government Analytical Chemist and Geologist) from 1879 until Francis’ death in 1889. Jenman next worked with John Burchmore Harrison until Jenman’s death in 1902. Professor Harrison, C.M.G. M.A. (Cantab.), “Co-initiator of sugar-cane breeding in the Western world”, chemist, geologist, agronomist and soil scientist was seconded to British Guiana in 1889 from Barbados where he had worked from 1879 as the Government Analyst. Another eminent scientist was Frank A. Stockdale (later Sir Frank, 1883-1949) who came in 1908 after a stint as Mycologist and Lecturer in Agricultural Science at the Imperial Department of Agriculture. “Professor Harrison’s Work at Barbadoes [sic]”, *Louisiana Planter*, No. 1, IV (1890), 9; G. B. Masfield, *A History of the Colonial Agricultural Service* (Oxford: Clarendon Press, 1972), pp. 161-62.

<sup>316</sup> Maurice Bird, “An Interesting Soil Water Question in British Guiana”, *Agricultural Journal of British Guiana*, No. 3, VII (1913), 155-157.

more productive than unmanured ones.<sup>317</sup> Moreover, ensuing research showed cane treated with high proportions of ammonia were more susceptible to fungus diseases.<sup>318</sup> Using chlorinated lime to sterilize soil and destroy harmful organisms had only a slight beneficial effect on cane yield.<sup>319</sup>

A summary report confirmed the favorable effects of nitrogenous additives—mainly sulphate of ammonia, nitrates of soda, potash and lime, diluted and powdered guano and dried blood—on all varieties of cane and under controlled conditions. The findings praised the benefits of slaked guano and sulphate of ammonia applied at a rate of forty to fifty pounds per acre (18-22 kilograms per 0.4 hectares)<sup>320</sup> An earlier finding that hydrate of lime (slaked ‘Barbados Lime’) countered harmful effects of naturally-occurring magnesia was retracted. Tests concluded that lime engendered a mechanical rather than chemical improvement and Harrison and his team suggested that similar benefits could be achieved at reduced cost by light ploughs or cultivators.<sup>321</sup> Belatedly, a main flaw in the work program was the absence of trials analyzing the range of soils—from alkaline clays to acidic peats—found on the plantations.<sup>322</sup>

### **Experiments with ‘flood-fallowing’**

Drought conditions concentrated naturally high levels of salts in the soil, a problem solved by flooding the land with fresh water in between cropping. Flood-fallowing was thought to improve structure, reduce salinity and increase the amount of

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<sup>317</sup> J. B. Harrison and R. Ward, “Trials with Molasses as a Sugar-Cane Manure or Fertiliser, and with Chlorinated Lime as a Soil Ameliorant”, *Agricultural Journal of British Guiana*, No. 3, VI (1913), 123-26.

<sup>318</sup> Noel Deerr, *Sugar House Notes and Tables* (London: E. & F. N. Spon, 1900), p. 23; “The Past Year in Demerara”, *International Sugar Journal*, No. 87, VIII (1906), 155.

<sup>319</sup> Harrison, “Trials with Molasses ...,” p. 126.

<sup>320</sup> Deerr, *Cane Sugar*, pp. 79-80.

<sup>321</sup> Harrison, “Trials with Molasses”, pp. 123-26, \_\_\_\_\_, “Sugar Cane Experiments in British Guiana”.

<sup>322</sup> Crabtree, “British Guiana Sugar Industry ...,” p. 214.

iron in cane soils.<sup>323</sup> Its revival followed the “Great Drought” of 1826 and fallowing was co-opted in the 1880s to control the Stem Borer pest (*Castniomera licus*) pest.<sup>324</sup>

Cane-pieces were taken out of cultivation after the third ratoon crop and flooded with nine to twelve inches (230-300 millimeters) of fresh water above their highest elevations for six to nine months beginning one to twenty days after the harvest.<sup>325</sup> Soil scientists believed that ‘resting’ the soil in this manner increased its porosity by allowing oxidization of iron compounds which then coated the clay particles and made them less sticky. Improved aeration, in turn, encouraged biological activity and drew nutrients from decaying plant stumps, roots and other detritus in the soil. Flood-fallowing also slowed the growth of land weeds and aquatic plants were ploughed back into the land.<sup>326</sup>

Fallowing experiments, in addition to optimizing submersion conditions, examined changes in the organic constituents of the soil. Testing also compared the value of varying the immersion times and of applying limestone before and after flooding.<sup>327</sup> Increasing the depth of the water improved yield and a few estates expended vast sums to reconfigure field layout and pump in water to maintain depths of up to twelve inches (305 millimeters) on the beds.<sup>328</sup> Post-fallow yield increased by as much as forty percent although the benefits were temporary and repeat fallowing was required before replanting.<sup>329</sup> British Guiana planters also liked to add rum

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<sup>323</sup> Blackburn established that the benefits of flood-fallowing were known in Guiana since the late 1820s. (p. 139) Fanshawe claims that flood-fallowing was first applied in neighboring Suriname. D. B. Fanshawe, “The Vegetation of Sugar-Cane Flood Fallows”, *Journal of Ecology*, XLII (January 1954), 212.

<sup>324</sup> Ahmad and Mermut, *Vertisols and Technologies for their Management*, pp. 397-98.

<sup>325</sup> Fanshawe, p. 211; *Agricultural Journal of British Guiana*, No. 1, V (1934), 8-9.

<sup>326</sup> Fanshawe, *Ibid.*

<sup>327</sup> *Ibid.*

<sup>328</sup> *Ibid.*

<sup>329</sup> Williams, “The Development of the Sugar Industry in British Guiana”, p. 124; Evans, “Field Research in British Guiana...”, p. 39.

distillery waste-water, ‘lees water’, to the fallowing process. The strategy was first tried at Plantation Montrose (East Coast Demerara) where lees was formerly “thrown away to plough land”.<sup>330</sup> The Colonial Company experimented with ways to distribute and utilize the pungent effluent circa 1871 although its effects reportedly caused the death of immigrants housed near to the source.<sup>331</sup> Flood-fallowing rewards were substantial enough to warrant continued and widespread use in the twentieth century.<sup>332</sup>

### **Implemental and mechanical tillage**

As the end of enslavement approached in the 1830s, planters focused on ways to alleviate the anticipated labor shortage. The agricultural and commercial bloc in Demerara, Essequibo and Berbice proposed machines as replacements for manual work and offered prizes to encourage mechanization.<sup>333</sup>

Cultivation tasks placed the highest demands on labor. At first, all tillage was manual and the enslaved used shovels, hoes and cutlasses (machetes) in the field.<sup>334</sup> The ‘Demerara Shovel’, crafted from a section of a hollow cylinder and with a socket for its handle, was popular.<sup>335</sup> A smaller version—the ‘shovel spoon’—was especially suited to the compact soils of the coast and river banks.<sup>336</sup>

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<sup>330</sup> Luke Hill, “On the Fallowing of Land...,” pp. 24-25; \_\_\_\_\_, “The Lees Question”, *Timehri*, I (1882), 163-65 and **passim**) Hill opposed the use of lees and claimed that it polluted the fresh-water canals. See also Deerr, *Cane Sugar*, pp. 100-01.

<sup>331</sup> Jenkins, pp. 38 and 324.

<sup>332</sup> Evans, “Field Research in British Guiana Past”, p. 39; Barnes, *The Sugar Cane*, p. 143.

<sup>333</sup> Thomas Watt, “Agricultural Societies in British Guiana: An Historical Sketch”, *Timehri*, VI, 1886), 259. An appeal appeared in a US periodical in 1869. “Thousands of pounds have been spent in trying to get the steam plow to operate by pumping the drains, but without effect; and the information I ask is, is there any labor-saving machine that would did the earth and turn it between ten to twenty inches deep, and thus save the immense amount of labor we now use?” Geo. H. Oliver, “Digging and Dredging Machines Wanted in British Guiana”, *Scientific American*, VI (February 1869), 86.

<sup>334</sup> *Anti-Slavery Monthly Reporter*, I (1827), 321; “Select Committee on Sugar and Coffee Planting”, p. 18.

<sup>335</sup> *Great Britain Board of Trade Journal*, LXXXVIII (July-September 1912), 410; United States House of Representatives, 56<sup>th</sup> Congress, Second Session, Document No. 356 Part 1, *Monthly Bulletin of the Bureau of the American Republics*, p. 533. “Demerara ploughs”, “Demerara shares’ and “Demerara

The earliest successful deployment of a plough in British Guiana dates to circa 1820 when enslaved men worked a wheeled device drawn by an ox team led by a draught-horse.<sup>337</sup> The Lancaster-made plough was tried on an eight-acre field (3.2 hectares) at Broom Hall (East Coast Demerara) owned by Josias Booker. The experiment was successful and colonists from Berbice and Essequibo asked to send their enslaved hands and cattle teams to Booker's plantation to learn how to work the plough.<sup>338</sup> Shortly after Emancipation (1838) another plough trial took place on plantations Philadelphia and Friends using imported horses and English ploughmen. The ploughs were successful on lighter pegasse soils typical of the backlands of many plantations but failed on dense frontland clays.<sup>339</sup>

A number of horses, mules, and oxen were sacrificed in early attempts at implemental tillage.<sup>340</sup> Plough oxen required large quantities of imported oats and could only be worked in shifts which made their use as expensive as manual labor.<sup>341</sup> Moreover, traversing the dense soil and circumventing fragile drainage and irrigation earthworks in the fields was problematic. Cattle hitched to cumbersome equipment often fell into drains and destroyed the dams.<sup>342</sup> Horses were an expensive substitute

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trenching shovels or open socket spades" were listed in British, American and Spanish trade circulars in the late 19th and early 20th centuries. (*Pocket Dictionary of Spanish Technical Terms, Comprising also the Most Usual French and Portuguese Trade Names, and Forming a Complete List of all Goods Ordered Through Birmingham Houses, for Spain and its colonies, Mexico, Central and South America* (Birmingham: Charles Redfern, 1869), p. 70.

<sup>336</sup> W. T. Walthall, "Agricultural Implements in British Guiana", *Reports from the Consuls of the United States*, Nos. 120-123, XXXIV (1890), p. 480.

<sup>337</sup> Josias Booker, "On diminishing Human Labour in the Cultivation of Cotton, Sugar, &c, 1828", *Gill's Technological Repository; or, Discoveries and Improvements in the Useful Arts*, VI (1830), pp. 211- 223. William Hilhouse wrote that ploughs were occasionally used "in turning uplands that have been long cultivated, but after the first essay, no further occasion has been found for their use, till they were rotten." (Hilhouse, "Agriculture in 1829.-II", 249) See also Bancroft, p. 363.

<sup>338</sup> Broom Hall was a cotton plantation. Booker later reopened neighboring Fairfield, which had been abandoned owing to lack of labor. Booker, "On diminishing Human Labour...", pp. 211- 223.

<sup>339</sup> *Parliamentary Papers*, XVI (1841), p. 75.

<sup>340</sup> Premium's neighbor lost sixteen oxen ploughing twenty acres (8.1 hectares) and the laborers eventually resorted to shovels. (\_\_\_\_\_, *Eight Years in British Guiana*, p. 61)

<sup>341</sup> *Ibid.*

<sup>342</sup> "Reports from Committees on Sugar and Coffee Planting...", p. 46.

owing to high purchase prices and the difficulty with acclimatizing animals imported from the United States and Venezuela.<sup>343</sup>

### **Alexander MacRae and his steam plough**

Mechanical cultivation, like mechanical drainage, was circumscribed by the high cost of equipment and difficulty with maneuvering through the fields. Resident planter Alexander MacRae devised a remedy tailored to local conditions.

MacRae's patent for a specialized plough described a steam engine fitted into a punt floating in a canal and anchored to a second punt in a parallel canal. The engine was linked by a cable to a plough which, when the punts moved along their respective waterways, was drawn across the field effecting "most expeditious ploughing".<sup>344</sup>

MacRae's design allowed harrows and other cultivating equipment to be attached to a steam carriage as a replacement for draught animals.<sup>345</sup> His machine was designed for level land and required stabilizing chains or rope attachments if used on hilly terrain. Critical setbacks at the time were the lack of engines powerful enough to

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<sup>343</sup> Premium, p. 61. See also Luard, "Steam Husbandry with open Drainage in Demerara", pp. 94-102; R. G. Duncan, "Cost of Sugar Production in British Guiana", *Timehri*, new series, (1894), VIII, 114-26; Thorpe, "Changes on Sugar Estates...", pp. 205-17, *passim*; Pinckard, III (1806), 206; Seaforth Bellairs, "Twenty Years' Improvement in Demerara Sugar Production. Part 1", *Timehri* V (1891), 328-36.

<sup>344</sup> MacRae was a planter who, on publication of his *Manual of Plantership in British Guiana* in 1856, had lived in the colony for fifty years. His plough is described in John Scott, *Farm Roads, Fences and Gates: A Practical Treatise on the Roads, Tramways, and Waterways of the Farm*, London: Crosby, Lockwood and Co., 1883, 50; Wray, *The Practical Sugar Planter*, pp. 115-117; and Commissioners of Patents, *Abridgments of the Specifications relating to Steam Culture* (London: Great Seal Patent Office, 1858), 21. MacRae was recognized as "the legitimate father of the Steam Plough" in "Steam Culture Mechanics", *British Farmer's Magazine*, new series, (1863), XLV, 20. His ploughing system was tried successfully at Possil near Glasgow (Scotland) in 1863. An 1841 dispatch from Governor Light of British Guiana affirmed that a [local] planter obtained an English patent for his steam plough which had been tested with favorable results in the colony. "Extract from Despatch from Governor Light to Lord Stanley", *Parliamentary Papers*, No. 7, LXV (1841)

<sup>345</sup> *Abridgments of the Specifications relating to Steam Culture*, 21. MacRae vied with a Mr. Pinkus for the title of original inventor but *British Farmer's Magazine*, after examining the structure and functioning of the two ploughs, declared MacRae's the original. ("Steam Culture Mechanics", 17-21)

drive the heavy ploughs through the dense clays as well as the expense of supplying large quantities of imported coal for the steam engines.<sup>346</sup>

### **Further trials with steam ploughing**

A variation on MacRae's plough, with a locomotive engine, was patented and tried by another Guianese resident, John Tulloch Osborn, in 1846 although the open drains constrained its use.<sup>347</sup> **(Figure 39)** An observer summarized the difficulties:

Cultivating from canal to canal entails working across the shortest length of the field, which is only from 165 to 178 yards, whereas the length from the middle walk to the side-line dam is never less than 550 yards. The former lengths are too short for economical working, from the number of turnings involved, and the only remedy would be to double the distance between the engines, by filling up every alternate canal; but this would necessitate the adoption of some other method of clearing the fields than that of the labourers carrying out the sugar-canes by back-loads, as is now done, for the distance between the punt-trenches is already too great for that.<sup>348</sup>

The Fowler Company developed a 'double engine' system with two engines, in separate punts, driving a plough.<sup>349</sup> A Fowler 'balancing plough' tried at Houston in Demerara in 1861 turned up "large upright clods" but a smaller implement was too short to cross the drains.<sup>350</sup> **(Figures 37 and 38)** John Rhodes Tilley, engineer and Demerara resident, patented his "improved cultivator", a device that allowed ploughs to be adjusted to till at various depths.<sup>351</sup> Edward Jenkins saw a steam plough at work

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<sup>346</sup> *Farmer's Magazine*, XXIII (June 1863), 498.

<sup>347</sup> "Patent 11, 304 1846. John Tulloch Osborne, Esq., of Demerara, Patentee", *Journal of Society of the Arts* (1 February 1856), 169; and John Scott, *Farm Roads*, 45; "The Essex Steam Plough or, Osborn's System of Rigger Haulage", *British Farmer's Magazine*, new series, (1865), XLIX, 229-30. John Timbs, *Yearbook of Facts in Science and Art* (London: David Bogue, 1848), pp. 76-77.

<sup>348</sup> Scott, *Farm Roads*... p. 51.

<sup>349</sup> *Ibid.* Osborn (also 'Osborne') had an earlier patent for 2 engines, each in its own punt, powering 2 ploughs. See *Farmer's Magazine*, XXIII (June 1863), 498.

<sup>350</sup> *The New Local Guide of British Guiana*, p. 41. Messrs. John Fowler and Company of Leeds, England, were the leading makers of ploughs and cultivation equipment supplied to British Guiana in the 19<sup>th</sup> century.

<sup>351</sup> "New Agricultural Inventions", *Scientific American*, No. 25, XXXVI (1877), 394; *Annual Report of the Commissioner of Patents for the year 1877*, p. 205.

at Montrose (East Coast of Demerara) circa 1871 and, from his description, it seems to have been an upgrade of MacRae's prototype.<sup>352</sup>

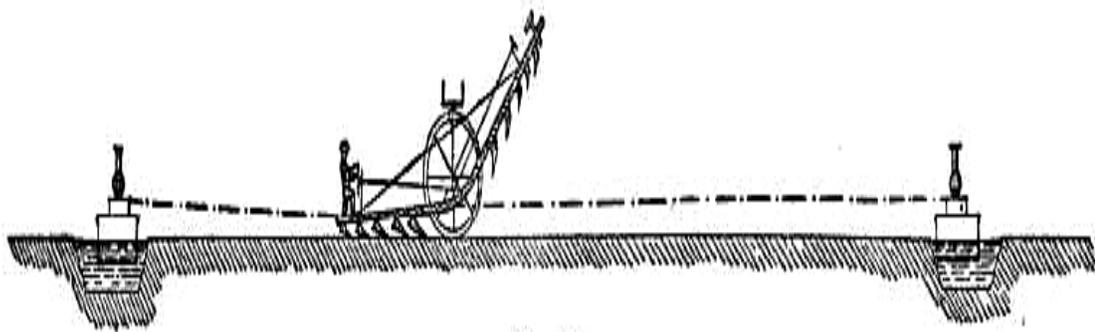


Figure 37: Fowler's double-engine ploughing system.<sup>353</sup>

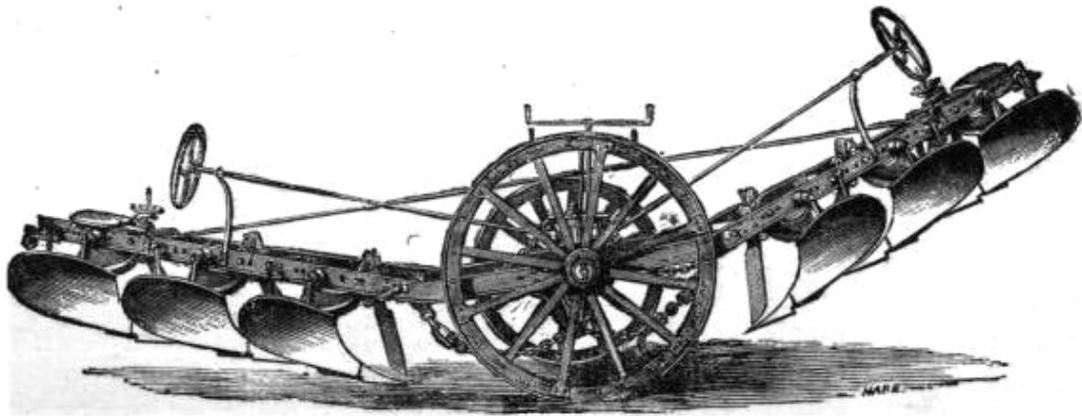


Figure 38: A Fowler 'Balancing Plough'.<sup>354</sup>

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<sup>352</sup> Jenkins, pp. 67-68. He wrote: "The steam-ploughing is done by an engine stationed in a punt, getting its fulcrum from the bank of the canal on which it floats. At the other end of the field to be ploughed is a movable anchor, with a steel pulley, in which works a wire rope. This rope winds over a drum in the punt, and to it is attached a powerful plough. As the rope is wound upon the drum, it pulls the shear through the stiff clay soil with resistless force."

<sup>353</sup> Scott, *Farm Roads*, p. 50.

<sup>354</sup> Peter Soames, *A Treatise on the Manufacture of Sugar Cane* (London: E. & F. N. Spon, 1872), p. 114. The ploughs are also called 'balance ploughs'.

**Mechanics' Magazine,**  
MUSEUM, REGISTER, JOURNAL, AND GAZETTE.

No. 1225.]

SATURDAY, JANUARY 30, 1847.

[Price 3d.

Edited by J. C. Robertson, 166, Fleet-street.

**OSBORN'S STEAM PLOUGH.**

Fig. 3.

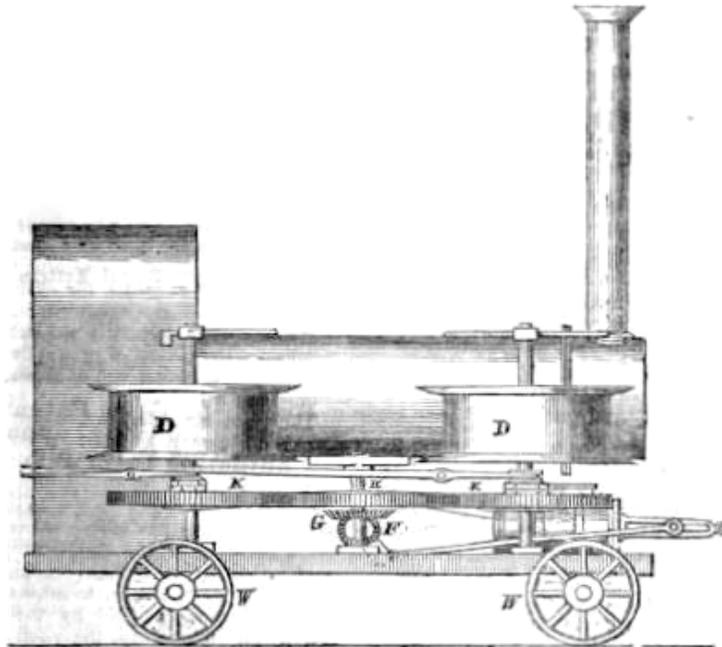


Fig. 4.

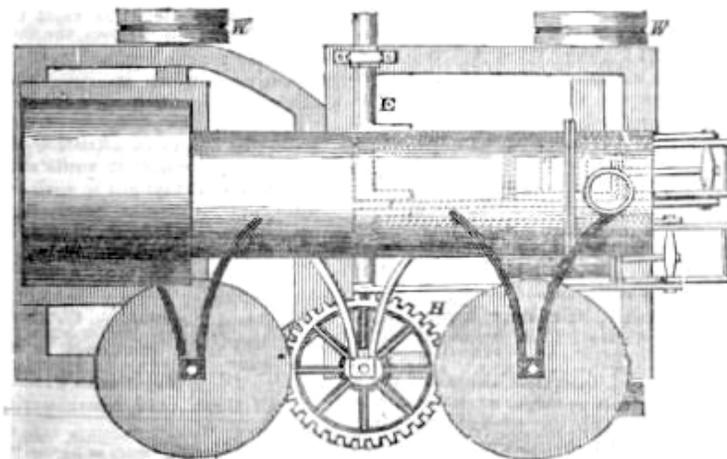


Figure 39: John Osborne's steam plough, *Mechanics' Magazine* 1847.<sup>355</sup>

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<sup>355</sup> *Mechanics' Magazine*, No. 1225 (January 20 1847)

In addition to the problems with the drains, the use of ploughs was constrained by the high cost of the fuel oil for the steam-powered machines.<sup>356</sup> In 1859 the colonial legislature attempted to intervene by offering a prize of \$5,000 (approximately £1,000) for the successful introduction of a steam plough into the colony and offered a similar sum for a “steam digging or grubbing machine”.<sup>357</sup> An increase in the prize was authorized in 1875, no doubt indicative of the failure to implement a functioning technology in the intervening period.<sup>358</sup>

Despite the overall failure with implemental and mechanized ploughing, officials passing through the colony during the 1840s reported “considerable success” with steam ploughs and were optimistic that their use would increase.<sup>359</sup> By 1884, however, the United States resident consul acknowledged that the only mechanical plough (presumably steam) in the colony was at Better Hope (East Coast Demerara) which had subsoil drainage. The consul confirmed that fractured and swampy plots, with open drains and prone to silting, precluded plough usage.<sup>360</sup>

A few estates managed to work ploughs, albeit on a limited scale and others continued to try them. A steam plough was tried on Plantation Canefield in Berbice in the early 1890s and planter A. R. Gilzean recalled that an uncle tried to counter the open drains by installing three wheels on his plough but the engine was not powerful enough to drive it.<sup>361</sup>

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<sup>356</sup> William Hill, “Following Land in British Guiana”, p. 31.

<sup>357</sup> *Mechanics' Magazine*, no. 31, II (1859), i.

<sup>358</sup> A prize of \$100,000 was offered with the proviso: “[A]ny person or persons who shall introduce . . . machinery capable of tilling the soil and other purposes connected with the manufacture of our staple of this colony, which can be worked at a moderate expense compared with the expense at present attending the cultivation of the soil.” E.C. Luard, “Steam Husbandry . . .”, p. 95.

<sup>359</sup> Walter Ware, “Stipendiary Magistrate’s Half-Yearly Report ending 30<sup>th</sup> day of June 1841”, *Parliamentary Papers*, XXIX (1842), p. 72.

<sup>360</sup> *United States Consular Reports*, No. 45 (September 1884), 683. (CUL)

<sup>361</sup> “Report of Society’s Meetings”, *Timehri*, new series, (1894), VIII, 188.

By 1893 various trials yielded insight into the problems with mechanizing tillage. Generally, saturated alluvial clays and fragile earthworks precluded the use of ploughs and small planters could not afford engines and fuel to power the machines. However, lighter soils aback some riverain estates such as Plantation Diamond on the Demerara River supported implemental and steam ploughs.<sup>362</sup>



Figure 40: Ploughing a field circa 1924.<sup>363</sup>

Belatedly, the sugar industry deduced that a complete re-arrangement of the fields was required. Afterward estates would mostly follow the ‘English Bed’ system’ with cane rows laid out parallel to the main navigation canal that held the punts and engines, the beds laid out on a perpendicular line to receive the ploughs.<sup>364</sup> The

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<sup>362</sup> Rodway, *Hand-book of British Guiana*, pp. 6-7.

<sup>363</sup> *British Guiana*, (Wembley: British Empire Exhibition, 1924), no page. (online)

<sup>364</sup> See **The field system: ‘Dutch’ versus ‘English’ Layout, CHAPTER 2**, this dissertation.

*Louisiana Planter* acknowledged in 1909 that Fowler's wire-rope canal ploughs had been used in British Guiana for many years but a decision had been made to adopt American animal-drawn models in place of the steam ploughs.<sup>365</sup> The herculean efforts to adapt ploughs had proved insurmountable and significantly, the return to draught ploughs coincided with a notable increase in Guiana sugar exports to the United States.<sup>366</sup> American-made farm tractors debuted in British Guiana early in the twentieth century although local soils could not provide adequate traction for the cumbersome machines and the idiosyncratic field layout was counterproductive.<sup>367</sup>



Figure 41: Loading the punts.<sup>368</sup>

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<sup>365</sup> “Cane Culture in British Guiana”, *Louisiana Planter*, No. 11, XLIII (1909), 162.

<sup>366</sup> See **APPENDIX 4 British Guiana sugar exports 1884 to 1904.**

<sup>367</sup> Clem Seecharan, *Sweetening ‘Bitter Sugar’*. Jock Campbell, *the Booker Reformer in British Guiana 1934-1966* (Kingston: Ian Randle Publishers, 2005), p. 319; “Tractors”, *Journal of the Board of Agriculture of British Guiana*, No. 1, XIII (1920), 1. The editor of the journal opined that “Bolshevik-like” handling by local repairmen would destroy the machines.

<sup>368</sup> *British Guiana*, (Wembley: British Empire Exhibition, 1924), no page. (online)

## Harvesting

Cane agriculture implies various functions that are difficult to satisfy with a single machine.<sup>369</sup> Aside from general cultivation—planting and manuring—equipment is needed to harvest and transport the stalks to the processing site. Further, specialized harvesters are required for hilly, irrigated canefields (Hawaii) or for flat, waterlogged land with open drainage typical of British Guiana and high tonnages of cane per acre exert tremendous strain on even the most durable machines.<sup>370</sup>

Physiological properties of the cane—its almost impenetrable rind, bamboo-like durability and propensity to run on the ground—make it resistant to grain crops cutters applied, for example.<sup>371</sup>

The harvest is a critical stage in converting cane juice to sugar crystals. In Guiana, cane was cut with the cutlass or machete at maximum ripeness and milled immediately to forestall desiccation, and loss of sucrose through inversion. Sucrose concentrates at ground level mandating that stalks to be cut at their lowest point but not high enough to include the sucrose-deficient top segments.<sup>372</sup> In addition, successful ratooning—the prevailing practice on tropical plantations—depends on manual harvesting to minimize damage to the plant stools from which new ratoons sprout. Manual cutting ensures that less debris enters the factory thereby increasing milling efficiency and eliminating the need for costly ‘cane laundries’ that use large quantities of water and draw sucrose from stalks damaged prior to milling.<sup>373</sup>

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<sup>369</sup> An established conclusion is that “the harvesting of sugar cane is one of the toughest jobs which any machine ever has been called upon to do.” See Geoff Burrows and Ralph Shlomowitz, “The Lag in the Mechanization of the Sugarcane Harvest: Some Comparative Perspectives”, *Agricultural History*, No. 3, LXVI (1992), 61-75.

<sup>370</sup> Vladimir P. Timoshenko and Boris C. Swerling, *The World's Sugar* (California: Stanford University Press, 1957), p. 134.

<sup>371</sup> Noel Deerr, *Cane Sugar*, p. 175.

<sup>372</sup> James Chen, *Cane Sugar Handbook*, p. 6.

<sup>373</sup> After developing a cotton harvester in the 1940s, the American company International Harvester was pressed to design a cane-cutting machine. By 1949, it had largely abandoned its research owing to the

Heavy machines in the canefields—especially in areas such as Guiana with dense clays—inadvertently compact the soil and retard ratoon growth.<sup>374</sup> In regions where cane is an irrigated crop (Hawaii), water in the drainage furrows inhibits the progress of mechanized cutters that need to penetrate the sides of the furrows to make a sufficiently low cut.<sup>375</sup> Finding economical and technically viable means to harvest cane remains a chief difficulty for the sugar industry and, up to the present, cane is cut by hand.<sup>376</sup>



Figure 42: Animal-drawn punts arriving at a mill in the nineteenth century.<sup>377</sup>

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difficulty with designing an affordable machine that could replicates manual cutting, leaf removal, loading and transporting functions. (Burrows and Shlomowitz, pp. 61-75.

<sup>374</sup> Timoshenko and Swerling, *The World's Sugar*, p. 133.

<sup>375</sup> Burrows and Shlomowitz, *passim*.

<sup>376</sup> Ibid. A 'cane-cutting' machine was tried at Hyde Hall in Trelawney (Jamaica) in the early 1840s. (Whitehouse, *Agricola's Letters...*, p. 311). Up to the 1950s only Hawaii, Louisiana and Queensland had mechanized some aspects of cutting and loading operations. G. B. Hagelberg, *The Caribbean Sugar Industries: Constraints and Opportunities* (New Haven: Yale University, 1974), p. 93.

<sup>377</sup> Browne, *Peeps at Industries, Sugar*, frontispiece photograph by E. W. Savory.

## Transportation

The earliest forms of plantation transport were animal-drawn. Draught animals—imported mule and horses—towed iron punts filled with cane along the Middle Walk to the factories.<sup>378</sup> **(Figures 41 and 42)** The historical canal-and-punt method was deemed anachronistic by observers favoring rail technology. The *Louisiana Planter* derided the “old-fashioned” practice and was perturbed by the presence of drainage trenches interwoven with the fresh-water canals.<sup>379</sup> By adopting freight cars to move cane to the factories the industry would eliminate the need to maintain adequate water levels to allow the punts to float freely in the navigation canals especially during droughts. Eliminating water carriage would also simplify the interdependent and complex drainage and irrigation network that hindered field mechanization.<sup>380</sup>

The local industry was, however, reluctant to finance an entirely new system of haulage as its specialized system had functioned effectively for centuries. The high cost of installing tramways—\$4,000 to \$5,000 per mile in the early twentieth century—motivated planters to keep the punt system.<sup>381</sup> Dual use of the waterways for irrigation (as needed) and for transportation helped keep operating costs economical.

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<sup>378</sup> Later, punts assembled on the estates from imported iron plates replaced wooden punts. Wood punts were more economical, however, as canal water tended to corrode the metal. (MacRae, p. 59)

<sup>379</sup> “Sugar Agriculture in the British West Indies”, *Louisiana Planter*, No. 10, XXVII (1901), 146.

<sup>380</sup> “American Hoist and Derrick Co’s Derricks in British Guiana”, *Louisiana Planter*, No. 10, XLIII (1909), 157.

<sup>381</sup> “American Machinery in British Guiana”, *Louisiana Planter*, No. 1, XLVIII (1912), 2-3.



Figure 43: Laborers carrying cane on their heads circa 1924.<sup>382</sup>

Given the problematic labor situation, it seemed certain that mechanized transport would eventually replace water haulage. Motorized vehicles arrived at the start of the twentieth century and the “great Missouri mules”, characteristic of the old plantation scene, were replaced by rubber-tired tractors hauling ‘trains’ of up to thirty punts each carrying five to seven tons of cane.<sup>383</sup> ‘Farmall’ tractors from the International Harvester Company hauled the punts for seven or eight miles (11.2 or 12.8 kilometers) along the canals.<sup>384</sup> Cane was still brought from the fields to the punts by ‘head-load’.<sup>385</sup> **(Figure 43)**

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<sup>382</sup> *British Guiana*, (Wembley: British Empire Exhibition, 1924), no page. (online) Field overseers in white shirts and helmets are visible.

<sup>383</sup> J. F. Williams, “Factory Routine”, and “The Development of the Sugar Cane Industry in British Guiana”, *Bookers Sugar* (London, 1954), p. 48; Barnes, *The Sugar-Cane*, p. 121; British Guiana, “Report of the Department of Lands and Mines”, *Administrative Reports, 1905-06*, p. 117. Early punts appear to have been smaller and carried between 2.5 to 3 tons of cane. Deerr, *Sugar and the Sugar Cane*, p. 83.

<sup>384</sup> Seecharan, *Sweetening Bitter Sugar*, p. 318.

<sup>385</sup> A ‘head load’ comprised a bundle of stalks tied together carried on a laborer’s head.

## Railways

Railways were not as common on British Guiana estates as they were in Cuba and St. Kitts, for example. Nevertheless, the technology was considered as the colony transitioned from enslaved to paid labor. Local societies offered premiums for schemes to install “moveable” railways with cars to take the harvest to the mill.<sup>386</sup> A single design for a “self-acting railway” was submitted but there is no evidence that it was built.

Estate managers and supervisors moved within the canefields in small, square-bottomed craft called *bateaux*.<sup>387</sup> However, a Commission appointed to investigate conditions in British sugar colonies reproached British Guiana for failing to provide transportation for workers who walked long distances along muddy dams and waded waist-deep through irrigation trenches to reach the fields.<sup>388</sup> Light passenger rail took workers to and from the canefields at Port Mourant and Blairmont (Berbice) in 1929, the only two estates with rail transport up to that time.<sup>389</sup>

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<sup>386</sup> Watt, “Agricultural Societies in British Guiana...,” p. 264.

<sup>387</sup> Overseers were sometimes ferried on the back of a sturdy cane-cutter. Curtis (ed.), *Demerara Doctor*, p. 128.

<sup>388</sup> *Report of the West India Royal Commission*, (Lord Olivier, Chairman) London: His Majesty’s Stationery Office, 1930, p. 94.

<sup>389</sup> Seecharan, *Sweetening Bitter Sugar*, p. 55.



Figure 44: The 'Hydro-Ford' with its young operators in 1920.<sup>390</sup>

#### **Water haulage: Blairmont's 'Hydro-Ford'**

An unorthodox instance of water haulage occurred at Blairmont Estate circa 1920. Visiting zoologist Albert Reese reported that he had gone hunting on the Abary River in Berbice in a vessel retrofitted with a Ford car's engine by J.R.C. Gordon, the estate manager. The boat—the "Creation"—was normally used to haul the estate's cane punts to the factory. As the banks of the Abary were too soft for a tow-path, the unique boat—the engine's rear axle connected to a paddle wheel in the stern and its steering gear linked to the boat's rudder—worked in place of horses and mules. With

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<sup>390</sup> Albert M. Reese, "Caiman Hunting in South America", *Natural History*, XX (1920), 427. The original caption reads: "The 'Creation.' A homemade motor-boat used for towing barges of sugar cane. The motive power is a topless and wheelless Ford Car."

an Afro-Guianese child at the helm of the “hydro-Ford”, Reese’s caiman hunting party motored up and down the river “in utmost comfort”.<sup>391</sup> **(Figure 44)**

## Section Two

### Cane and cane research

Sugar ‘cane’—a perennial grass native to Asia—grows as a tall reed that can reach heights up to twelve (3.6 meters) and measure 3 inches (7.6 centimeters) in diameter.<sup>392</sup> Its leaves are sword-shaped and two to four feet long (0.6 to 1.2 meters)

Cane is propagated by cuttings, a method known as ‘ratooning’, or by seed.<sup>393</sup> Cultivated varieties belong to the genus *Saccharum* (*S.*) of which *S. officinarum* are the ‘noble’ canes distinguished for thick stems, high sucrose content and a marked susceptibility to disease.<sup>394</sup> Conversely, *S. spontaneum* (‘wild’ canes) include hardy varieties that are resistant to disease but contain less sucrose. Hybrids that combine the best qualities of *officinarum* and *spontaneum* have been developed for commercial purposes and *S. sinense* and *S. Barberi* are preferred crosses.<sup>395</sup> Breeding aims for ideal commercial characteristics, high plant tonnage and sucrose yield, resistance to diseases, and good ratooning power. Plants should be able to withstand drought and excess moisture and be easily milled.<sup>396</sup>

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<sup>391</sup> Ibid.

<sup>392</sup> Stalks may grow to thirty feet under the most favorable conditions. Deerr, *Cane Sugar*, pp. 1-2. Schomburgk saw cane “some of which measured six to seven inches in circumference” growing unattended in the interior. Schomburgk, *A Description of British Guiana*, p. 102.

<sup>393</sup> Many doubted that cane could be raised from seed and propagation by cuttings was the only method prior to the 1880s. In 1888, Soltwedel in Java and Harrison and Bovell in Barbados, working independently, found that cane could grow from seed. See earlier this chapter for details on ratooning.

<sup>394</sup> Barnes, *The Sugar Cane*, p. 47.

<sup>395</sup> Ibid, pp. 47-48; Deerr, *Cane Sugar*; Don J. Heinz, *Sugarcane Improvement through Breeding* (Amsterdam: Elsevier, 1987)

<sup>396</sup> Specifically, Caribbean growers wanted purer juice and less rotting. (F. A. Stockdale, “The Improvement of the Sugar-Cane by Selection and Hybridization”, *West Indian Bulletin. Journal of the Imperial Agricultural Department for the West Indies*, No. 2, VII (1906), 345. Agriculturalists in temperate Louisiana, for example, prized resistance to frost and blizzards.

Improvements may be conditioned by selection and hybridization but a successful variety rarely enjoys commercial longevity as ongoing research invariably produces replacements.<sup>397</sup> Experts agree that there is no ideal variety capable of standardized behavior in varying environments and each region seeks canes best suited to its climate and soils.<sup>398</sup> The Bourbon was popular until the 1880s when disease reduced yield and the search began for disease-resistant varieties.

### **Cane breeding experiments**

The Bourbon and the White Transparent canes remained the principal varieties cultivated in British Guiana up to the end of the nineteenth century.<sup>399</sup> **(Figure 45)** However, various diseases began to attack the plants from the 1890s reducing field yield and sugar output.<sup>400</sup> Where the Bourbon had grown for years, the soil appeared “Bourbon Sick” and gave low returns even after heavy applications of manure. The White Transparent fared slightly better.<sup>401</sup>

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<sup>397</sup> ‘Bourbon’ and ‘Otaheite’ are distinct canes with similar physical and chemical properties. The names are, however, often used interchangeably. Deerr, quoting the *Demerara Argosy*, July 1897, gives synonyms of canes grown in the British Guiana Botanical Gardens as Bourbon=Lahaina=Otaheite=Lousier=Portier; White Transparent=Cheribon=Hope=Light Java. Deerr, *Sugar and the Sugar Cane*, p. 20.

<sup>398</sup> G. C. Stevenson, *Genetics and Breeding of Sugar Cane* (London: Longmans, Green and Co. Ltd., 1965), pp. 246-47.

<sup>399</sup> Guiana switched from the “Old Creole” or “Puri” canes to the Bourbon/Otaheite circa 1796. (David Watts, p. 434; Shahabuddeen, *From Plantocracy to Nationalisation*, p. 34) The new varieties were hardier, ratooned well and gave more juice and megass. (Watts, p. 434) Rind Fungus was then widespread in the Caribbean. (Lewton-Brain, *West Indian Bulletin*, No. 1, VI (1905), 33.

<sup>400</sup> Barnes, *The Sugar Cane*, p. 116.

<sup>401</sup> “Sugar Cane Experiments in British Guiana”, *Bulletin of the Imperial Institute* (9 July 1903), 82.



Bourbon.

390. 6 06



White Transparent.

White & Graham, L<sup>ds</sup>, Edin<sup>g</sup> & London

*G. W. H. Graham*

Figure 45: The Bourbon and White Transparent canes.<sup>402</sup>

<sup>402</sup> Stockdale, "The Improvement of the Sugar-Cane by Selection and Hybridization", between pages 350-51.

From the 1890s to the 1920s local experiments focused on select Demerara and foreign canes to find replacements that would give more sucrose and yield than the Bourbon.<sup>403</sup> Selection and cross-fertilization (hybridization) produced many new varieties, each subjected to trials with ammoniac and nitrogenous manures and fertilizers. Seedlings were tested on experimental plots and on land that had been withdrawn from cultivation for more than twenty years.<sup>404</sup> Trials were not confined to the Botanic Gardens as several estates received test canes with Great Diamond and Peter's Hall Estates (East Bank Demerara) conducting the largest trials.<sup>405</sup>

Demerara and Barbados D.625 and B.208 emerged as the most promising seedlings.<sup>406</sup> Fourteen new canes were produced by the 1890s and a few soon supplanted the parent Bourbon.<sup>407</sup> Where a mere 550 acres were planted with new varieties in 1889, by 1910 approximately 41,000 acres were growing canes resulting from the research.<sup>408</sup> More than seventy varieties had been tried by 1912 and the Bourbon's share of total cultivation was reduced to only thirty percent.<sup>409</sup> Continuing

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<sup>403</sup> Estimates of cane yield per acre vary according to climate and topography, especially where microclimates exist within the sugar-growing area. Deerr and Rolph allow sixty to seventy tons per acre for a newly-opened field in Demerara. (Deerr, *Sugar and the Sugar Cane*, p. 32; George M. Rolph, *Something About Sugar* (San Francisco: John J. Newbegin, 1917), p. 269. Bell estimated 30 tons per acre. "Report from the Select Committee on Sugar Industries. Minutes of Evidence and Appendix", *Parliamentary Papers*, VI (1878/79), p. 195.

<sup>404</sup> "Sugar Cane Experiments in British Guiana", p. 84.

<sup>405</sup> "Report of the Society's Meetings", *Timehri*, new series, (1898-99), XII, 125; "Seedling Cane Experiments", *International Sugar Journal*, No. 27, III (1901), 127-28.

<sup>406</sup> J. M. Reid, *British Guiana Commercial Handbook* (Demerara: The Argosy, 1920), p. 15; "British Guiana", *Louisiana Planter*, No. 4, XLIII (1909), 55. In the nineteenth century, new cane varieties were assigned a number prefixed with the initial of the country of origin or alternatively, the plantation of origin. Thus D.74 is seedling No. 74, first bred at Demerara, and P.O.J. (or POJ) 213 is seedling No. 213 from the Proefstation Ost Java (Experiment Station of East Java. P. A. Yoder, "Sugar Cane Culture for Syrup Part VII", *Facts about Sugar Index*, XV (1 July-30 December 1920), p. 260. Several canes are also named for Diamond Estate in Demerara.

<sup>407</sup> J. B. Harrison and George Jenman, *Report on Agricultural Work in British Guiana, 1890* (Georgetown, 1891), pp. 14-17.

<sup>408</sup> F. A. Stockdale, "The Improvement of the Sugar-Cane by Selection and Hybridization", *West Indian Bulletin*, No. 2, VII (1906), 367.

<sup>409</sup> J. B. Harrison, "Yields of Varieties of Sugar-Cane: Crops of 1912", *Journal of the Board of Agriculture of British Guiana*, No. 1, VII (1913), 33-36.

in this vein, estates received forty test canes in 1921, including offspring of Bourbon, Demerara, and Jamaica parentage and varieties raised from seed.<sup>410</sup>

Demerara seedlings were developed to suit the unique microgeography of the coast. Bred to withstand perpetually waterlogged, saline clays with an elevated mineral content, they nevertheless failed on well-drained, calciferous soils of the Caribbean islands. Local canes tried in Antigua and St. Kitts-Nevis under different test conditions, achieved mixed success.<sup>411</sup> At the start of the twentieth century, Demerara and Barbados seedlings—notably D.74, D.95, B.147 and B.208—were considered “superior in many respects” to canes bred in Louisiana, Queensland, Hawaii and Cuba.<sup>412</sup> Demerara seedlings were then resistant to Iliau (*Melanconium iliau*)—caused by a parasitic fungus and prevalent in Hawaii—and were proposed as replacements where Iliau flourished.<sup>413</sup> Other Demerara canes—D.115, D.116, D.306 and D.145—compared favorably with varieties cultivated successfully in Queensland.<sup>414</sup>

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<sup>410</sup> *Journal of the Board of Agriculture of British Guiana*, No. 1, XV (1922), 104-05.

<sup>411</sup> Other factors influenced performance. Barbados seedlings tried elsewhere gave more satisfactory results when compared with Demerara canes although it was suggested that better results were possible if the latter were planted more closely together. “Sugar-Cane Experiments in Antigua and St. Kitts 1910-11”, *Journal of the Board of Agriculture of British Guiana*, No. 2, VI (1912), 59.

<sup>412</sup> American Breeders Association, F. Stockdale, “Improvement of Sugar-cane by Hybridization and Selection”, *Proceedings of the Meeting held at Lincoln, Nebraska, January 17-19 1906*, p. 146.

<sup>413</sup> H. L. Lyon, “Iliau, An Endemic Cane Disease”, *Report of Work of the Experiment Station of the Hawaiian Sugar Planters’ Association* (September 1912), p. 27.

<sup>414</sup> “Valuable Sugar-Canes”, pp. 430-31.



D N° 74.

390.6.06



D N° 95.

Wether. S. Graham, L<sup>th</sup>, Litho. London.

*G. W. Woodman*

Figure 46: Two famous Demerara-bred canes, D74 and D95.<sup>415</sup>

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<sup>415</sup> Ibid between pages 360-61.

D.74 and D.95 are “historical canes”, the first pair sent out by John Harrison from British Guiana and prized for their ability to mature early.<sup>416</sup> (**Figure 46**) D.74, a noble cane, was remarkably successful abroad. A 1901 account highlights prized characteristics:

D74 is a tall, *erect*, [emphasis original] green cane with very long joints, very long and deep roots, suckers and ratoons abundantly, has a large sugar content, and has uniformly given a heavy tonnage. It is a soft cane, yielding in the station mill, without saturation, 80-82 percent of juice. The leaves are upright in growth and are without prickles.<sup>417</sup>

D.74, first distributed to Louisiana plantations in 1893, proved its worth by withstanding a destructive blizzard and freezing temperatures twice in November 1911.<sup>418</sup> The variety was also singled out for its extraordinary resistance to hurricane-force winds in Mauritius.<sup>419</sup> D.74 and D.95—a purple cane—survived unseasonable cold weather between 1895 and 1899 and held the experiment station record in Hawaii for tons of cane and tons of sugar per acre yielded.<sup>420</sup> The pair was also favored in Louisiana, Alabama, Texas, Mississippi, Georgia, Florida and South Carolina and tried in Colombia, Cuba, Puerto Rico, India, Java and Mexico.<sup>421</sup>

In Louisiana, D.74 and .D95—imported and propagated by Professor William Stubbs at the Louisiana Experiment Station—outlasted hundreds of other canes in

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<sup>416</sup> Deerr, *Cane Sugar*, p. 37. The first Demerara seedlings were received in Louisiana in 1893. See William C. Stubbs, “Comparative Results of Seedling Sugar Canes, D.74 and D.95 with our Home Sugar Canes (Louisiana Striped and Louisiana Purple)”, *Louisiana Planter*, No. 8, XXXII (1904), 131, 130-36. D74 and D95 were seedlings of the White Transparent variety originally bred in Barbados. Timoshenko and Swerling, *The World's Sugar*, p. 128.

<sup>417</sup> “Seedling Canes D.74 and D.95”, *Louisiana Planter*, No. 19, XXVII (1901), 291. ‘[S]aturation’ implies the use of water to expedite sucrose extraction. See **Extraction technologies, CHAPTER 4**, this dissertation.

<sup>418</sup> Stubbs, p. 131; J. H. W., “Louisiana Cane Cultivation”, *Hawaiian Planters' Record*, No. 2, IV (1911), 96; “The Survival of the Fittest”, *Louisiana Planter*, No. 8, XVII (1912), 123-24.

<sup>419</sup> “Seedling Sugar Canes in Mauritius”, *Louisiana Planter*, No. 17, XXXVIII (1907), 258.

<sup>420</sup> “Seedling Canes D.74 and D.95”, pp. 289-90; Deerr, *Sugar and the Sugar Cane*, p. 23.

<sup>421</sup> Ibid. Dr. Peter Griggs, who has written extensively on the Queensland Sugar Industry, maintains that D.95 was never cultivated in Australia. Personal email from Dr. Griggs, Friday, 21 August, 2009.

trials and “held their precedence in Louisiana in excellence, and in general efficiency, as better than any other canes of which we have knowledge.”<sup>422</sup> D.95 bested the Louisiana “Home” cane with greater yield per acre; purer, higher-sucrose juice and better milling qualities.<sup>423</sup>

Despite the acclaim, some Louisiana planters concluded that D.74 and D.95, though commercially viable, were vulnerable under conditions of protracted drought. D.74, with its erect growth pattern, failed to provide adequate shade and hastened weathering of the thin Louisiana soils. It was also susceptible to Borer insects.<sup>424</sup> While reducing the spacing between rows provided more ground cover, difficulty controlling the Leaf Borer (*Perkinsiella saccharicida* K.) was a factor that reduced the popularity of D.74. By the 1920s, it was one of several formerly highly-valued canes that “failed spectacularly” under a barrage of diseases—Ratoon Stunting Disease (RSD), Red Rot, Mosaic and Pythium Root Rot.<sup>425</sup> The ‘wonder canes’ from British Guiana disappeared from commercial fields.

In spite of the failures, other Demerara canes—D.1135, D.117 and D.1451—were grown in southern Queensland and Hawaii. D.1135, in particular, was grown experimentally and commercially on forty-one Hawaiian plantations in 1913.<sup>426</sup> By 1914 plantations in neighboring Suriname used Demerara seedlings almost exclusively

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<sup>422</sup> “Some New Demerara Seedlings”, *Louisiana Planter*, No. 25, LII (1914), 418.

<sup>423</sup> “More about the Demerara Seedling Canes”, *Louisiana Planter*, No. 5, XLII (1909), 72-73.

<sup>424</sup> *Ibid.*

<sup>425</sup> Barnes, *The Sugar Cane*, 36; Timoshenko and Swerling, p. 128.

<sup>426</sup> “Sugar-Cane Experiments in Antigua and St. Kitts 1910-11”, p. 60; “The Relation of Applied Science to Sugar Production in Hawaii”, Report of the Honolulu Hawaiian Sugar Planters’ Association Experiment Station, October, 1915, pp. 71-72. Despite Deerr’s claim that D1135 was “very extensively grown in Australia”, Dr. Peter Griggs contends that it was grown only in southern Queensland where it tolerated frost and drought. It was not favored by mill-owners outside the region because of its low sucrose content. Noel Deerr, *Cane Sugar*, 37-38; personal email from Dr. Griggs, Friday, 21 August, 2009.

as replacements for the Bourbon.<sup>427</sup> Demerara canes were also prolific parents to seedlings developed later in Hawaii.<sup>428</sup>

At home, the seedlings were not as successful. D.74 and D.117 proved especially vulnerable to the Leaf-hopper menace and D.74 was superseded by D.109 and D.625, the latter becoming the most cultivated variety developed by John Harrison.<sup>429</sup> To its credit, a 1911 report affirms that D.118—an offspring of D.625—yielded 150 tons of cane per acre or the equivalent of about six tons of sugar per acre in trial.<sup>430</sup>

Contrary to claims that the British Guiana planter belittled the value of the seedling cane, they were active participants in a comprehensive program of research from 1890 to the closure of the Sophia Station in 1920. Data from the trials give clues to early difficulties with breeding cane from seed. Up to the 1900s there was no clear indication that the traits of the parents were transferring satisfactorily to the progeny. Size of the offspring, saccharine richness and general viability were unpredictable. Further, while older varieties showed a marked tendency to genetic variation, new seedlings duplicated the characteristics of their parents, especially D74 and D95.<sup>431</sup> That the offspring after a few decades of commercial cultivation might have been due to genetic instability precipitated by inbreeding, a hypothesis advanced by Stevenson.<sup>432</sup> By the end of the nineteenth century British Guiana had turned its

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<sup>427</sup> “Dutch Guiana” *Louisiana Planter*, No. 26, LIII (1914), 404-05.

<sup>428</sup> Deerr, *Cane Sugar*, 39. D109, with remarkable drought-resistant capabilities, is the parent of the celebrated Mauritius variety, M134/32, which was instrumental in increasing sugar output from the island in the 1950s. (J. M. M. Engels, V. Ramanatha et al., (eds.), *Managing Plant Genetic Diversity* (U.K: CABI Publishing, 2002), p. 309.

<sup>429</sup> D. L. Van Dine, “The Sugar-Cane Insects of Hawaii”, United States Department of Agriculture, Bureau of Entomology Bulletin, No. 93 (1911), 25; Deerr, *Sugar and the Sugar Cane*, p. 23; \_\_\_\_\_, *Cane Sugar*, p. 37.

<sup>430</sup> “Seedling Canes”, *Journal of the Board of Agriculture of British Guiana*, No. 4, IV (1911), 217.

<sup>431</sup> “Sugar Cane Experiments in British Guiana”, *Bulletin of the Imperial Institute* (9 July 1903), 86-87.

<sup>432</sup> Stevenson, pp. 246-47. He asked “Can it be that genetical [sic] erosion due to exaggerated unilateral selection may result in a genotype fitted primarily to a narrow environmental niche?”

attention to soil enhancement. Improved yields were, from this point on, contingent on the application of the fertilizers.<sup>433</sup>

### **British Guiana sugar experiment stations**

British Guiana became a regional hub for cane plant research from the 1880s.<sup>434</sup> The British Guiana Sugar Planters' Association assumed financial and organizational responsibility for the work and collaborated with the local Department of Agriculture to establish and maintain experiment stations.<sup>435</sup> A central Botanic Station and Gardens attended by a Government Chemist was set up at former Plantation Vlissengen on the outskirts of Georgetown in 1879. With the establishment of the British Guiana Department of Science and Agriculture in 1905 and an important milestone was achieved as government funding became available.

The Sophia Station, established in 1920 was dedicated to cane research. It was funded by a cess (tax) of thirty cents per cultivated acre levied on planters. Botanists experimented with canes from Barbados, Trinidad, Mauritius, Australia, Egypt, St. Croix, Cuba and the Dominican Republic planted under quarantine conditions.<sup>436</sup> Prior to the passage of the Sugar Planters' Experiment Station Ordinance No. 29 of 1919 which established Sophia, experimental fields had been set up at Diamond and Providence Estates in Demerara.<sup>437</sup> Planters habitually imported seedlings for private trial but imports were later restricted to the Gardens and official experiment stations to

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<sup>433</sup> See Bellairs, "Twenty Years' Improvements in Demerara Sugar Production. Part I", 328.

<sup>434</sup> Caribbean cane research began in Barbados. (J. H. Galloway, "Botany in the Service of Empire: the Barbados Cane-breeding Program and the Revival of the Caribbean Sugar Industry 1880s to 1930s", *Annals of the Association of American Geographers*, No. 4, LXXXVI (December 1995), 682-706)

<sup>435</sup> Apart from cane, the Department researched other crops including rice, cocoa, coconuts and cassava.

<sup>436</sup> *Journal of the Board of Agriculture of British Guiana*, No. 1, XV (1922), 107. The industry has, since Dutch rule, been subject to various taxes. In addition to export taxes and tariffs, a Sugar Production Tax introduced in 1942 levied a charge of \$1 per ton of sugar as well as Distillery and Cane-acreage taxes. Further, the British Guiana Sugar Producers' Association retained £1 5shillings per ton for its Price Stabilization Fund, another £1 per ton for 'estate rehabilitation' and 10 shillings per ton for the Sugar Industry Labour Welfare Fund. Seecharan, *Sweetening Bitter Sugar*, 179.

<sup>437</sup> *Journal of the Board of Agriculture of British Guiana*, No. 2, XIII (1920), 6-66.

avoid the spread of ‘foreign’ diseases such as the virus ‘Mosaic’ that had appeared in Java in 1892.<sup>438</sup> More than 600 varieties of seedlings developed from early trials formed the basis for work that continued at Sophia where seedlings were matched with suitable soil types. The work continued to the 1930s despite inadequate funding.<sup>439</sup>

A West Indian Sugar Commission of 1930, sent out from England, confirmed a need for additional funding to develop and distribute new cane varieties and for fertilizer research. The Commission found a “progressive programme of work”, inclusive of soil studies, ongoing at the Sophia Station and appealed for more government funding.<sup>440</sup> The plea was largely ignored and Sophia closed in 1934 for want of funds.<sup>441</sup> A central government-funded control and testing laboratory was established in 1937.<sup>442</sup>

### **Cane disease and pest research**

Sugarcane is a target of several mammalian and insect pests and plant diseases. The effects worsened during abnormal climatic conditions, notably drought and heavy rains.<sup>443</sup> During the nineteenth century root, stem and leaf Borers—*Lepidoptera*,

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<sup>438</sup> Chen, *Cane Sugar Handbook*, p. 4.

<sup>439</sup> Initial research suggested that local varieties were best suited to local soils and Britain was reluctant to finance projects that provided only localized benefits though there were plans to divide the operating costs for the Sophia Station among the British Caribbean sugar colonies.

<sup>440</sup> The Station had been partly funded by way of a “direct acreage tax” and its progress stalled after the 1930s. Governor Denham appealed for an annual grant of \$5,000 from the Colonial Development Fund. Governor Denham to Lord Passfield, No. 563, 27 November 1930. (TNA, UK)

<sup>441</sup> *Agricultural Journal of British Guiana*, No. 1, V (1934), 4.

<sup>442</sup> Shahabuddeen, *From Plantocracy to Nationalisation*, p. 35. The lull ended with the establishment of the British Guiana Sugar Producers’ Association in 1942 “to promote research and other scientific work in connection with the cultivation of sugar cane and the production of sugar and its other products and by-products”. (Barnes, *The Sugar Cane*, p. 480) Guiana joined the Central Sugar Cane Breeding Station in Barbados in 1945 and restricted its own work to propagating and evaluating Barbadian canes. (Shahabuddeen, p. 35) ‘Leaf-scald’ disease was inadvertently brought to the Caribbean via the ‘wonder cane’ from Java, POJ 2878. Although this variety was fairly resistant to the disease, Guiana canes were not. Scald first appeared on Bookers’ Estates and Sophia reopened in 1952 to research scald-resistant varieties. (Ibid)

<sup>443</sup> See also **The drainage problem, CHAPTER 2**, this dissertation. An early synopsis of cane disease in the British Caribbean is found in William T. Thiselton-Dyer, “Note on the Sugar-Cane Disease of the West Indies.” *West Indian Bulletin*, No. 1, II (1901), 211-16. See also Deerr, *Cane Sugar*, Chapter IX

*Coleoptera*, and *Diatraea*—especially, at all stages of their life cycles, were recurrent scourges. Moth Borers (*Diatraea saccharalis*; *D. canella* and *incohati* in Guiana) present in the Caribbean since 1828, laid waste to local fields in 1879.<sup>444</sup> An infestation of the Frog-hopper (*Tomaspis flavilatera*) occurred in 1918 and locusts, grasshoppers, scale insects and various beetles caused significant damage.<sup>445</sup> By the 1930s insect pests were responsible for loss of approximately ten percent of the total crop each year.<sup>446</sup>

The Colonial Development Fund disbursed grants to help with pest eradication and entomologists researched remedial measures and cautioned planters to propagate only healthy seedlings and ratoons. Burning the canefields to eliminate leaves and other vegetation—trashing—was recommended although beneficial ants that preyed on the Moth Borer, for example, were inadvertently destroyed.<sup>447</sup> A “promising parasite” that fed on the eggs of the Giant Moth Borer (*Castnia licus Drury*) was brought from the Amazon River and distributed to estates.<sup>448</sup> Field testing and research on the *Trichogramma* took place at Non Pariel, Anna Regina, Lusignan and

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G. E. Bodkin, Government Economic Biologist, identified thirty-two insect species in 1913. (\_\_\_\_\_, “Insects Injurious to Sugar cane in British Guiana, and Their Natural Enemies”, *Journal of the Board of Agriculture of British Guiana*, No. 1, VII (1913), 199-203. See also “Sugar-Cane Borers in the West Indies”, *Kew Bulletin*, 166-69.

<sup>444</sup> *Ibid*, p. 153.

<sup>445</sup> *Journal of the Board of Agriculture of British Guiana*, No. 3, XI (1918), 96-97. Some, like the froghopper, also attacked rice and pasture grasses which made them doubly dangerous to the agriculture sector. “Entomological Notes”, *Journal of the Board of Agriculture of British Guiana*, No. 4, VI (1913), 166. See also H. A. Ballou, “Review of the Insect Pests Affecting the Sugar-Cane”, *West Indian Bulletin*, No. 1, VI (1905), 37-47.

<sup>446</sup> *Agricultural Journal of British Guiana*, No. 1, V (1934), 10; *Journal of the Board of Agriculture of British Guiana*, No. 2, X (1916-17), 75.

<sup>447</sup> “The Late Miss Ormerod and Insect Pests in British Guiana”, *Journal of the Board of Agriculture of British Guiana*, No. 4, VI (1913), 169-70. See also ‘**Supplying**’, ‘**trashing**’, ‘**moulding**’ and ‘**relieving**’, **CHAPTER 3**, this dissertation.

<sup>448</sup> *Agricultural Journal of British Guiana*, No. 1, V (1934), 11.

Uitvlugt.<sup>449</sup> A local design for a “Balloon Catcher” was developed specifically to trap grasshoppers and the design diffused to other cane-growing regions.<sup>450</sup>

Non-insect plagues included Rind Disease, Red Rot (Root Fungus) caused by various fungi—*Colletotrichum falcatum*, *Diplodia cacaoicola*, *Melanconium sacchari*, individually or in combination—and Leaf-spot, White Blight and Black Blight or Smut.<sup>451</sup> The organisms infected plant tissue and reduced sucrose content by ‘souring’ the cane.<sup>452</sup> Rind had caused damage to canefields in British Guiana since the 1890s and entomologists recommended applying fungicides directly to the plants, practicing crop rotation, and planting healthy ratoons and seedlings.

### **Animal pests and controls**

Aside from insects, a variety of animal predators fed on the cane. Herds of Capybara (*Hydrochoerus Capybara*), Grey Fox (*Canis rudis*), Crab Dog (*Procyon Cancrivorus*), monkeys and wild deer often decimated the crop and snakes, mainly anacondas and pythons, attacked workers in the fields.<sup>453</sup> The mongoose—imported to control reptiles and successful in Jamaica—was vulnerable to large animal predators

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<sup>449</sup> G. E. Bodkin, “The Egg Parasite of the Small Sugar Cane Borer”, *Journal of the Board of Agriculture of British Guiana*, No. 4, VI (1913), 188-198, **passim**.

<sup>450</sup> An American journal described the Catcher in 1917 and confirmed that it originated in British Guiana. The device was adopted in India captured approximately 400 tons of grasshoppers in 1915. Charles R. Jones, “Grasshopper Control”, *Bulletin of the Agricultural Experiment Station of the Colorado Agricultural College*, No. 233 (June 1917), 11-12.

<sup>451</sup> See Deerr, *Cane Sugar*, 164-66 for a synopsis of the Rind fungus research. At the time, researchers were divided on the origins and cause of the disease.

<sup>452</sup> J. R. Bovell, “Field Treatment of the Diseases of the Sugar Cane in the West Indies”, *West Indian Bulletin*, I, 34; L. Lewton-Brain, “Review of the Principal Fungoid Diseases of the Sugar Cane”, *West Indian Bulletin*, No. 1, VI (1905), 33; Frank Stell, “Notes on Fungi: Red Rot of Sugar Cane”, *Journal of the Board of Agriculture of British Guiana*, No. 1, XIV (1921), 40-41; “Sugar-Cane Borers in the West Indies”, *Kew Bulletin*, Nos. 67-68 ( July-August 1892), 166-68. The *Kew Bulletin* recorded vigorous measures to combat Rind Disease in 1896. (J. B. Harrison, “Sugar Cane Disease in British Guiana”, *Kew Bulletin*, DIV (May-June 1896), 106-108; Deerr, *Sugar and the Sugar Cane*, p. 29; and \_\_\_\_\_, *Cane Sugar*, pp. 156, 164-65.

<sup>453</sup> St. Clair, *A Residence in the West Indies and America*, I, 137.

in Guiana.<sup>454</sup> Jaguars and other small South American cats were common and frequently killed draught-animals on the estates.<sup>455</sup>

Cane rats—*Holochilus spp.*—were prevalent and widespread infestations prompted local efforts at control and eradication. Rats gnaw young shoots, ripe stalks and suck the juice, reducing cane yield and output.<sup>456</sup> Damaged stalks become vulnerable to fungi, bacteria and insects.<sup>457</sup> The rodents swam canals and trenches easily and hid from bird predators in the vegetation. Fast-breeding and difficult to dislodge when established in colonies, rats thrived on account of the proximity of cane plots to rice fields in the plantation zone and, though rice is a preferred food, the animals move to cane after the rice harvest.<sup>458</sup> The sugar industry adopted a three-pronged approach to rat control employing biological, trapping and poisoning strategies.<sup>459</sup> ‘Rat-catcher gangs’ were paid up to \$20 a week for their services in the 1880s.<sup>460</sup> Systematic poisoning emerged as the “only satisfactory remedy”.<sup>461</sup>

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<sup>454</sup> S. R. Cochran, “Some Enemies of our Cane-fields”, *Timehri*, new series, (1894), VIII, 104-05.

<sup>455</sup> Henry Kirke, *Twenty Five Years in British Guiana* (London: Sampson Low, Marston & Company, 1898), pp. 85-87.

<sup>456</sup> Cochran, *Ibid.*

<sup>457</sup> C.R. Haynes, J. Singh and H. B. Davis, *Recent rodent infestations on sugar estates in Guyana and the effectiveness of an integrated management approach to the problem*, Agricultural Research Centre, Guyana Sugar Corporation, Guyana, 2007, 2. Major epidemics of the *Holochilus sciurens berbicensis*—reclassified in 1963 as *H. brazilensis*—were reported for Blairmont (West Berbice) in 1935, Uitvlugt (West Coast Demerara) in 1951, and Blairmont, Rosehall and Wales (West Bank Demerara) in 1958-59. Large numbers of other species are also present, notably *Oryzomys navus* and *Mus musculus*, the House Mouse. (1-2)

<sup>458</sup> Barnes, *The Sugar-Cane*, p. 321.

<sup>459</sup> *Ibid.*, pp. 318-21; Haynes, Singh and Davis, p. 2.

<sup>460</sup> “Letter from Father Trew to William Russell”, *Timehri*, II (1882), 317.

<sup>461</sup> Barnes, p. 321.

## CHAPTER 4

### TRANSFORMING THE FACTORIES

The British Guiana sugar industry reacted to persistent crises in the global sugar trade by trying to restore profitability and maximize its competitive edge. As with field improvements, factory modernization focused on minimizing production costs and increasing sugar output. A plethora of new methods and equipment were tried, many borrowed from the European beet industry.

#### **Sugar-making**

Cane sugar derives from a naturally-occurring disaccharide, sucrose, present in the cane plant (sugarcane) Sucrose belongs to the carbohydrate group, ‘saccharides’, containing carbon plus hydrogen and oxygen in the same ratio as water. The other chemical constituent is its cellulose fiber.<sup>462</sup>

Sugar-making is not strictly a manufacturing process; it is a chemical conversion where liquid cane juice is extracted, purified, boiled and refined as sugar crystals.<sup>463</sup> Summarily, the phases of non-refined sugar-making are (1) juice extraction, (2) chemical and mechanical removal of soluble and insoluble impurities, or ‘defecation’ (3) evaporation by heating to ‘syrup’ and boiling to the point where

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<sup>462</sup> See M. A. Clarke, “Sugars and Non Sugars in Sugarcane”, Chen and Chou, *Cane Sugar Handbook*, pp. 21-39.

<sup>463</sup> In refineries, raw (usually brown) sugar was washed (the ‘affination’ stage) before reprocessing. Several treatises explain the basics of sugar production. For nineteenth century sugar-making techniques see William Julius Evans, *The Sugar Planter’s Manual* (Philadelphia: Lea and Blanchard, 1848), p. 22; Hagelberg, *The Caribbean Sugar Industries*, p. 40; Chen and Chou, *Cane Sugar Handbook*, 1993; Jock Galloway, *The Sugar Cane Industry. An Historical Geography From Its Origins to 1914* (Cambridge: Cambridge University Press, 1989); David Watts, *The West Indies*; Shahabuddeen, *From Plantocracy to Nationalisation*; Barnes, *Sugar Cane*, 1974; *Bookers Sugar 1954*, , Noël Deerr, *History of Sugar*; \_\_\_\_\_, *Cane Sugar*; \_\_\_\_\_, *Sugar and the Sugar Cane*; \_\_\_\_\_, *Sugar House Notes and Tables*, Sidney Mintz., *Sweetness and Power: The Place of Sugar in Modern History* (New York: Viking Books, 1985)

crystals begin to form (4) ‘Curing’ which involves separating the sugar crystals from its residual molasses by centrifugation and drying and cooling.<sup>464</sup>

Historically, cane was crushed and the juice expressed and fed into large vats where it was strained to remove debris and ‘temper lime’ added to lighten the color. Clarified juice then passed through a series of evaporating pans where it was reduced by heating and continually skimmed to remove impurities. Once sufficiently concentrated, the syrup was put into shallow wooden troughs and allowed to crystallize. The fresh sugar was ‘cured’ by packing in barrels or hogsheads, each with an opening in the bottom to allow residual molasses to drain out. After curing’, the raw sugar or ‘muscovado’ was ready for sale. While the fundamentals of the liquid-to-solid conversion are essentially unchanged over time, various techniques have simplified, standardized and expedited processing.

### **Sugar technology in the nineteenth century**

Various industrial developments—particularly steam technology—helped enhance sugar manufacturing.<sup>465</sup> Improved iron forging and steel-making simplified fabrication of essential equipment.<sup>466</sup> Agricultural chemistry research provided indispensable mineral-based fertilizers such as phosphorus and potassium.<sup>467</sup> Sugar-

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<sup>464</sup> Currently sugar is screened to remove lumps and bulk packaged.

<sup>465</sup> Patents related to harnessing steam as a motive force date to 1630, noted improvements by Savery (1698), modifications by Papin (1705) and Savery, Cawley and Newcomen who collaborated on a working prototype in 1705. James Watt’s condenser, air pump and rotary devices in 1769 and 1782, preceded his 1784 rotary engine capable of driving mills and pumping water. See Robert Stuart, *Historical and Descriptive Anecdotes of Steam Engines, and of their Inventors and Improvers* (London: Wightman and Cramp, 1829), II, 622-31.

<sup>466</sup> Americans William Kelly, Henry Bessemer and Robert Mushet worked on steel-making patents while the German-born Siemens brothers (in London) collaborated with the Martins’ of France to develop the open-hearth process based on technology from an earlier Siemens’ invention, the regenerative gas furnace. (See Charles Huston, “The Iron and Steel Industry.” In Chauncey M. Depew, (ed.), *1795-1895 One Hundred Years of American Commerce* (New York: D. O. Haynes and Company, 1895), I, pp. 326 and 320-328, and **passim**.)

<sup>467</sup> Arthur W. Slater, “Fine Chemicals”, *A History of Technology*, Charles Singer et al. (eds.), (Oxford: Oxford University Press, 1958), V, pp. 299-321.

making also profited, directly and indirectly, from rail and water-transport engineering and networks. Noël Deerr—sugar scientist and historian—opined that engineering, especially, was indebted to the sugar industry for the impetus to invent and refine the cane roller-mill, vacuum and multiple-effect evaporation and various forms of the filter press and curing centrifugal.<sup>468</sup>

Technology diffused to and from British Guiana in many ways during the nineteenth century. Local planters visited their peers in the Caribbean and further afield and shared working knowledge of sugar production.<sup>469</sup> Overseers and managers from British Guiana transplanted ideas and technical information when they relocated.<sup>470</sup> At times, technicians and fabricators accompanied imported equipment for the installation and to provide operating instruction.

### **Power sources in British Guiana**

Energy was required to transport cane to the factories, power crushing mills, process juice into crystals and move sugar and by-products to the ports and supply lighting in the factories.<sup>471</sup> Processing demanded the most input and, accordingly, the

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<sup>468</sup> Deerr, *History of Sugar*, II, 589. William Kelly was experimenting with wrought-iron for making sugar-kettles in Kentucky in 1847 when he discovered how to make steel. (Herbert N. Casson, *The Romance of Steel* (New York: A. S. Barnes and Company, 1907), pp. 5-8.

<sup>469</sup> “A Demerara Planter in Louisiana. Some Notes for the *Argosy*”, *Louisiana Planter*, No. 1, XXI (1898), 423. In 1841 a Demerara planter in Jamaica gave details on cane cultivation, the state of labor, factory machinery, the evaporation process and haulage. Some strategies were adopted on Jamaica estates. (Whitehouse, *Agricola’s Letters...*, pp. 16-23. The letters date to between 1841 and 1844)

<sup>470</sup> In the 1890s, Donald McKenzie, formerly of Vryheid’s Lust (East Coast Demerara), found employment as field-manager at the first sugar estate established in Mozambique. The estate, Mopea, employed four other ex-Demerara overseers—William Hunter; Kemp formerly of Plantation Pearl (East Bank Demerara); Duncan from Versailles (West Bank Demerara) and Wyllie, previously at Providence (East Bank Demerara) The five Demerarians among 13 overseers hired for Mozambique’s fledgling operation underscore British Guiana’s role in the start-up of Mozambique’s sugar industry. (“Sugar Cane Cultivation in Mozambique”, *Louisiana Planter*, No. 8, XIX (1897), 125). A Demerarian settled in Peru but maintained contact with his former home via the *Argosy*. (“Sugar Cultivation in Peru”, *Louisiana Planter*, reprinted from the *Argosy*, No. 15, XXVI (1901), 237.

<sup>471</sup> In 1890, sugar factories were the ‘only users of electric light’. [Argonaut], “British Guiana”, *Louisiana Planter*, No. 11, V (1890), 195-96. It is unclear when electrification of all phases of production in Guiana sugar factories took place. *Central Amistad* was the first factory in Cuba to

largest capital investment. Energy conservation measures have been in place since the startup of the sugar industry and producers consider fuel cost, availability—immediate and long-term—efficiency of handling and use and, more recently, waste control and emissions.<sup>472</sup>

In Guiana, early mills were driven by wind, water or animal-power.<sup>473</sup> The first horse-driven sugar mill was erected in 1664 by Jan Doenson, a Dutch planter in Essequibo, and this type was common where water was inaccessible. By the 1770s mules were imported from Spanish territory along the Orinoco River.<sup>474</sup> A hundred years later the Guiana colonies had forty-five water and animal-powered mills producing approximately 2,000 tons of sugar annually.<sup>475</sup> As cultivation shifted to the Atlantic coast, windmills harnessed the power of the northeast trade winds. Leguan Island (Essequibo River) had eight windmills by 1806-07 but the simple, direct-drive apparatus were superseded by steam machinery.<sup>476</sup>

Fuel needs were initially satisfied with local wood and imported English and North American coal of which approximately twenty-five hundredweight (1.27 metric tons) were needed to produce one ton of sugar.<sup>477</sup> Brought in as ships' cargo, coal arrived in 'hogsheads' (wooden casks) that were reused to export sugar.<sup>478</sup>

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convert to electric power in 1913. See "Recent Developments in Operating Sugar Mills", *Metallurgical and Chemical Engineering*, No. 5, XVI (March 1917), 288.

<sup>472</sup> Chen, p. 666. Global warming concerns now inform measures to control emissions and manage waste although efforts were minimal in the nineteenth and early twentieth centuries. See the discussion on lees pollution in **CHAPTER 3: Experiments with 'flood-fallowing'**, page 100 and footnote 331.

<sup>473</sup> William Russell, "Sugar-cane Mills", *Timehri*, II (1883), 381; St. Clair, I, 134.

<sup>474</sup> Bancroft, *Essay on the Natural History of Guiana...*, p. 363; *Essequibo and Demerary Gazette*, 19 November, 1803. American cattle were highly recommended by Planter L. Warren Orderson writing from Tobago in 1810. *Essequibo and Demerary Gazette*, 21 August 1810.

<sup>475</sup> Williams, "Factory Routine", p. 47.

<sup>476</sup> Bingley, *Travels in South America*, p. 77. Deerr, *History of Sugar*, I, 537. Théophile Rousselot, 'a Martinique engineer', substantially refined the three-roller mill and Bell, a Barbadian planter, invented 'the dumb turner', a device that improved crushing, in 1805.

<sup>477</sup> Thorpe, "Changes on Sugar Estates from 1865-1894", p. 209. Another view was that for every ton of sugar exported from British Guiana, a corresponding ton of coal was imported. Bellairs, "Sugar-making in Demerara", *Littell's Living Age*, p. 610. Up to the 1860s, estates also used local 'firewood'—a mixture of bamboo and Courida charcoal—for coal-fired evaporating pans on 'common-process'

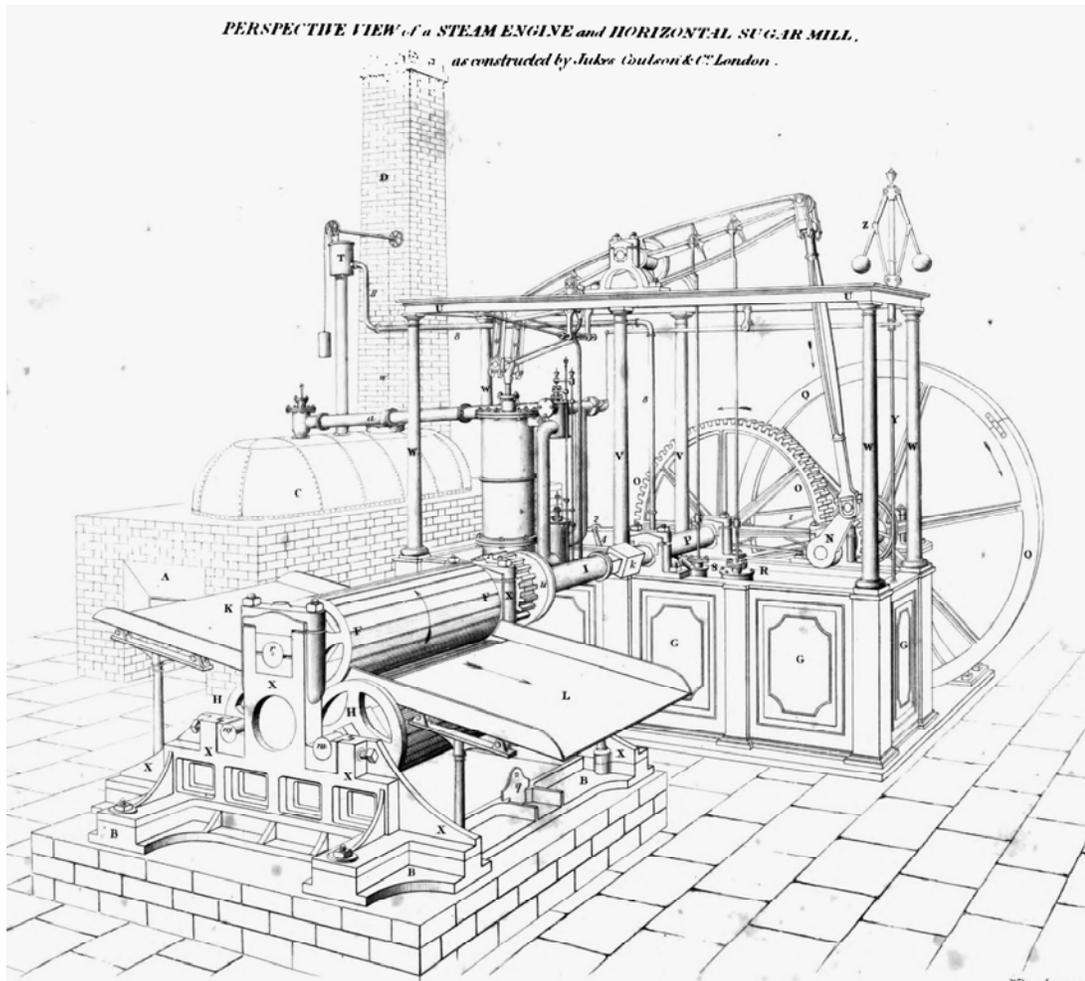


Figure 47: Ten horse-power steam engine attached to a horizontal cane mill.<sup>479</sup>

Coal was invariably expensive and scarce especially during trade embargoes and wartime.<sup>480</sup> As with other plantation necessities, prices were influenced by availability and demand. High freight costs and shortages during wartime or

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(muscovado) estates such as Mon Repos (East Coast Demerara). "Some Haphazard Notes of a Forty-Two Years' Residence in British Guiana", *Louisiana Planter*, No. 1, XXII (1889), 8-9.

<sup>478</sup> ST72, Letter dated 19 April 1820. (ICS)

<sup>479</sup> John Farey, *A Treatise on the Steam Engine, Historical, Practical and Descriptive* (London: Longman, Rees, Orme, Brown, and Green, 1827, Plate XXII.

<sup>480</sup> W. Price Abell, "Notes on Steam Boilers Applicable to Sugar Estates", *Timehri*, new series, (1887), I, 320.

embargoes were routine setbacks for the sugar industry.<sup>481</sup> Steam technology presented opportunities to use coal more efficiently, especially following the post-Emancipation labor crises, and well-financed estates employed coal-fired steam-driven crushing mills and steam boilers for open and closed evaporating pans alike.<sup>482</sup>

### **Steam technology and fuel economy**

The sugar industry records some of the earliest applications of steam technology anywhere and the British Caribbean was among its pioneers.<sup>483</sup> Historians date the introduction of the first steam engine into British Guiana to 1805.<sup>484</sup> However, there is an earlier date on record.

An English patent was awarded in 1801 for a sugar-mill powered by an eight horse-power engine fabricated at Soho (London) and sent out to Demerara.<sup>485</sup> This Boulton and Watt engine was set in machinery designed by millwright John Rennie and “performed excellently”.<sup>486</sup> Guiana’s leading planters soon transitioned from

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<sup>481</sup> John Collins, *The Case of the Sugar Colonies* (UK: J. Johnson, 1792), pp. 32-34. St. Clair wrote that English merchandise was re-sold in British Guiana sometimes for as much as 500 percent above the purchase price. St. Clair, *A Residence in the West Indies and America*, I, 109-10.

<sup>482</sup> Stewart, *Steam Engineering on Sugar Plantations...*, p. 13.

<sup>483</sup> Jamaica had experimented with steam technology since 1768 and commercial use dates from 1808. Cuba was the first non-British territory to use steam in 1797. See Deerr, *History of Sugar*, II, 549-61; Veront Satchell, “The early use of steam power in the Jamaican sugar industry 1768-1810”, *Transactions of the Newcomen Society*, LXVII 1995/96), 221-231; C. Davy, “Steam-Engine for a Sugar House”, *Mechanics’ Magazine*, No. 402, XV (1831), 114. Tann traces the origins the Caribbean’s steam engines highlighting the work of the Boulton and Watt firm and millwright John Rennie. Jennifer Tann, “Steam and Sugar: The Diffusion of the Stationary Steam Engine to the Caribbean Sugar Industry 1779-1840”, *History of Technology*, XIX (1997), 63-84.

<sup>484</sup> Dalton, *History of British Guiana*, I, 229 and 276; *The New Local Guide of British Guiana*, p. 10; Rodway, *History of British Guiana*, II, 282; Deerr, *History of Sugar*, II, 553. Dalton’s claim is unsubstantiated and he placed the first engines at Belle Vue and Hague (Demerara) whereas Deerr maintains that Belle Plaine and Friendship (Essequibo Islands) got steam engines in 1805. The 1805 date is repeated in J. F. Williams, “Factory Development”, p. 57); by Shahabuddeen, p. 27 and in *The Local Guide...*, p. 10. Wagner wrote that “... steam driven mills had been introduced about 1800...”, but offers no bibliographic corroboration. Wagner, p. 49.

<sup>485</sup> Stuart, II, 715. The operations at Soho (England) were owned by Boulton & Watt. (634)

<sup>486</sup> Ibid. Also Farey, *A Treatise on the Steam Engine*, p. 715. Rennie was John Rennie Sr., (1761-1821), the celebrated Scottish civil engineer and millwright apprenticed to Matthew Boulton and James Watt. (A. E. Musson and Eric Robinson, *Science and Technology in the Industrial Revolution* (London: Gordon and Breach, 1969; reprint 1989), p. 65.

animal, water and wind-power to steam technology. Between 1813 and 1817 Fawcett, Preston and Company shipped forty-two “cane engines” to Demerara including eight condensing steam engines.<sup>487</sup> Sanbach, Parker and Tinné of Demerara and Liverpool installed a new engine in 1818 at their plantation, Coffee Grove, on the Essequibo coast.<sup>488</sup> Visitors in the 1830s were greeted by “tall chimneys of numerous steam engines” at the entrance of the Demerara River opposite Stabroek, the colony’s capital.<sup>489</sup> By 1833 Meerzorg on Wakenaam Island (Essequibo River) had a steam-powered cane-crusher; every estate on the island had a steam engine and some had two.<sup>490</sup> At this time many animal, water and wind-powered mills were in ruins.<sup>491</sup>

While it is unlikely that every plantation was equipped, steam was the preferred motive power by the end of the 1830s.<sup>492</sup> By the 1840s the industry had learnt to economize by using latent heat from the boilers and the evaporators.<sup>493</sup> Nevertheless, in 1852 the Berbice Reading Society stressed that, although the technology was known in the colony, planters needed improved engines and boilers, “contrivances for raising water” (pumps), distillery equipment, mechanical crystallizers and steam ploughs and cultivators.<sup>494</sup>

Efficient steam application and management demanded considerable technical expertise for setup and maintenance and, up to the early twentieth century, engineers

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<sup>487</sup> Deerr, *History of Sugar*, II, 553.

<sup>488</sup> ST 57. (ICS)

<sup>489</sup> Alexander, *Transatlantic Sketches*, p. 15.

<sup>490</sup> *Ibid.*, p. 60. These statistics are repeated in George Newenham Wright and Jehoshaphat Aspin et al., *The New and Comprehensive Gazetteer. Supplement* (London: Thomas Kelly, 1838), pp. 163-68. Barbados reportedly had no steam engines in the 1830s, but had approximately 300 windmills. (Alexander, *Transatlantic Sketches*, p. 87)

<sup>491</sup> Alexander, pp. 77.

<sup>492</sup> Shahabuddeen, p. 27.

<sup>493</sup> Whitehouse, p. 326.

<sup>494</sup> “Correspondence from the Berbice Society of the Arts 15 July, 1852”, *Journal of the Society of Arts*, I, (November -November 1952/3), 17.

and boiler attendants were inexperienced and installation faulty.<sup>495</sup> Industrial accidents involving steam-driven machinery were common and often fatal.<sup>496</sup> Five persons died when a faulty boiler exploded at Plantation Huist t’Dieren (Essequibo Coast) in the 1880s.<sup>497</sup> Up to that time planter William Russell saw everyday damage to crankshafts, pinions and couplings resulting from inefficient applications of steam.<sup>498</sup> As furnace and boiler technology improved, steam equipment became more common in Guiana. New boilers and evaporators came with regulating valves, gauges and audible safety alarms although older equipment was still in use on some estates at the end of the century.<sup>499</sup>

Prior to the abolition of slavery, steam power was envisaged as reducing the laboriousness of factory work, especially night work.<sup>500</sup> There is little evidence, however, that the enslaved benefited from the use of steam machinery. Rather, steam increased planters’ profits and reduced production costs by providing an alternative to wasteful open-fire evaporation.<sup>501</sup>

### **The cane megass furnace**

Early furnaces, boilers and fixtures were characteristically oversized in Guiana and used coal inefficiently.<sup>502</sup> As the nineteenth century progressed, the industry came

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<sup>495</sup> James Stewart, *Steam Engineering on Sugar Plantations, Steamships and Locomotive Engines* (New York: Russell’s American Steam Printing House, 1867), pp. 13-15. Stewart identified several installation problems in the British Caribbean.

<sup>496</sup> E.D. Meier, “The Power in a Pound of Coal”, *Cassier’s Magazine* XVIII (May-October 1900), 65-70.

<sup>497</sup> Kirke, pp. 126-28. Kirke saw remains of the boiler embedded in parapet adjoining the public road.

<sup>498</sup> William Russell, “Cane Mills; and Megass as Fuel”, *Timehri*, III (1884), 48.

<sup>499</sup> “The Overseer’s Manual”, *Sugar Cane*, No. 147, XIII (1881), 540-545, **passim**; “Demerara Letter, March 15th 1890”, *Louisiana Planter*, No. 15, IV (1890), 253.

<sup>500</sup> Alexander McDonnell, *Considerations on Negro Slavery With Authentic Reports, Illustrative of the Actual Condition of the Negroes in Demerara* (London: Longman, Hurst, Rees, Orme, Brown, and Green, second edition; 1825), pp. 212-13.

<sup>501</sup> Adamson, *Sugar Without Slaves*, p. 192.

<sup>502</sup> [‘Argonaut’], “British Guiana”, *Louisiana Planter*, No. 19, V (1890), 358.

to rely instead on burning dried megass (cane stalks leftover from juice extraction) as fuel.<sup>503</sup>

Megass was initially burnt under in open fires under the evaporating pans and, after steam technology was introduced, used as boiler fuel. Planters preferred sun-dried megass, although they also used the air-dried version. Air-drying was inefficient as large quantities of fresh megass needed took a long time to dry, using up a lot of labor and floor space. Drying was slow especially during Guiana's bi-annual rains.<sup>504</sup> Further, dry megass was highly flammable owing to small amounts of juice retained that fermented into alcohol, increasing the fire risk on estates.<sup>505</sup>

By the 1880s, experiments with coal, dried, and green (fresh) megass were carried out to assess the merits of each as a fuel source.<sup>506</sup> Sugar industrialist Nevile Lubbock's comparative cost benefit analyses of coal, 'logie megass' (air-dried), sun-dried and green megass resolved that green megass was cheapest.<sup>507</sup> Thereafter, a majority of local furnaces were reconfigured and, by the beginning of the twentieth century, many factories relied exclusively on green megass.<sup>508</sup> 'Marie wet begass' furnaces that used thirty to forty percent less fuel and rendered the boilers more

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<sup>503</sup> Megass is now called 'bagasse' and classified as 'first-mill bagasse'—the leftovers from first crushing. 'Final bagasse' is the residue from the last crushing consisting largely of cane fiber with some mineral matter mixed in, sugars not extracted in the milling process and other substances. See Barnes, *The Sugar Cane*, pp. 446-54; Hilhouse, "Agriculture in 1829", p. 37. In Barbados, dried megass was already in use as fuel and field manure by 1667. Raymond Phineas, "The production of sugar in Barbados c.1667", *Annals of Science*, No. 2, I (1936), 179.

<sup>504</sup> Wray, *The Practical Sugar Planter*, pp. 175-76.

<sup>505</sup> See **CHAPTER 2**, for a description of **Megass logies**. Hilhouse opined that twenty percent less sun-dried megass was required to make the same amount of sugar than megass dried in the logies and that sun-drying made it less flammable by reducing the chance for residual juice to ferment into alcohol. ("Agriculture in 1829", p. 37) Wray justified using coal instead of megass arguing that coal was so 'abundant, cheap and desirable, as to render it, in every respect, more suitable than dried cane-trash or 'magasse' [sic]. (*The Practical Sugar Planter*, p. 61) Quoting a price of £1 sterling per ton, he posited that 2,640 pounds of coal were required to make a ton of sugar. Estimates at the time ranged from 2,500 to 2,800 pounds per ton.

<sup>506</sup> See Russell, "Sugar-cane mills", 381-86; \_\_\_\_\_, "Cane Mills; and Megass as Fuel", *Timehri*, III (1884), 48-67; Thomas Shields, "Sugar-cane mills", *Timehri*, II (1883), 386-392.

<sup>507</sup> Nevile Lubbock, "Wet Megass, Sun Dried, and Logie Megass as Fuel", *Timehri*, III (1884), 97-102.

<sup>508</sup> "Process and Power of Sugar Manufacture", *Louisiana Planter*, No. 2, LII (1914), 43.

efficient were a popular choice.<sup>509</sup> During the period 1890-1894, 520 furnaces were rebuilt to accommodate green megass in Guiana alone, saving the industry more than £10,000 annually.<sup>510</sup>

In transitioning from dried to green megass sugar industrialists weighed the savings from eliminating storage sheds (megass logies), the cost of fire-lookouts and insurance and labor required to move megass to and from storage against expenditure on fuel, steam equipment and ‘stoker-men’ who used long, iron ‘feeders’.<sup>511</sup> A further improvement, the ‘Automatic Megass Fireman’, eliminated the need for manual feeding, lessened the risk of injury and sealed arguments in favor of the green furnace. The Davson Company factories in Berbice were the first to adopt automatic feeders in the 1890s and the Colonial Company later installed the equipment on its estates.<sup>512</sup>

### **Cane-carriers, conveyors and hoists**

In factory mechanization varied according to the resources available to each estate. By the early 1840s, a few had steam-powered elevators or ‘cane carriers’ to move megass between the drying logies and the boilers and furnaces and to transfer cane from the punts into the mills.<sup>513</sup> Stipendiary Magistrate Strutt reported in 1841-1842 that whereas six years prior there had been only a single cane carrier and megass elevator in Demerara, every plantation now had one or both.<sup>514</sup> On less wealthy

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<sup>509</sup> [Argonaut], “British Guiana”, p. 358. The Marie furnace was invented by J. Leon Marie of Martinique and Louisiana and made by Manlove, Alliott and Co. of Nottingham, England.

<sup>510</sup> William Price Abell, “Megass and Refuse Furnaces”, *Cassier’s Magazine* X (May-October 1896), 192.

<sup>511</sup> “Report of the Society’s Meetings”, *Timehri*, Part 1, III (1884), 182-197, especially 195-96.

<sup>512</sup> W. Price Abell, “The Automatic Megass Fireman”, *Timehri*, new series, (1892), VI, 352-53; “Reports of Meetings of the Society”, *Timehri*, new series, (1892), VI, 354.

<sup>513</sup> Premium, pp. 92-93; MacRae, p. 52; [Brumell], pp. 32-35; Whitehouse, p. 326. Even after mechanization, a few laborers were still needed to throw the cane onto the carriers.

<sup>514</sup> *Parliamentary Papers*, XXIX (1842), p. 65.

plantations up to the 1890s cane was carried between the storage sheds and furnaces by women and child laborers.<sup>515</sup>



Figure 48: Old hoist at Leonora, 2004. The factory closed in 1986.<sup>516</sup>

Band and screw conveyors for moving sugar and molasses were regarded as wasteful and insanitary and visiting engineer William Abell recommended the installation of modern Fletcher and Company equipment.<sup>517</sup> In 1902 the first mechanical cane unloader (hoist) used in the British Caribbean was installed at Albion Estate in Berbice.<sup>518</sup> By 1909 the American Hoist and Derrick Company of Minnesota had erected a sixty-six foot (20 meter) hoist at Uitvlugt (West Coast of Demerara)

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<sup>515</sup> Jenkins, p. 39. He saw “bare-legged Coolie-women and boys” carrying dried megass in baskets.

<sup>516</sup> Photograph by Rakesh Rampertab. Used with permission.

<sup>517</sup> W. P. Abell, “Economising Sugar Carriers”, *Timehri*, new series, (1889), III, 382.

<sup>518</sup> Deerr, *History of Sugar*, II, 365.

ending centuries of laborious manual work.<sup>519</sup> Enmore (East Coast of Demerara) also upgraded to mechanical loaders in 1911 and an American-made hoist, similar to those used in Louisiana, was at Port Mourant in 1912.<sup>520</sup> **(Figure 49)** In the early twentieth century twelve estates had mechanical cane carriers, ten purchased from American sources and two from British fabricators.

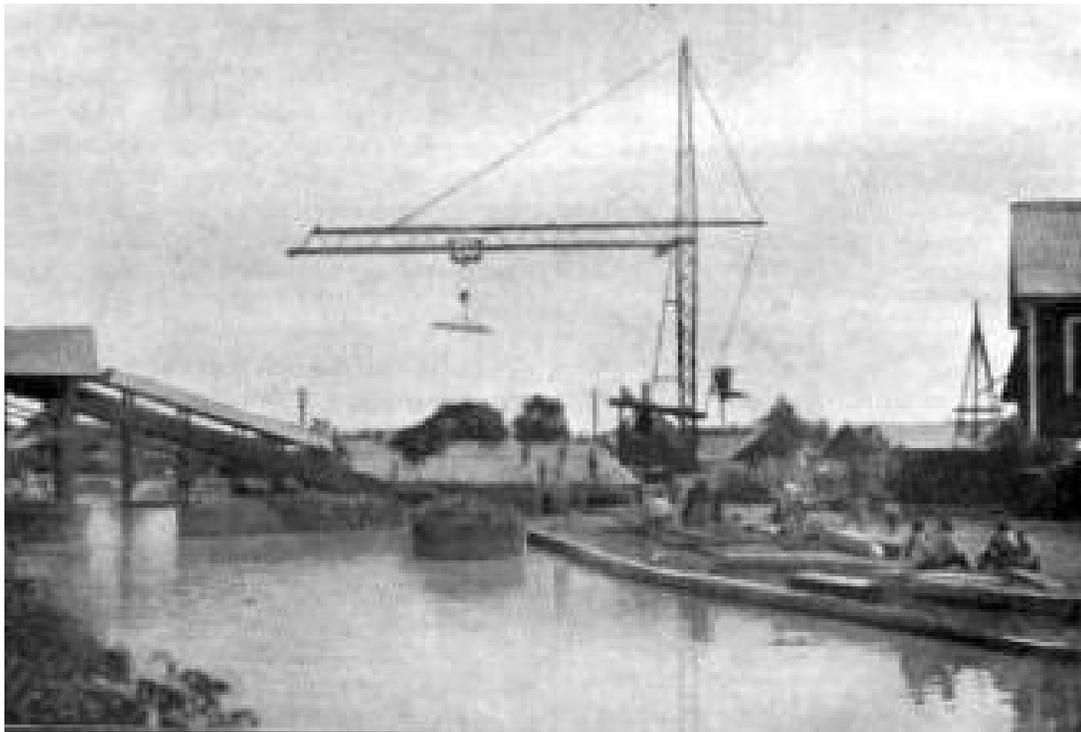


Figure 49: An American-made cane hoist at Port Mourant circa 1912.<sup>521</sup>

### **Improved crushing methods and machinery**

Cane was first crushed between wooden rollers turned by hand or by pressing stalks laid out on a flat surface.<sup>522</sup> Vertical rollers were made of wood encased in iron

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<sup>519</sup> “American Hoist and Derrick Co’s Derricks in British Guiana”, *Louisiana Planter*, No. 10, XLIII (1909), 157.

<sup>520</sup> “American Machinery in British Guiana”, *ibid.*

<sup>521</sup> “American Machinery in British Guiana”, *Louisiana Planter*, No. 1, XLVIII (1912), 2-3.

<sup>522</sup> Chen, *Cane Sugar Handbook*, p. 2; John Geddes McIntosh, *Technology of Sugar* (London: Scott, Greenwood and Son, third revised edition; 1916), p. 310

or steel and set in wooden frames. Upgrades featured hollow, cast-iron, horizontal rollers mounted in a triangular arrangement. Horizontal mills were cheaper to operate, more powerful, easily installed and gave better megass.<sup>523</sup>

The introduction of steam technology coincided with the development of the horizontal, three-roller cane mill. A mill installed at Tuschen de Vrienden (West Coast Demerara) by its parent company Sanbach, Tinné and Company in 1822 was among the first in the colony, arriving just four years after the first horizontal mill used in a British colony was shipped to Mauritius.<sup>524</sup>

Early mills were imperfect and a common flaw was loss of juice which, after extraction, was reabsorbed into waste (megass) leaving the rollers. Further, the dense rind of the Bourbon—the staple cane variety up to the end of the nineteenth century—clogged lightweight rollers.<sup>525</sup> Rollers in constant use required daily checks to maintain maximum and constant crushing pressure.<sup>526</sup> Breakage was common until the introduction of steel gearing and machines—‘defibrators’—that shredded the cane before it was fed into the crushing mills.<sup>527</sup>

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<sup>523</sup> “Sugar-Making in the West Indies”, *Quarterly Journal of Agriculture*, IV (December-March 1833/34), 58. Briefly, cane-crushing apparatus was modified over time. Early vertical 2-roller types were supplanted by 3-roller mills and by horizontal mills fitted with 2 to 6 rollers. Single mills, comprising 3 rollers placed so that their centers formed an isosceles triangle were the most efficient. Engineers fine-tuned the positioning and composition of the rollers—hollow or solid—to adjust pressure on the cane and changed the composition and form of the headstock for more flexibility during turning. New gearing apparatus using the ‘dumb turner’ (also ‘dumb returner’ or ‘trash turner’), redirected cane back to the rollers and ended manual re-feeding. Rollers were resized, multiple mills in tandem were driven by single engines and steel gearing controlled roller rotation speed. Reformulated foundry mixes gave coarse grained roller surfaces and grooved surfaces that shredded cane more easily. See Deerr, *Sugar and the Sugar Cane*, pp. 89-108, **passim**; \_\_\_\_\_, *History of Sugar*, II, 536-49, and Francis Watts, pp. 75-81. See Skekel’s Patented Three-Roller Sugar Mill, following.

<sup>524</sup> *Catalog of Record Books of Fawcett, Preston and Company*, available online at <http://www.nationalarchives.gov.uk/a2a/records.aspx?cat=136-bfp&cid=0#0>.

<sup>525</sup> Raymond Beachey, “Sugar Technology in the British West Indies in the Late Nineteenth Century”. *Caribbean Historical Review*, Nos. 3-4, (December 1954), 170.

<sup>526</sup> Stewart, *Steam Engineering on Sugar Plantations*, pp. 17-20 and 25-26.

<sup>527</sup> Seaforth M. Bellairs, “Twenty Years’ Improvements in Demerara Sugar Production Part II”, *Timehri*, new series, (1892), VI, 3; Deerr, *Cane Sugar*, pp. 228-32.

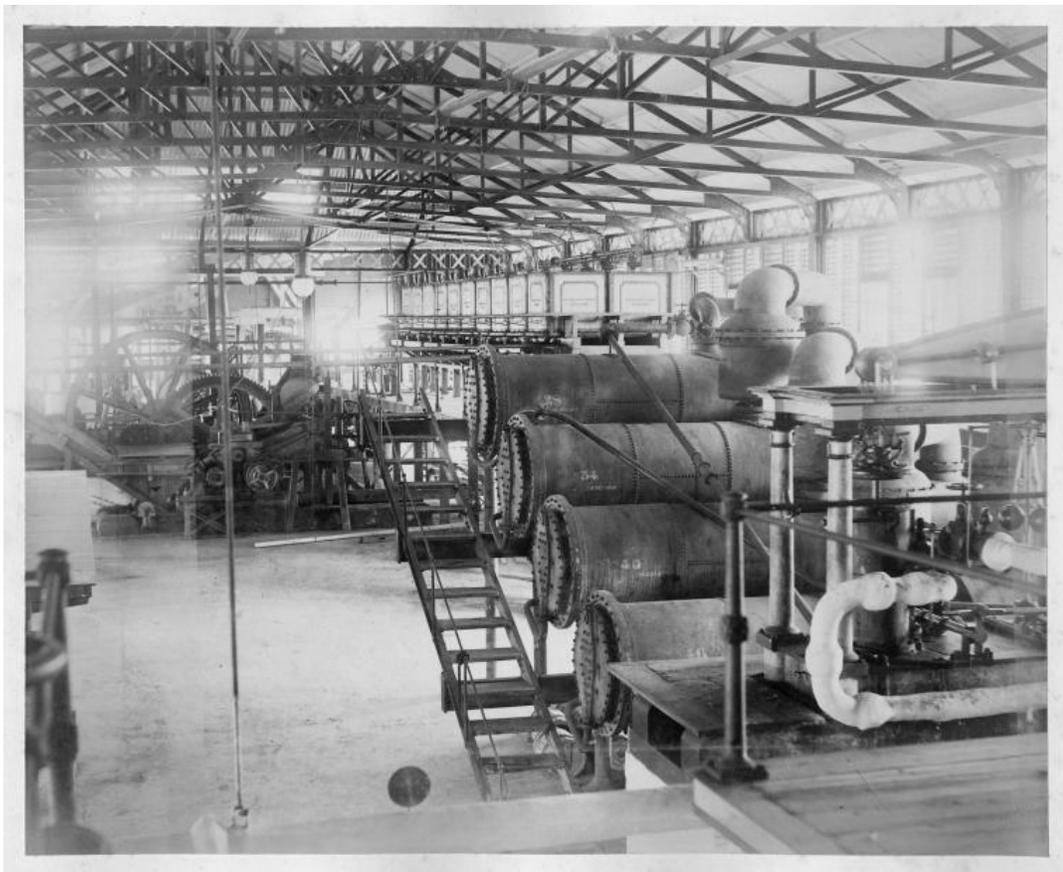


Figure 50: Multiple roller mill in a British Guiana factory circa 1900.<sup>528</sup>

Hollow rollers invariably lacked sufficient crushing power and up to the 1850s, a steam-driven single mill extracted only sixty to seventy percent juice.<sup>529</sup> Mill problems persisted and privately-sponsored trials evaluated crushing capacity at various factories during 1883 and 1884. William Russell and James Mann tested mills throughout the colony on behalf of the Royal Agricultural and Commercial Society. At the time five factories—Uitvlugt, Anna Regina, Leonora, Providence and La Bonne Intention—practiced double-crushing, while ten others—Maryville, Philadelphia,

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<sup>528</sup> J. Siza (Photographer), Plate 2, *Views of British Guiana*.

<sup>529</sup> “Correspondence from the Berbice Society of the Arts, 15 July 1852”, p. 17. Although horizontal mills superseded vertical prototypes, ‘Sugar King’ William Russell viewed the horizontal as more efficient. William Russell, “Sugar-cane mills”, *Timehri*, II (1883), 381.

Tuschen de Vrienden, Zeelugt, De Willem, Cornelia Ida, Diamond, Rose Hall, Skeldon and Port Mourant—continued with single crushing.<sup>530</sup> The trials showed that single-crushing rarely resulted in extraction rates exceeding sixty-six percent while double crushing gave only seventy-two to seventy-four percent juice.<sup>531</sup> Clearly, the mills had improved only marginally since the 1850s and the trial advocated enlarging the rollers and attaching them to less powerful engines. The presumption was that slower rotation would enhance crushing capacity.<sup>532</sup>

Ernest Francis, Government Analyst, tried a custom mill fabricated by the Demerara Foundry and recorded similar results in 1888.<sup>533</sup> Significantly, Francis' investigations led him to conclude that the rate of juice extraction depended more on the amount and type of fiber found in different parts of the cane stalk. Minimal improvements in extraction seemed to relate more to the physiology of cane rather than to defective equipment.<sup>534</sup> The findings suggested that selecting a variety with a softer outer rind was as important as choosing the machinery to crush it. Inefficient mills were gradually replaced as producers worked to increase crushing capacity and extraction rates.<sup>535</sup>

By the end of the century the use of multiple roller mills in tandem was common. The practice, known as 'multiple crushing', passed cane successively through several three-roller (single) mills. Moreover, many factories had installed defibrators that pre-shredded the cane.

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<sup>530</sup> Russell, *ibid.*

<sup>531</sup> Nevile Lubbock, "Diffusion of sugar cane, compared with double crushing in mills", *Timehri*, new series, (1890), V, 2.

<sup>532</sup> Russell, "Sugar-cane mills", pp. 381-86; \_\_\_\_\_, "Cane Mills; and Megass as Fuel", 48-67, *passim*; Shields, pp. 386-92.

<sup>533</sup> E. E. H. Francis, "Cane Crushing", *Timehri*, II (1884), 224.

<sup>534</sup> *Ibid.*, p. 226. Francis died in Guiana on August 31, 1889 at age 38.

<sup>535</sup> Deer, *History of Sugar*, I, 546-47.

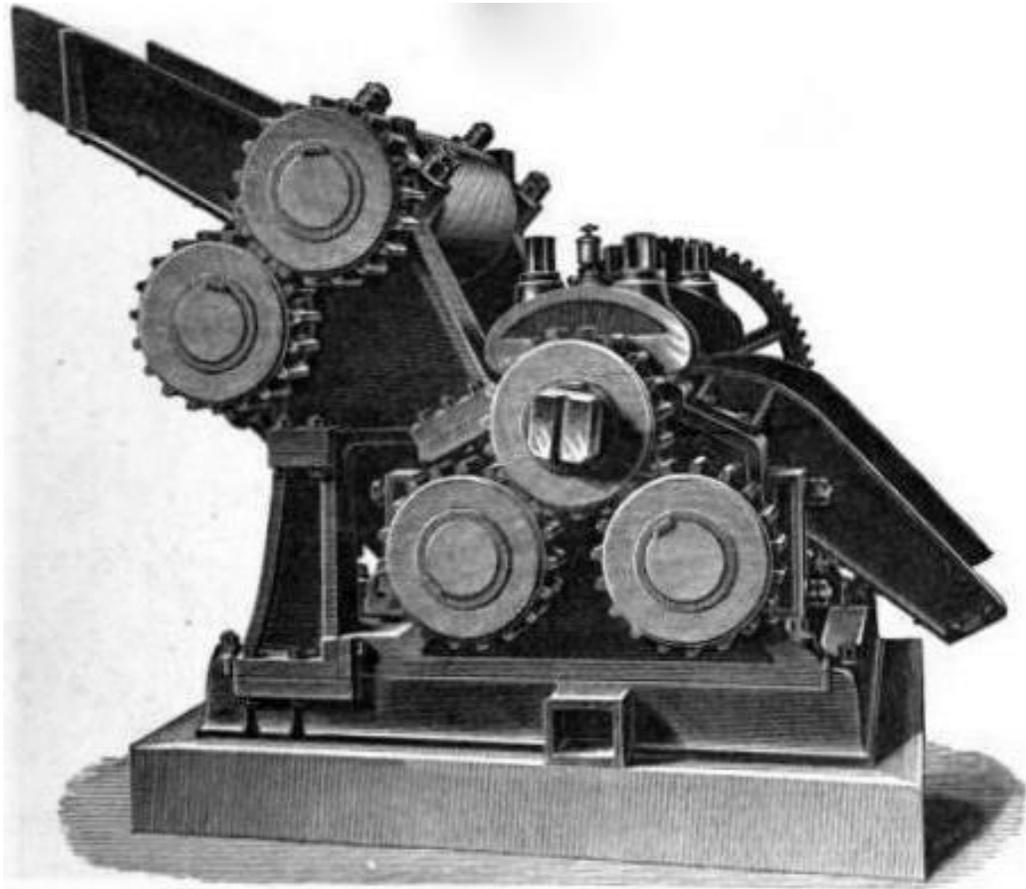


Figure 51: Thomson and Black's five-roller mill.<sup>536</sup>

Multiple crushing made use of machinery that was readily available when two or more estates merged.<sup>537</sup> By 1893 factories were using mills with up to six or more rollers with “very good milling results” and were equipped with state-of-the-art machinery”.<sup>538</sup> Port Mourant (Berbice) got a George Fletcher and Company five-roller mill in 1905-06 with an engine powerful enough to drive up to six additional rollers.<sup>539</sup>

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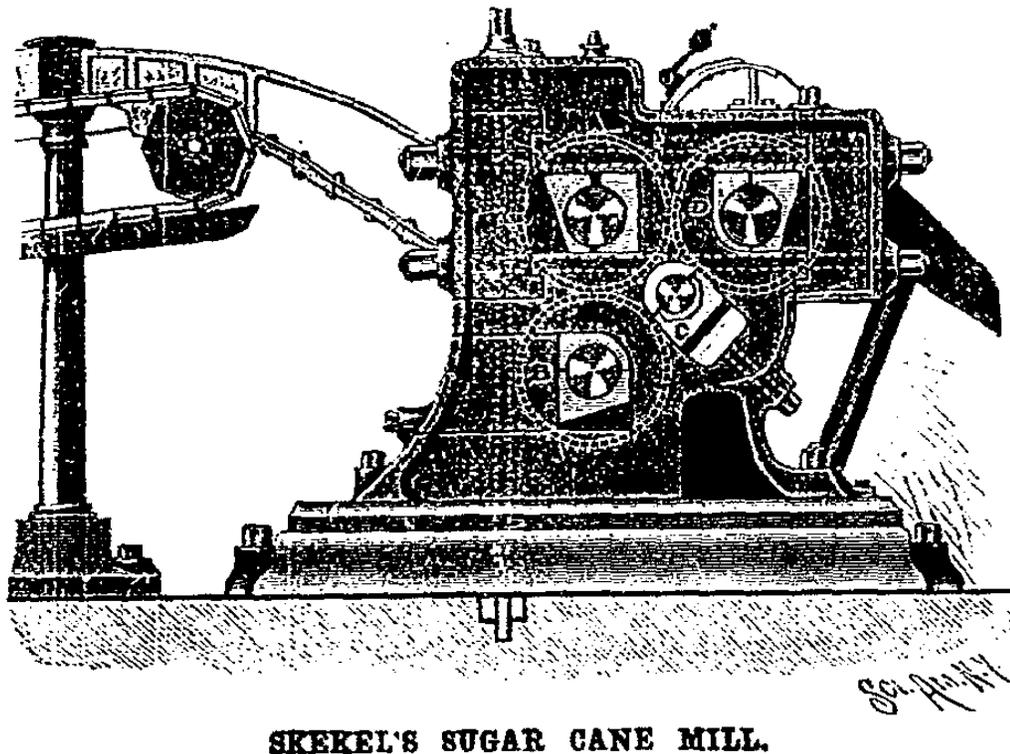
<sup>536</sup> Charles Warnford Lock, Benjamin E.R. Newlands and John A.R. Newlands, *Sugar: A Handbook for Planters and Refiners* (London: E & F. Spon, 1888), pp. 156-57. The mills were fabricated by McOnie, Harvey and Company of Glasgow and adopted first in Brazil, then in British Guiana and Peru.

<sup>537</sup> Thorpe, p. 206; Rodney, *Guyanese Sugar Plantations in the Late Nineteenth Century*, p. 28.

<sup>538</sup> Rodway, *Hand-book of British Guiana*, 32. Mills categorized as 9, 12 or 15 roller mills were actually conjoined 3, 4, or 5 three-roller units. (Wilcox, *Tropical Agriculture*, p. 51)

<sup>539</sup> “A New Mill for Berbice”, *International Sugar Journal*, No. 85, VIII (1906), 3.

Plantation Diamond in Demerara had upgraded to a modern nine-roller Cora mill by 1907.<sup>540</sup>



**SKEKEL'S SUGAR CANE MILL.**

Figure 52: Donald Skekel's prototype in *Scientific American*.<sup>541</sup>

### **Skekel's patented Three-Roller Sugar Mill**

In 1888 Donald Skekel, a Demerara engineer, patented his “Improved Three-Roller Sugar Mill”. While the most common mill in the colony comprised three rollers aligned horizontally in a triangular arrangement, Skekel proposed a different placement.<sup>542</sup> **(Figure 52)**

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<sup>540</sup> J. Da Silva, “Cane Crushing and Maceration” *Louisiana Planter*, No. 23, XXXVIII (1907), 361.

<sup>541</sup> *Ibid.* Skekel showed a model of his mill at an exhibition in Jamaica in 1891.

<sup>542</sup> According to the specifications “The front roller is placed vertically under the top roller. They are placed in positions to enable the strain to be carried entirely and directly through the two gland bolts, relieving the head stock of the strain which causes so many disastrous results in the present system. The final crushing roller is placed horizontally and in the same plane as in the top roller, and is secured by

His patent repositioned the rollers to prevent re-absorption of juice falling onto the megass as it passed through the bottom roller, a critical failing of older mills.<sup>543</sup> Skekel also eliminated the bothersome ‘dumb turner’ or ‘dumb returner’—a fixed bar or plate between the two bottom rollers of a triangular mounting that directing the flow of the cane that broke frequently, replacing it with a small, grooved roller.<sup>544</sup> Two new headstocks and fittings to elevate one roller were all that was required to upgrade an existing mill as its rollers, mount and liquor plate arrangement were all retained.<sup>545</sup> In addition, Skekel’s mill required less power than older mills and was easily disassembled for lubrication and maintenance.<sup>546</sup> The advantages of the new model were its negligible adaptation costs and reduced fuel consumption.

The usefulness of Skekel’s patent was the subject of considerable speculation at home and abroad.<sup>547</sup> He gave a demonstration to planters in Barbados in 1890 and at least one mill erected there extracted seventy-one percent juice from one hundred pounds of cane, a result almost equal to double crushing with a pair of three-roller mills.<sup>548</sup> One of Skekel’s mills was used at Plantation Herstelling in Demerara but the extent of its diffusion is undocumented.<sup>549</sup> It is likely that local manufacturers chose not to adopt it as the efficacy of double-crushing increased. Recycling mills culled from abandoned factories and arranging them to crush in tandem was an economizing solution that thrifty Guianese planters preferred.

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wrought iron strap bolts bearing the entire strain. (D. Skekel, “An Improved Three-Roller Mill” *Timehri*, new series, (1888), II, 207-11, **passim**.)

<sup>543</sup> Ibid. Francis Watts, p. 77.

<sup>544</sup> Skekel, pp. 207-11, **passim**.

<sup>545</sup> Ibid, p. 212.

<sup>546</sup> Howell Jones, “Report on Skekel’s Sugar Mill.” *Timehri*, V (1891), 311; and “An Improved Sugar Cane Mill”, *Scientific American*, No. 18, LXVII (1892), 274.

<sup>547</sup> Francis Watts, p. 77. Watts misspells Skekel as ‘Skegels’.

<sup>548</sup> “Big Extraction”, *Louisiana Planter*, No. 23, IV (1890), 429; Francis Watts, p. 77; “An Improved Sugar Cane Mill”, p. 274.

<sup>549</sup> Bellairs, “Twenty Years’ Improvements in Demerara Sugar Production. Part II”, 4.

### **Extraction technologies: ‘Diffusion’, ‘Maceration’ and ‘Imbibition’**

Trials were also held to compare double-crushing with another extraction method, ‘diffusion’, borrowed from the beet industry.<sup>550</sup> Briefly, beet ‘diffusion’ involves dipping or soaking beet slivers into boiling water and repeating the process in receptacles containing weaker solutions of beet juice and water until the mulch is exhausted and a concentrated beet sucrose achieved through osmosis. The final decoction is heated to isolate the sucrose and sugar made in the usual way. Diffusion dispensed with grating and pressing beets and reduced processing time.

Heightened interest in water-aided extraction in the 1840s prompted a local planter to fund exploratory visits to Louisiana where cane ‘diffusion’ was being tried.<sup>551</sup> However, material differences between beet and cane forestalled straightforward transfer of the technology between the two industries.<sup>552</sup> Beet, a soft vegetable, was easier to slice, crush and pulverize than a hardy cane stalk normally seven feet (3 meters) long. Cane’s leathery, pliable and virtually impenetrable rind impeded slicing and cutting knives needed constant sharpening and maintenance. Further, cane diffusers had to be compact to save space, use only a minimum amount of water for each stage of dilution and process large quantities of cane daily.<sup>553</sup>

Diffusion got its start with Quintin Hogg’s experiments in the 1880s. The lure of new business prompted a German beet-sugar engineer Shultz, of the Sangerhausen Company, to travel to Guiana for a consultation that resulted in a contract for the first

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<sup>550</sup> Whether diffusion was first applied to beet or cane is unclear but Ware claims that Mathieu de Dombasle applied the principles to beet in 1821. (Lewis S. Ware, *Beet-Sugar Manufacture and Refining, Vol. 1. Extraction and Depuration* (New York: John Wiley and Sons, 1905), p. 135. Deerr distinguishes between mechanical and chemical extraction. The former ruptures plant cells (i.e. by crushing) to extract juice while chemical extraction induces the cane to give up its sucrose by osmosis. Deerr, *Sugar and the Sugar Cane*, p. 124.

<sup>551</sup> Premium, *Eight Years in British Guiana*, pp. 48-49; Wray, *The Practical Sugar Planter*, pp. 296-98.

<sup>552</sup> See **Confluences of cane and beet processing**, later this chapter.

<sup>553</sup> “Mr. Cage on Mills and Diffusion Combined”, *Louisiana Planter*, No. 12, I (1888), 133.

diffusion plant set up at Hogg's Non Pariel Estate in 1886-87.<sup>554</sup> The initiative suffered a number of setbacks owing to defective slicing equipment. The failure of Sangerhausen's horizontal slicers prompted Hogg to consider vertical types he had seen in Asaka, India.<sup>555</sup>

In spite of the high cost, diffusion experiments persisted to the 1880s and the results appeared in various publications.<sup>556</sup> Hogg's wealth allowed him to outfit his estates with costly diffusion equipment but his daughter, Ethel, later lamented that he had introduced it at a time when crushing mills were inefficient and diffusion benefitted from cheap coal and high sugar prices.<sup>557</sup> A simultaneous rise in coal costs and precipitous drop in sugar prices rendered diffusion uneconomical. Further, improved furnaces burning green megass all but eliminated the need for coal.

Aside from the expense, diffusion presented other significant disadvantages. Fine shredding precluded the use of stalks as megass, eliminating the industry's cheapest and preferred fuel. Additionally, diffusion 'baths' required a constant supply of piped, fresh water unavailable on a majority of Guiana estates during the nineteenth century.<sup>558</sup> Diffusion, requiring costly new equipment, a lot of fresh water and coal, eventually fell out of favor but the industry continued to experiment with a variety of extraction methods.

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<sup>554</sup> *Parliamentary Papers*, LVII (887), p. 132; "British Guiana", *Louisiana Planter*, No. 19, V (1890), 358.

<sup>555</sup> Lock, Newlands and Newlands, *Sugar: A Handbook for Planters and Refiners*, p. 235.

<sup>556</sup> George Garnett, "Improvements in Agriculture and Manufactures", *Timehri*, new series, (1889), III, 191; Deerr, *Sugar and the Sugar Cane*, p. 132. Heriot claimed that diffusion was "adopted with considerable success in Demerara, Java, [The] Hawaiian Islands, Mauritius and India". (T. H. P. Heriot, *Manufacture of Sugar from the Cane and Beet* (London: Longmans, Green and Co., 1920), p. 66.

<sup>557</sup> Ethel Hogg, *Quintin Hogg. A Biography* (London: Archibald Constable & Co Ltd., 1904), pp. 319-20.

<sup>558</sup> See Llewellyn Jones, "A Few Popular Facts about Diffusion", *Timehri*, new series, (1894), VIII, 33-34; and "Cane Slicing and Diffusion." *Timehri*, new series, (1886), V, 289-92, **passim**.

### **A noteworthy adaptation: Russell and Risien's 'Imbibition'**

Historically, the terms 'maceration', 'imbibition' and 'saturation' are used interchangeably in the cane sugar industry to describe a variety of water-based extraction techniques.<sup>559</sup> Initially, cane maceration involved steeping megass in hot or cold water, prior to a second 'double' or multiple crushing, to maximize sucrose extraction.

On 30 November 1874 William Russell and George Walters Risien of Demerara obtained a patent for "Improvements in the method of and apparatus for extracting the juice and crystallisable matter from sugar cane, and after manipulation of the same." The patentees described their strategy:

The features of novelty which constitute this invention consist in passing the cane stalks, through two mills spaced about thirty feet apart and connected by a chamber. In this chamber works and endless band or carrier, and the chamber is provided with two tiers of pipes, through which a continuous supply of hot water, or steam, or cane juice passes in a spray and saturates the expressed cane stalks or begass [sic] on passage of same from mill to mill. The hot water, or hot water and steam, is supplied from the cane juice heaters used in the manufacture of sugar, and the juice from the second mill may also be used for saturation by passing it through a juice heater and then to the supply pipes for saturating the begass [sic] before mentioned.<sup>560</sup>

Russell and Risien based their design on the principles of osmosis, like beet diffusion, but omitted slicing the cane. Significantly, they proposed using dilute juice in the extraction process, applying either jets of hot water or a mixture of juice and water to megass passing through a perforated chute after a first crushing.<sup>561</sup> The

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<sup>559</sup> For Guiana, it is often unclear in the records whether maceration or imbibition was used, even where the process was named. To add to the confusion, *imbibition* is also occasionally written as 'inhibition'. See Bill Albert, *An Essay on the Peruvian Sugar Industry, 1880-1910* (Norwich: School of Social Studies, University of East Anglia, 1976), p. 279.

<sup>560</sup> *Chemical News*, XXXII (January 14 1876), 20-21.

<sup>561</sup> John A. R. Newlands and Benjamin E. R. Newlands, *Sugar: a Handbook for Planters and Refiners* (London: E. & F. N. Spon, 1909), p. 180; Deerr, *Cane Sugar*, p. 247. (The Honorable) William Russell (1827-1888) was born into a famous family in Elginshire, England, and migrated to British Guiana in the 1860s. He managed Leonora (West Coast Demerara) and was attorney for several other estates. Nicknamed "The Sugar King" for his vast knowledge of the sugar industry, Russell's "powerful, wiry

strategy eliminated lengthy soaking and averted the fine shredding that made megass useless as furnace fuel. (Figure 53)

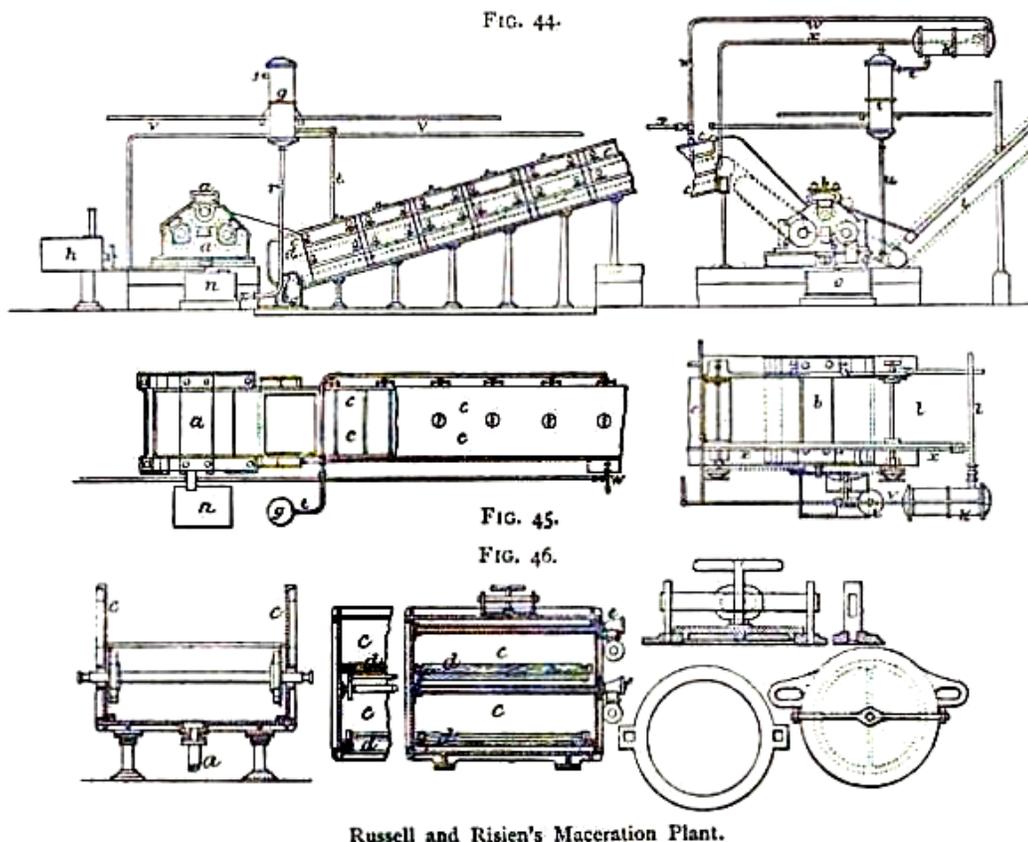


Figure 53: Russell's and Risien's patent drawings.<sup>562</sup>

frame and long flowing beard” was reportedly known “by every man and woman from Skeldon to Pomeroun” and he was described as a “man of immense energy and drive”. Russell wrote extensively on a variety of subjects—improving drainage and irrigation, the water supply, immigration, labor, and on opening up the interior of British Guiana—and was President of the Royal Agricultural and Commercial Society of British Guiana from 1877-1885. He died in 1888 and his memorial currently stands in the grounds of the Georgetown City Hall. (See also C.O. 111/406 PRO December 4, 1875. TNA, UK) Risien—engineer at Leonora in the 1880s—obtained another patent in 1874 for “heater and furnace covering for steam boilers, more particularly, copper walls.” He died sometime after 1891. See B. Woodcroft, (ed.), *Chronological and Descriptive Index of Patents Applied for and Patents Granted*, London: Office of the Commissioners of Patents for Inventions, 1868, 322; and <http://www.vc.id.au/tb/bgcolonistsR.html>

<sup>562</sup> Newlands and Newlands, p. 182. Although the patent is captioned “Russell and Risien’s Maceration Plant”, the technique is distinguishable as *imbibition*.

Imbibition gave higher extraction rates than single mill crushing and Russell claimed that the process delivered twenty percent more sugar and used slightly more coal but in a more efficient manner. Moreover, the megass generated was drier and available for immediate use as a ‘green’ fuel.<sup>563</sup> Significantly, the process made use of mills already installed in factories with few adjustments.

By 1876, Leonora Estate (West Coast Demerara) was making ordinary muscovado and “Best White” vacuum-pan sugar by maceration, targeting markets in England and Copenhagen.<sup>564</sup> La Bonne Intention was also making sugar by maceration and a visiting chemist from Cuba’s *Central Santa Lucia* in 1907 observed the process at Diamond Estate (East Bank Demerara) in 1907.<sup>565</sup>

Guianese agriculturalists showed great interest in beet maceration and diffusion techniques and tested the merits of applying them to cane. Nevile Lubbock found no economic advantage to switching to diffusion if an estate had a satisfactory double crushing plant.<sup>566</sup> Other experiments found a slight advantage for diffusion when compared with double crushing and imbibition combined.<sup>567</sup> The chief setback with diffusion was that the process used considerable more water than imbibition.

Imbibition extended the benefits of double crushing and was enhanced by improved filter press technology after the 1850s.<sup>568</sup> Following the introduction of tandem crushing using multiple roller mills, imbibition became the cheapest and most

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<sup>563</sup> “Maceration a Success”, *Sugar Cane*, VII (December 1 1875), 657-58.

<sup>564</sup> Philadelphia International Exhibition, *Official Catalog of the British Section Part I*, (1876), p. 311;

<sup>565</sup> *Ibid*; Francis Walker (ed.), *United States Centennial Commission, International Exhibition 1876. Reports and Awards Group III*, p. 9; Da Silva, p. 361. As Russell managed Leonora and La Bonne Intention, they were likely using his imbibition process. Beachey maintained that Russell introduced maceration and diffusion in 1878 at La Bonne Intention but the inventors had already secured a patent in 1874. (Beachey, *The British West Indies Sugar Industry...*, p. 63)

<sup>566</sup> Lubbock, p. 9.

<sup>567</sup> Maurice I. Coster, “Notes on the Dilution of the Juice in the Sugar Cane”, *Timehri*, IV (1885), 71-75.

<sup>568</sup> See **Confluences of cane and beet processing**, later this chapter.

efficient way to maximize extraction.<sup>569</sup> The terms ‘single imbibition’, ‘double imbibition’, and ‘compound imbibition’ apply to adding water and/or juice to the megass at various stages of milling. Imbibition strategies have been revised several times based on recalculations of the amount of water and immersion time needed for optimum extraction and proper positioning of the spray jets, among other factors.<sup>570</sup> By the end of the 1880s planters could choose from among the four extraction techniques applied individually or combined. Whether using double crushing alone or with imbibition (single or compound) or diffusion, the local industry had been relentless in its efforts to improve extraction rates.

### **Improving ‘Defecation’**

Purifying cane juice is an important phase of sugar manufacture. It is achieved by mechanical filtration (sieving, straining and skimming), by heating and through the addition of various chemicals. Thorough cleaning or ‘defecation’ and clarification give a light-colored, purer sugar preferred by manufacturers and consumers in the nineteenth century.

Defecation removes pieces of cane stalk, leaf remnants, mud and other impurities before juice is reduced as sugar crystals.<sup>571</sup> Further, adding alkaline substances to fresh juice lightens its color and helps destroy inherent glucose that can cause inversion and souring.<sup>572</sup> Popular additives included milk, wood ash, cow’s

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<sup>569</sup> *Encyclopedia Britannica*, XXVI (1911), 37; Albert, *An Essay on the Peruvian Sugar Industry*, 279. The lack of adequate water fresh prevented Antigua from adopting imbibition and diffusion. Its Central Factory opted in 1907 for a Krajewski crusher which did “excellent work”. “The Antigua Central Sugar Factory”, *Louisiana Planter*, No. 22, XXXVIII (1907), 338.

<sup>570</sup> M. L. Pellet, “Under What Conditions Should the Imbibition of Bagasse Prove Economical and Profitable”, *Louisiana Planter*, No. 2, LII (1914). For an explanation of modern sugar-making processes see Chen and Chou, *Cane Sugar Handbook*, **passim**.

<sup>571</sup> See Lock, Wigner and Harland, *Sugar Growing and Refining*, Chapter IV: Defecation and Clarification.

<sup>572</sup> Deerr, *Sugar House Notes and Tables*, p. 83; Beachey, *Sugar Technology in the British West Indies in the Late Nineteenth Century*, p. 174; Samuel Sadtler, *A Handbook of Industrial Organic Chemistry* (Philadelphia: J. B. Lippincott Company, 1906), p. 128.

blood, alum, lime, chalk and egg whites that bonded with the dissoluble cellulose (gums) and were more easily skimmed off.<sup>573</sup>

In nineteenth century Guiana factories cane juice—‘liquor’—passed from the crushers to ‘receivers’ or ‘rackers’ (large vats or trays) where debris was skimmed with rakes and the liquor filtered through one or more meshed strainers. The liquor was then raised by way of a pulsometer (*monte-jus*) to a ‘sulphuring vat’ for chemical clarification. Inside the vat, sulphurous gas was diffused through the liquor to neutralize remaining acids and lighten its color.<sup>574</sup> The liquor was mechanically strained again using bag filters or, rarely for Guiana, discharged into iron filter pans with animal charcoal filters.<sup>575</sup> Sediment (‘mud’ or ‘filter cake’) was extracted via pipes inserted into the bottoms of the vats and the clear liquid above drawn off by a self-acting float valve (‘ball cock’) The clarified liquor was moved to another vessel, tempered with lime and heated to between 200 to 220°F (93 -104°C). Final concentration occurred in multiple effect evaporators and crystallization in vacuum-pans.

Up to the 1860s, the principal clarifying agent was bisulphate of lime, usually mixed in with the liquor in copper ‘sulphur boxes’ churned by steam engines.<sup>576</sup> By the 1880s phosphate of lime was substituted to neutralize acids in the liquor. The lime bonded with insoluble particles, mainly cellulose, and the resultant ‘scum’ was

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<sup>573</sup> Lock, Wigner and Harland, pp. 542-548; Deerr, *History of Sugar*, II, 578; “No. 1 Sugar Manufacture”, *De Bow’s Review*, 387-89.

<sup>574</sup> Sulphurous ‘gas’ was used as a bleaching agent and made by dissolving sulphur dioxide in water. The benefits and techniques of ‘sulphitation’ are described in Deerr, *Cane Sugar*, Chapter 16.

<sup>575</sup> Soames, *A Treatise on the Manufacture of Sugar*, pp. 29-30. Among many filtration devices used in Caribbean factories were Dumont’s quadrangular two-piece basket-type apparatus which used animal charcoal filters, and Peyron’s cylindrical version also using animal charcoal. (“No. 1 Sugar Manufacture”, pp. 390-92. ‘Bone black’ (charcoal) was tried on Enmore estate in the 1880s but ultimately discarded as too expensive. (Rodney, *Guyanese Sugar Plantations in the Nineteenth Century*, p. 64) Guiana factories had already circumvented the fresh-water problem by employing improved chemical filtration techniques instead of costly charcoal.

<sup>576</sup> Bellairs, “Twenty Years’ Improvements in Demerara Sugar Production Part II’, 6-8.

skimmed off during heating.<sup>577</sup> Sediment remaining in the pans was refiltered and its residual liquid incorporated into the bulk of clarified juice and the waste reserved for use as field manure. A second clarification moved the bulk of the liquor to ‘eliminators’ where it was boiled rapidly and skimmed again. At this point, more lime was added if further lightening was required and the liquor passed for final evaporation.<sup>578</sup>

The use of sub-acetate of lead as a clarifying agent gave “perfect results” until it was found poisonous and banned. Patented by Dr. John Scoffern in 1847, the substance was tested by chemists John Shier and Wilton Turner at Plantation Hope in December 1849 who proved that traces of lead remained in liquor even after the addition of the antidote, sulphurous acid.<sup>579</sup> Additional testing by Shier at the Colonial Laboratory resulted in sugar clarified with sub-acetate of lead being declared unsafe for human consumption.<sup>580</sup> There is no evidence of further use in Guiana.

High-pressure steam driven clarifying equipment was installed by the 1850s and W. and A. McOnie and Company of Glasgow was a preferred supplier.<sup>581</sup> Experiments with filtering cane juice through iron and zinc granules and drawing on the electrical properties of metal containers treated with various chemical additives were found useless for juice clarification. Vacuum juice heaters were introduced circa the 1860s, indicative of further attempts at fuel economy on the estates. The heaters

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<sup>577</sup> Hilhouse, “Agriculture in 1829”, p. 36.

<sup>578</sup> By the 1870s, a process known as ‘carbonation’ used large amounts of ‘milk of lime’ lime for clarification and carbon dioxide to counter over-liming. Carbonation was only used to make white sugar for direct consumption. (Deerr, *Sugar House Notes and Tables*, pp. 34-35 and 186-87, 289)

<sup>579</sup> “On the Use of Lead in the Manufacture of Sugar”, *Pharmaceutical Journal*, No. 6, X (1850), 177. Turner had been privately contracted to investigate ways of improving sugar manufacture.

<sup>580</sup> “Process of Refining Sugar by the Salts of Lead”, *London Medical Gazette*, new series, (1850), XII, 755-58; John Shier to Henry Barkly, 27 December 1849, *Parliamentary Papers*, XXXIX (1851), p. 9.

<sup>581</sup> MacRae, *Manual of Plantership*, p. 36.

used latent heat from the steam boilers to warm the juice before it entered the evaporators.<sup>582</sup>

### **Open pan evaporation: ‘copper-walls’**

Early sugar-making techniques derived from practical experience. After extraction, cane juice was heated and evaporated to syrup and concentrated as sugar crystals in a series of hemispherical metal pans called ‘coppers’.<sup>583</sup> Each copper had an open fire underneath and the size and number of pans was proportionate to the scale of manufacturing on each plantation. The alignment of the pans within the ‘copper-wall’, or ‘battery’, also varied among plantations and colonies.<sup>584</sup>

Each pan was progressively smaller in size and served dual clarification and evaporating functions. When syrup was sufficiently reduced, it was ladled into coolers and then packed into barrels—hogsheads—for ‘curing’. Curing allowed residual molasses to drip through a hole in the bottom of the barrel leaving behind raw, brown, muscovado. The chief disadvantage of open pan evaporation was that the individual fires under the pans required careful tending to avoid flare ups that could burn the juice. Direct, open fires also wasted latent heat while using up large quantities of fuel, either costly coal or megass that had to be dried before use.<sup>585</sup>

By the eighteenth century sugar-makers had adapted their copper-walls to draw heat from a single independent furnace via a connective flue under the pans. This fuel-saving system was known as the ‘Train’.<sup>586</sup> As a latecomer to sugar-making, British

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<sup>582</sup> S. M. Bellairs, “Defecation of Cane Juice by Electricity”, *Timehri*, new series, (1890), IV, 74-75 and **passim**.

<sup>583</sup> The pans were known as ‘kettles’ in the United States.

<sup>584</sup> *Journal of the Society of Arts*, No. 68, II (1854), 279.

<sup>585</sup> Later furnace technology burned fresh (‘green’ or wet’) megass. See **The cane megass’ furnace**, earlier this chapter

<sup>586</sup> The Train is, variously, the ‘Jamaica Train’ or ‘French Train’ and was found worldwide in various forms. (“No. 1 Sugar Manufacture”, *De Bow’s Review*, p. 381. The Train was used in Cuba prior to the eighteenth century but was replaced by single-fire evaporation circa 1780. Cuban sugar historian Moreno-Fraginals found the single-fire alternative retrogressive as although it required smaller

Guiana seems to have bypassed the use of individually-fired pans and progressed directly to the Train that used a single furnace for heating.

The vessels of the Train rested or ‘hung’ suspended by flanged rims in a framework of refractory brick and mortar. The pans were labeled according to size and placement within the Train. A ‘first teache’ was closest to the fire source and preceded the ‘second teache’, both vessels serving as clarifiers. The hot ‘liquor’ then passed to three or four pans in succession and was concentrated as ‘syrup’. The ‘strike’ was the smallest receptacle in the line-up in which final concentration occurred before crystallization.<sup>587</sup> **(Figures 54 to 57)**

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quantities of wood and used megasse as fuel, juice concentration times were protracted. However, Cuban mills had harvested so much fire-wood that the forests had nearly disappeared. The Jamaica Train was reintroduced into Cuba in 1828. (See Manuel Moreno Fraginals, *El Ingenio. Complejo Economico Social Cubano del Azúcar* (Habana: Editorial de Ciencias Sociales, 1878), pp. 88-89) Side-by-side placement of a pair of teaches with the remaining pans arranged behind in a perpendicular line was already in vogue in the Hispanic and French colonies by the late 18<sup>th</sup> century. He called the single fire arrangement “el tren español”—the Spanish Train. (pp. 88 and 88-92)

<sup>587</sup> *Journal of the Society of Arts*, No. 68, II (1854), 279. The pans were variously called ‘teaches’, ‘taches’, or ‘tayches’. In Louisiana and the Francophone sugar territories the largest copper or *Grand* received the fresh juice; the *Flambeau* was the pan closest to the fire and the juice achieved a syrupy texture in the *Sirop*. The *Batterie* was the smallest. While the first and second pans were of copper on account of its superior heat-conducting properties, the others were usually cast or wrought iron.

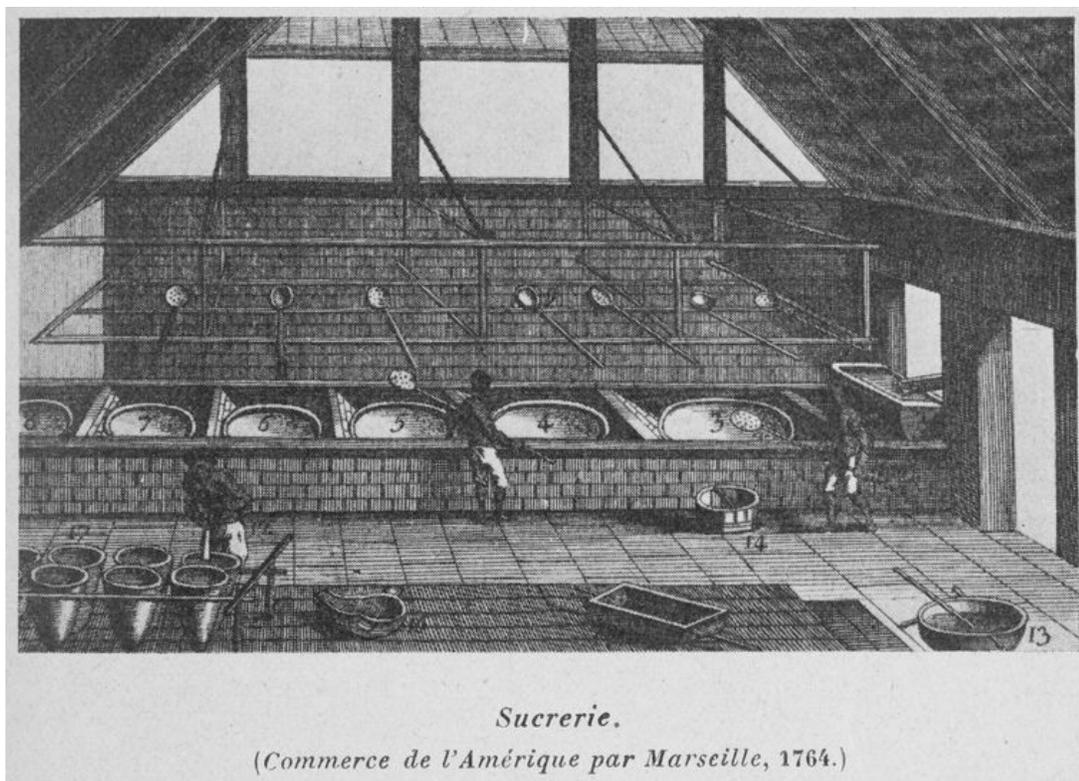


Figure 54: Interior of an early colonial Boiling House.<sup>588</sup>

Some Trains featured a battery of seven or eight vessels, usually a 600 and 500-gallon pan, and others capable of holding 400, 300 and 200 gallons of cane juice. The smallest pans each held sixty gallons.<sup>589</sup> Even after the spread of vacuum-pan technology, copper-walls remained in widespread use on estates where high-quality muscovados were made.<sup>590</sup> Not unexpectedly, given the persistent efforts to reduce production costs, British Guiana employed several modifications.

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<sup>588</sup> *La Sucrierie Indigène et Coloniale*, No. 1, LV (Janvier 1900), Plate XX.

<sup>589</sup> *Ibid.*

<sup>590</sup> British Guiana (Demerara) was famous its high-quality 'table' sugars. See '**Demeraras**', '**Yellow Crystals**' and '**Refining Crystals**', this chapter

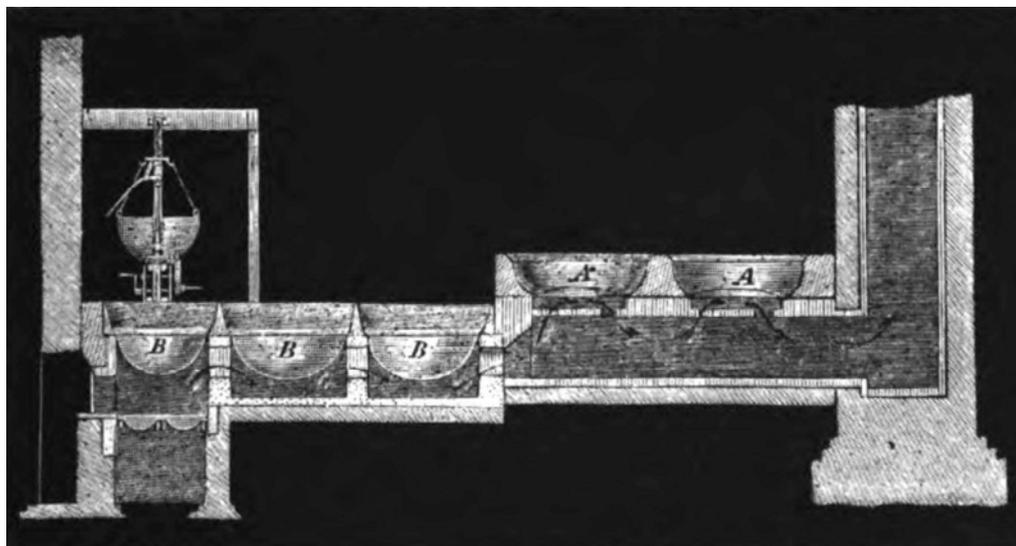


Figure 55: An improved Train circa 1851.<sup>591</sup>

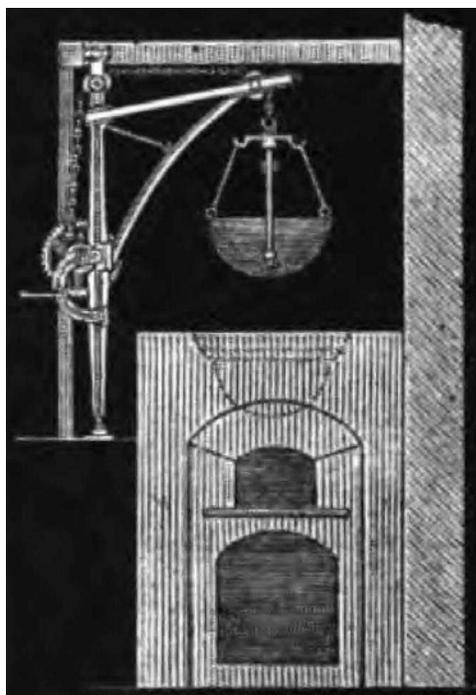


Figure 56: Detail of the mechanized dipper or 'skipping teache'.<sup>592</sup>

<sup>591</sup> Friedrich Ludwig Knapp, Edmund Ronalds and Thomas Richardson, *Chemical Technology; or Chemistry, Applied to the Arts and to Manufactures* (London: Hippolyte Bailliere, 1851), III, pp. 283 and 284. The diagram shows a pair of clarifying pans (A), two evaporating pans (B), and the smallest or 'strike teache' (B, left) with its mechanized dipper.

<sup>592</sup> Ibid.

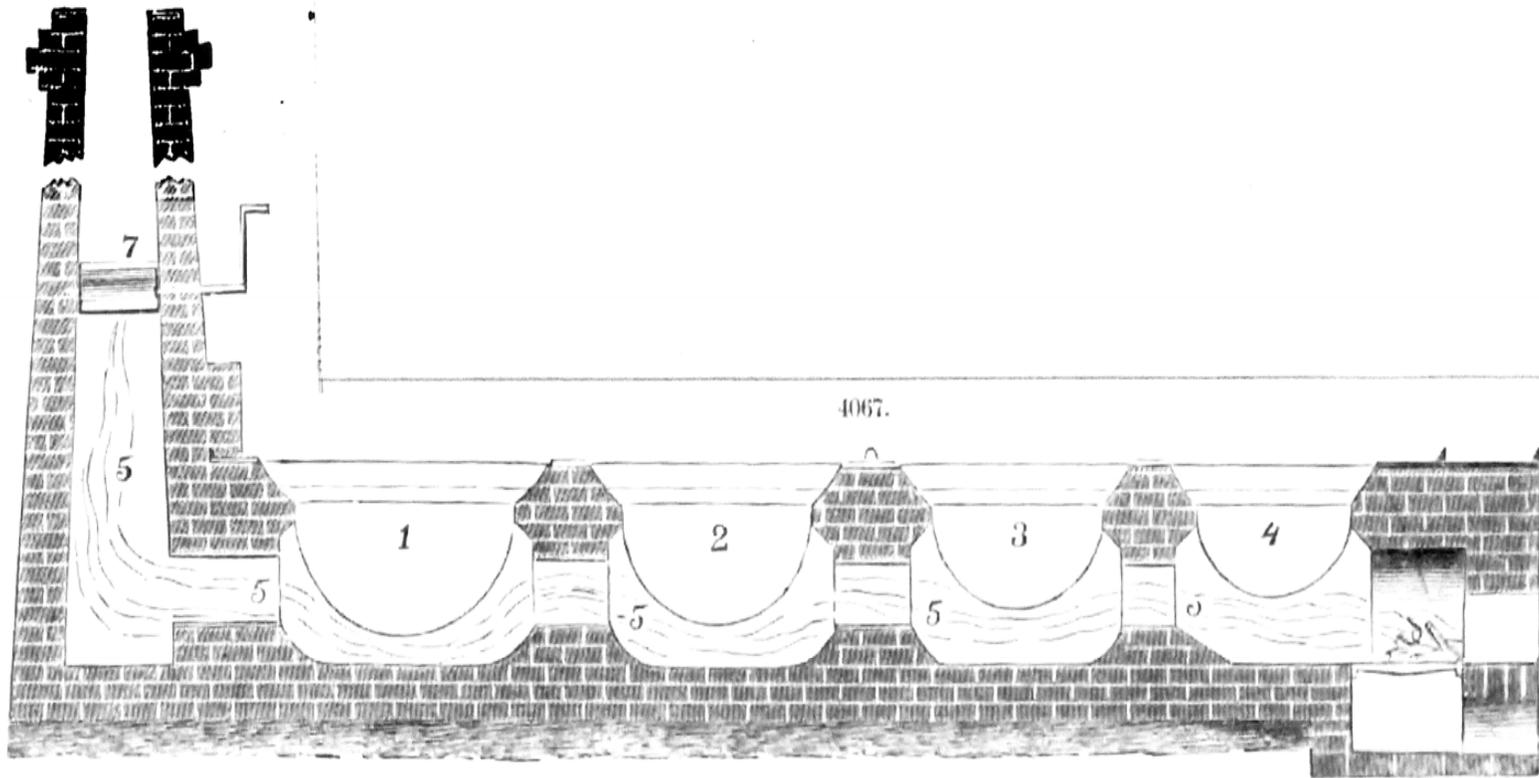


Figure 57: A typical ‘Jamaica Train’.<sup>593</sup>

<sup>593</sup> Benjamin Park, *Appletons’ Cyclopaedia of Applied Mechanics*, (London: D. Appleton and Company, 1891), II, 840. The evaporating pans are labeled 1 to 4. A single fire (right) is the source of heat passed through the flue under the pans. The chimney is at left.

## The ‘Demerara Plan’: an alternative copper-wall

Notwithstanding the characterization of British Caribbean sugar-makers as archaic, enterprising minds at Plantation La Penitence in Demerara devised a notable improvement that was patented in 1845.<sup>594</sup> The invention derived from a partnership between Robert Barr Purbrick, an English engineer, and his colleague Isaac Henry, a Demerara planter with thirty years experience in sugar-making at the time of the patent.<sup>595</sup>

Essentially, the ‘Demerara Plan’ reconfigured the form of evaporating pans by substituting a long, rectangular receptacle with a concave bottom in place of several, separate, round pans with spherical bottoms. The reconfiguration exposed more of the pans’ surface to heat, shortening evaporating times and reducing the risk of burnt and discolored juice. Additional savings accrued from the economical use of a single furnace as well as from eliminating the elaborate brickwork that customarily surrounded each pan.<sup>596</sup> (Compare **Figure 54** and **58, 59** and **60**)

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<sup>594</sup> La Penitence is sometimes misspelled ‘La Penitance’.

<sup>595</sup> Henry (Manager at La Penitence) gave a demonstration of the invention to his counterparts in Louisiana. The patent lasted six months. Yeates, also named in the patent, may have been the fabricator. Purbrick stated that the invention consisted of “...the form of the pans or coppers ... being rectangular in their horizontal plan (instead of circular, as in the common sugar-pans or coppers heretofore commonly used), and their bottoms being portions of cylindrical surfaces, concave and convex combined, as hereinbefore described (instead of being portions of spherical concave surfaces, as in the said common sugar-pans or coppers), and with flat vertical surfaces at those parts which will be adjacent when a number of such pans or coppers are set in a row or series, suitably for joining one to another at such flat vertical surfaces, as hereinbefore described, without leaving any interval between the several pans or coppers. Also in combining a number of such pans or coppers together in a series, and setting them in brickwork, as hereinbefore described ; whereby such series of pans or coppers, so combined, will become, as it were, one long vessel, with parallel sides, and an undulating bottom, and having partitions across its width, at the highest parts of the undulations of the bottom, so as to divide its interior capacity into compartments; and with the whole of the said undulating bottom covering over and forming the upper part of the flue or passage, from the fire-places to the chimney, as hereinbefore described.” (R. B. Purbrick, “An Investigation into the Relative Merits of ‘Purbrick and Yeates’ Patent Sugar Pans,’ and Those in Ordinary Use”, *Journal of Society of Arts*, No. 68, II (1854), 279-282, and *Newton’s London Journal of Arts and Sciences*, XXVII (1846), 172-75, **passim**).

<sup>596</sup> *Journal of the Society of Arts*, p. 279. The drawing accompanying Abraham Garnett’s 1830 patented “teache cover” shows individual, round evaporating pans using a single-furnace with connecting flue (**Figure 60**) Francis Hoard (also of Guiana) patented a “Circulating Sugar Boiler” in 1837. (**Figure 61**) The ‘Demerara Plan’ seems to have drawn on principles of earlier inventions but with a new type of evaporating pan. See **Miscellaneous inventions**, later this chapter.

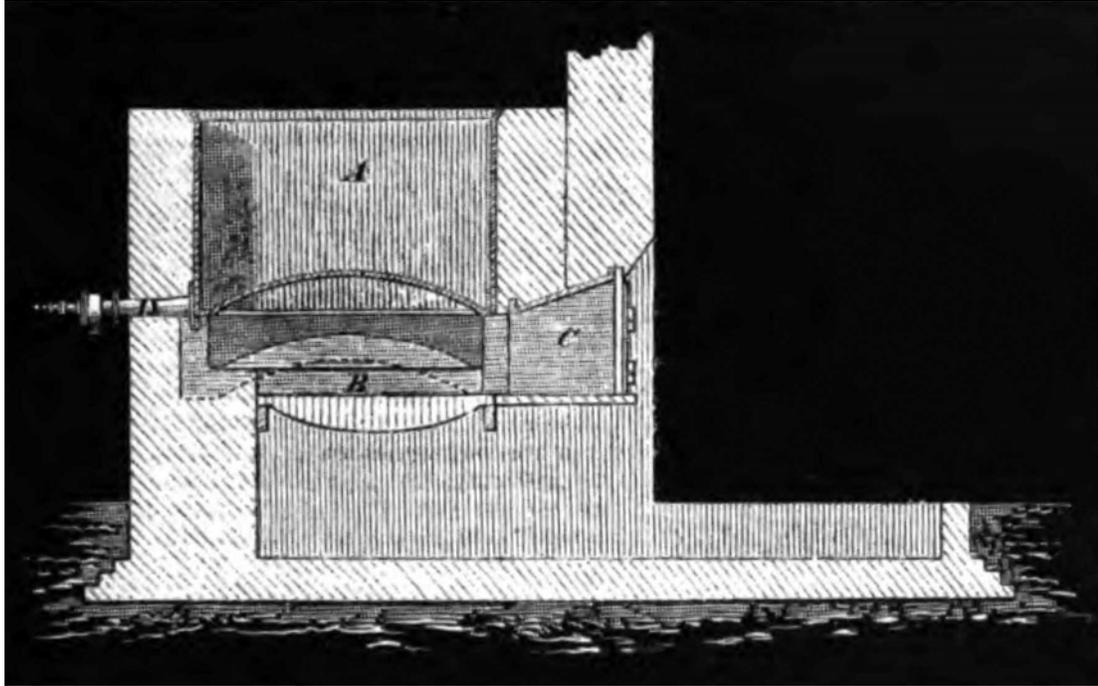


Figure 58: Purbrick and Yeates' 1845 'Demerara Plan'.<sup>597</sup>

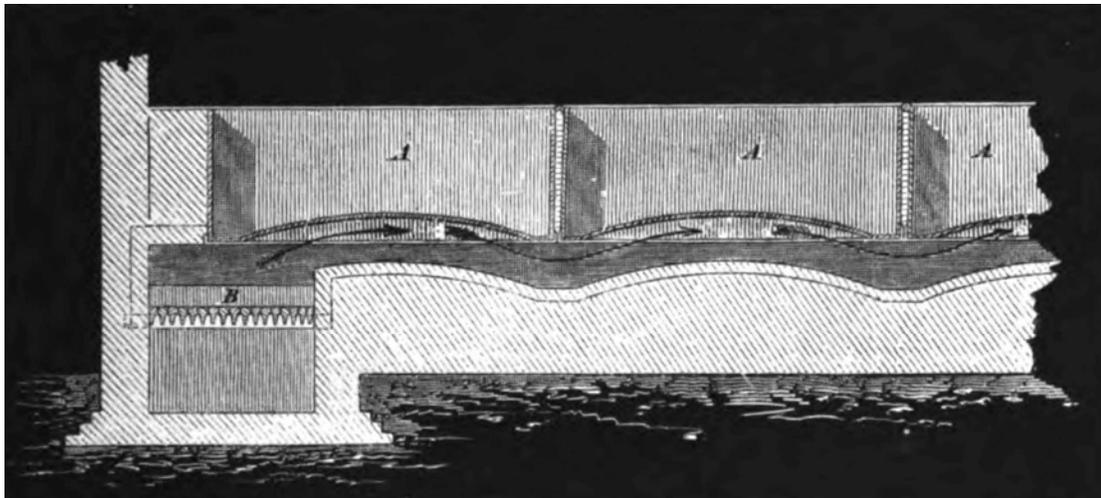


Figure 59: Section through Purbrick and Yeates' 'Demerara Plan'.<sup>598</sup>

<sup>597</sup> R. B. Purbrick, *ibid.* Evaporating pans with concave bottoms.

<sup>598</sup> *Ibid.* Cross section illustrating heat direction through the flue.

The influential *De Bow's Review* of 1848 recommended the Plan and flat-bottomed teaches were in use in Mauritius, Reunion (then Île Bourbon), and Seberang Perai (then Province Wellesley) by 1848 although whether these were Purbrick's pans is unclear.<sup>599</sup> Isaac Henry, the co-inventor, offered to share the technology with American sugar makers at the request of G. de Bretton, a Louisiana planter.<sup>600</sup>

The use of 'double batteries', an arrangement that featured two teaches side-by-side and the remaining pans arranged behind in single file, was widespread and superseded single-battery evaporation.<sup>601</sup> The advances represented a further economizing trend in the British Guiana sugar industry and W. F. Whitehouse of Jamaica acknowledged in 1845 that the Demerara system of boiling was the best known.<sup>602</sup>

#### **Closed evaporation: 'multiple effects' and vacuum-pans**

Open-pan evaporation (the copper-wall method) was a slow, subjective and complicated process even after the adoption of single furnace Trains. Heavy seasonal rains—common in Guiana—could delay 'curing' (separating crystals from residual molasses) for up to a month.<sup>603</sup>

Evaporation in closed vessels was faster, yielded drier, large-grained, light-colored crystals and produced twice the amount of sugar as an equal quantity of syrup reduced in the copper-wall.<sup>604</sup> Slightly less fuel was used as heating in a closed, depressurized receptacle concentrated liquids more rapidly.<sup>605</sup> Several types of closed

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<sup>599</sup> "No. 1 Sugar Manufacture", pp. 382-85 and 395; Wray, *The Practical Sugar Planter*, pp. 304-05.

<sup>600</sup> *De Bow's Commercial Review*, new series, (January-July 1853), XIV, 86-87. Henry was also willing to supply the Americans with copper-walls and with a sugar 'dipper' he had invented.

<sup>601</sup> *De Bow's Commercial Review*, p. 86.

<sup>602</sup> Whitehouse, *Agricola's Letters and Essays...*, pp. 338, 341.

<sup>603</sup> Shahabuddeen, p. 27; John Scoffern, *The Manufacture of Sugar, in the Colonies and at Home, Chemically Considered* (London: Longman, Brown, Green, and Longmans, 1849), p. 79.

<sup>604</sup> Scoffern, *Manufacture of Sugar*, p. 79; Adamson, *Sugar Without Slaves*, pp. 172-73.

<sup>605</sup> In the 19<sup>th</sup> century vacuum-pan crystallization occurred at temperatures between 130° F to 180° Fahrenheit (54 to 82° Celsius), whereas open pans attained temperatures of up to 250° Fahrenheit (121°

evaporators were developed including ‘bath’ and ‘film’ evaporators, ‘concretors’ and ‘multiple effects’.<sup>606</sup>

The principles of multiple effect evaporation was patented by American engineer Norbert Rillieux of Louisiana in 1840 and adopted throughout the sugar-making world.<sup>607</sup> Multiple effect evaporators (also *multiple effets*) concentrate cane juice by heating to the point where it becomes dense enough (as ‘syrup’) for crystallization to occur. Multiple effects comprised a set of closed, interconnected cylindrical cast-iron vessels (calandria) in which juice was concentrated by heating successively smaller quantities in depressurized (vacuum) chambers. Each vessel in the series relied on latent heat from the calandria preceding it and from other steam powered boilers and engines in the factory and enabled more efficient use of heat energy.<sup>608</sup>

Double (two calandria), triple and quadruple effects perfected by various patents were adopted in Guiana as early as 1855.<sup>609</sup> Plantations Vryheid’s Lust and Enmore had triple effect evaporators in the 1870s and ‘Yaryans’ from the Yaryan Manufactory of Toledo, Ohio were in use at Plantations Annandale and Reliance in 1888, though these had to be realigned and retrofitted with regulating shutter and slide

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Celsius). Cane juice tended to caramelize (darken) at high temperatures. Sadtler, *Handbook of Industrial Organic Chemistry*, p. 131; and *Mechanics’ Magazine*, No. 1074, XL (1844), 162; W. A. Kentish, “Making sugar by steam and in vacuo”, *Mechanics’ Magazine*, XXXII (5 October-20 May 1839/40), 41-43; Silliman, *Manual on the Cultivation of the Sugar Cane...*, p. 58

<sup>606</sup> Lock, Wigner and Harland, *Sugar Growing and Refining*, pp. 282-95; Deerr *Cane Sugar*, Chapter XVIII, especially pp. 340-42.

<sup>607</sup> A Gadesden low-pressure, open-fired evaporator—an alternative to the vacuum pan— was installed before 1848 on a Berbice estate worked by an experienced English technician. See William Julius Evans, pp. 171-73.

<sup>608</sup> International Library of Technology, *Manufacture of Sugar, Cottonseed, Oil and Products* (Scranton: International Textbook Company, 1909), pp. 4-5.

<sup>609</sup> Deerr and Brooks, “Development of the Practice of Evaporation...,” p. 19. The 1855 date is earlier than Deerr’s original “about 1880” introduction date. (Deerr, *Cane Sugar*, p. 342)

valves before they worked efficiently.<sup>610</sup> The Foster and Campbell patented triple effect manufactured by McOnie of Glasgow was also tried on a few estates with “splendid results” as was equipment made according to Chapman’s patent by the Fawcett Company of Liverpool.<sup>611</sup>

‘Vacuum-pan’ is the term ascribed to the vessel in which crystallization occurred. After reduction in the multiple effect evaporators, the thick syrup passed to the vacuum pan and was ‘boiled to grain’ or crystallized. Early vacuum-pans were shallow, spherical receptacles made of iron with pipes and valves to admit the syrup and allow depressurization.<sup>612</sup>

Vacuum-pans were successfully tried first at Plantations Richmond and Land of Plenty in Essequibo in 1830 with equipment supplied by William Oaks and Son of London through their agent in Demerara, Thomas Dodson.<sup>613</sup> The Oaks firm’s trial lasted almost two years during which the equipment was modified and improved “by practical experience”.<sup>614</sup> By August 1832, vacuum-pans were reported to be operating successfully on six estates in Guiana.<sup>615</sup> **(Figure 60)**

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<sup>610</sup> Bellairs, “Twenty Years’ Improvements in Demerara Sugar Production Part II”, p. 13; and “Demerara Items”, *Louisiana Planter*, No. 19, I (1888), 220; “Demerara Letter, March 15th 1890”, *Louisiana Planter*, No. 15, IV (1890), 253; *Manufacture of Sugar, Cottonseed, Oil and Products*, p. 3.

<sup>611</sup> “Demerara Letter”, *ibid.*

<sup>612</sup> Deerr, *Sugar and the Sugar Cane*, p. 221.

<sup>613</sup> Abraham Booth, “An Account of the Important and Successful Results of Experimental Trials in Demerara”, *Mechanics’ Magazine*, No. 469 (July 1832), 283; Deerr submits that installation first occurred at John Gladstone’s Vreed-en-Hoop (*History of Sugar*, II, 561) Following Deerr, Williams (“The Development of the Sugar Cane Industry in British Guiana”, p. 122); Beachey (*The British West Indies Sugar Industry in the Late Nineteenth Century*, p. 68); Galloway (*The Sugar Cane Industry...*, p. 137); Adamson (*Sugar Without Slaves*, p. 172); Lowell Ragatz, *The Fall of the Planter Class in the British Caribbean* (New York: The Century Co., 1928), p. 65; and Wagner [“Structural Pluralism and the Portuguese...”, p. 49] all date first use/installation to 1832-33 at Vreed-en-Hoop in Demerara. Records examined by this researcher substantiate James Rodway’s claim of first usage in late 1830 on the two Essequibo plantations, [*Hand-book of British Guiana*, pp. 291-92], that is consistent with Booth’s accounts. This researcher has not seen William Oaks and Thomas Dodson’s *On the Manufacture of Sugar by Evaporation and in Vacuo and Curing by the Pneumatic Process* (London: Harjette and Savill, 1834)

<sup>614</sup> Booth, “Further Accounts of the Operations Now in Progress in Demerara, for Obtaining Pure Raw Sugar Direct From the Cane Juice”, *Mechanics’ Magazine*, No. 520, XIX (1833), 275-281, *passim*; and “Description of the Apparatus for Manufacturing Pure Raw Sugar Direct From the Cane; Introduced

OAKS AND SON'S SUGAR MANUFACTURING APPARATUS.

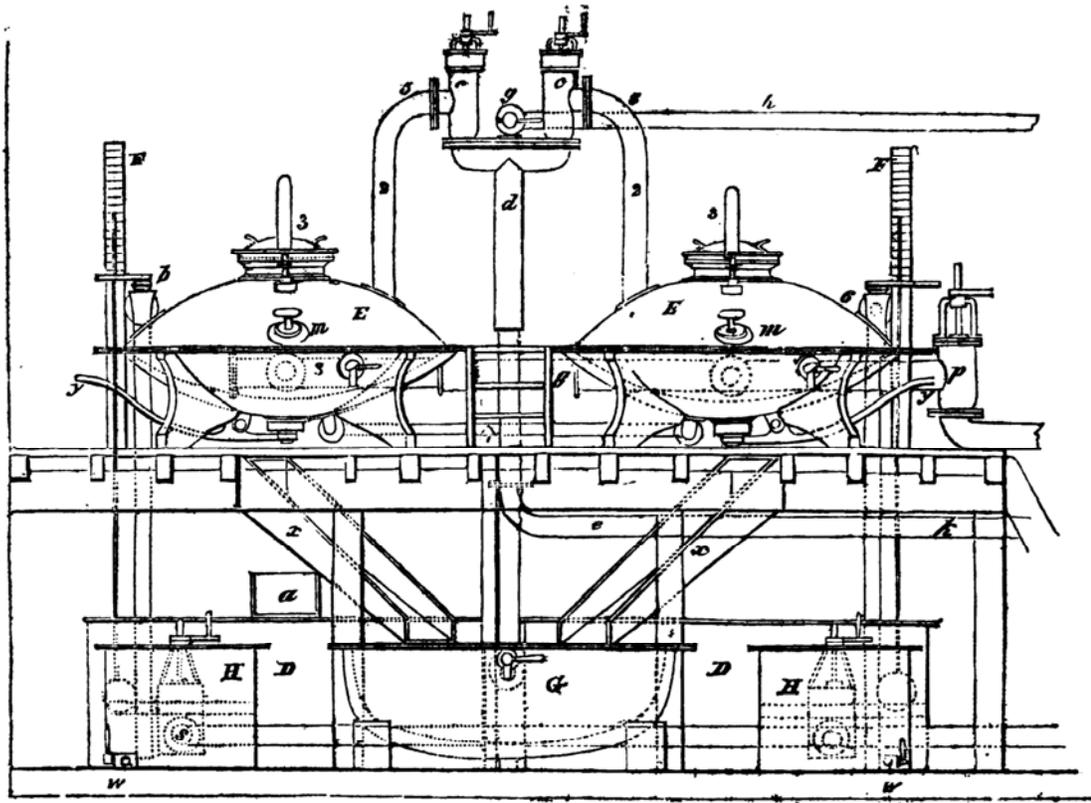


Figure 60: Vacuum-pan apparatus manufactured by Oaks and Son circa 1833.<sup>616</sup>

A principal benefit of vacuum-pan technology was that more sugar crystals were produced from an equal quantity of syrup than with the copper-wall system. Copper-walls also left more residual molasses in sugar and which leaked from the barrels during transshipment. Vacuum-pan crystallization allowed for greater control of the granulation process and produced crystals that were larger, and more symmetrical and uniform.

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into Successful Operation in Demerara, by Messrs. Oaks and Son, London.” *Mechanics’ Magazine*, No. 540, XX (1833), 177-180. At this time the British Guiana Board of Commerce was about to offer some 10,000 *livres* to “French adventurers” for information on the process of “en vacuo crystallization” when Oaks, a coppersmith from Houndsditch, England, sent his machinery to the colony.

<sup>615</sup> “New Process in the Manufacture of Sugar”, *Imperial Magazine*, second series, II (September 1832), 435-36. See also **Miscellaneous inventions**, this chapter.

<sup>616</sup> *Mechanics’ Magazine*, No. 540, XX (1833), 177.

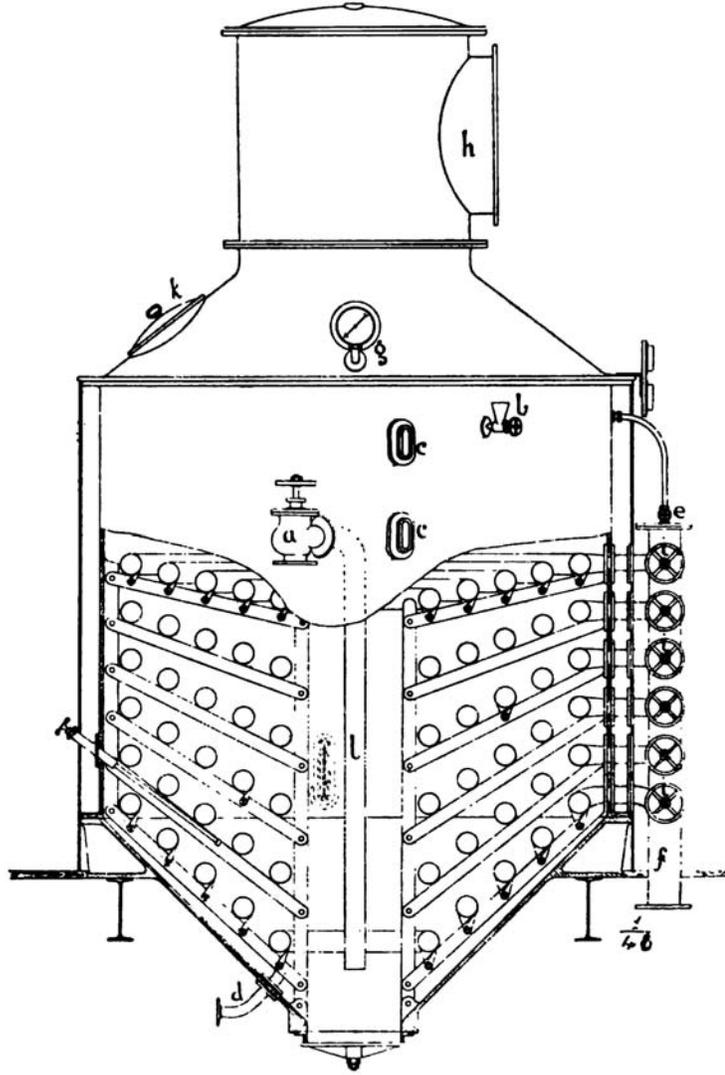


Figure 61: A vacuum-pan in the 1900s.<sup>617</sup>

Significantly, vacuum-pan sugar exports from British Guiana suffered an early, devastating trade setback. As the first consignment arrived at Bristol in 1833, the British Treasury classified it as refined sugar on which higher duties were payable.

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<sup>617</sup> Deerr, *Sugar and the Sugar Cane*, p. 222

Part of the shipment was returned to Guiana and the discriminatory charge remained in effect until 1846 when sugar tariffs were revised.<sup>618</sup>

Although vacuum-pans were installed in factories, few were actually used on account of the shortage of skilled ‘pan boilers’ during the early years.<sup>619</sup> Inexperience led to many mishaps throughout the 1830s and early 1840s.<sup>620</sup> Goedverwagting (East Coast Demerara) had a particularly challenging experience with its new pans and incurred substantial losses during its 1845/46 season.<sup>621</sup> Neighboring Enmore was saved from a similar fate because its copper-wall fixtures had not been discarded and also on account of the tenacity of its attorney, Porter, who “was quite determined he should not be beaten, and was not.”<sup>622</sup> Proprietor Clementson employed a pan boiler from Barbados and provided him with housing and \$1,000 dollars annually but his efforts were “most disastrous.”<sup>623</sup> Albion Estate in Berbice got its vacuum-pan in 1864 only after its manager had been in the colony for twenty-four years and had witnessed various trials and experiments.<sup>624</sup> Up to 1865 there were fewer vacuum-pan estates than those producing muscovado sugars.<sup>625</sup>

Vacuum-pans became more common as local operators mastered the techniques of improving clarification and defecation, notably after Chemist Shier’s research and experiments in the 1840s and 1850s increased awareness of how to

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<sup>618</sup> Deerr, Noel and Alexander Brooks, “Development of the Practice of Evaporation With Special Reference to the Sugar Industry”, *Transactions of the Newcomen Society*, XXII (1941/42), 19; Adamson, *Sugar Without Slaves*, p. 173.

<sup>619</sup> R. J. K., “Fifty Years of Sugar Planting in British Guiana”, *Louisiana Planter*, No. 22, IV (1890), 405. A pan-boiler tended the boiling of the syrup whether in the copper-wall or vacuum pan. His importance was reflected in his high wages, at \$1 per day, the highest offered on an estate in 1874.

<sup>620</sup> Rodney, *Guyanese Sugar Plantations in the Late Nineteenth Century*, p. 28.

<sup>621</sup> R. J. K., p. 405.

<sup>622</sup> Ibid.

<sup>623</sup> “Some Haphazard Notes of a Forty-Two Years’ Residence in British Guiana”, *Louisiana Planter*, No. 1, XXII (1899), 9.

<sup>624</sup> R. J. K., p. 405.

<sup>625</sup> Thorpe, “Changes on Sugar Estates...,” p. 208.

achieve a purer juice using chemicals and new equipment.<sup>626</sup> Usage grew as the pans were paired with high-pressure, steam-powered clarifiers imported from the 1850s, and with vacuum juice heaters from the 1860s.<sup>627</sup>

Combined use of new equipment enabled further fuel economy and rendered vacuum-pans more cost-effective.<sup>628</sup> By 1871, following the opening up of markets in the United States resulting from favorable tariff arrangements, seventy-five of 131 estates converted to vacuum-pan evaporation while fifty-six produced muscovado.<sup>629</sup> Vacuum-pan samples from four estates—Ogle, Hope, Enmore, and Friends—were displayed at the 1851 international exhibition in London, whereas the 1876 Philadelphia Exhibition showed sugar from eight estates.<sup>630</sup>

By the 1880s improved technology has eliminated much of the guesswork formerly associated with closed evaporation. Vacuum-pans came equipped with valves, gauges and pumps to control air pressure as well as juice intake and discharge apparatus. Judiciously-placed apertures allowed operators to see inside the evaporators and proof-sticks verified when syrup was ready for crystallization and discharge into the centrifugals.<sup>631</sup> The technology symbolized such an advance for the sugar industry that a distinction between ‘common-process’ plantations and ‘vacuum-pan’ estates was routinely made, the latter synonymous with modern, efficient operations.<sup>632</sup>

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<sup>626</sup> Chemist John Shier introduced the Litmus Test and Planter MacRae corroborates its use in Guiana factories by the 1850s. See MacRae, p. 36.

<sup>627</sup> MacRae, p. 36.

<sup>628</sup> Ibid.

<sup>629</sup> *Proceedings of the Royal Colonial Institute*, IV (1872-73), Appendix C, pp. 137-40.

<sup>630</sup> The estates were Great Diamond, Met-en-Meerzorg, Bel Air, Ogle, La Bonne Intention, Tuschen de Vrienden, Uitvlugt and Greenfield. The Royal Commission, *Official Descriptive and Illustrated Catalogue of the Works of Industry of All Nations Part IV Colonies. Foreign States* (London: Spicer Brothers, 1851), pp. 978-79.

<sup>631</sup> “The Vacuum Pan, and Hints on the Boiling of Syrup and Molasses in the Same, for the Manufacture of Yellow Crystals in Demerara. (From the “Demerara Argosy””, *Sugar Cane*, No. 140, XIII, pp. 143-151.

<sup>632</sup> *Parliamentary Papers*, XIII (1878-79), p. 153.

There were few noteworthy disadvantages to vacuum-pan and multiple effect evaporation especially applicable to Guiana. Until the 1880s, closed boiling made skimming the syrup impossible and territories known to produce impure juice—British Guiana included—would have been reluctant to use the apparatus as, irrespective of its benefits of economy and speed, impure juice gave poor quality sugar.<sup>633</sup> Attention to closed evaporation increased after research started by chemist Dr. John Shier in 1845 helped improve clarification and after the equipment was redesigned for ease of use and safety.<sup>634</sup> Moreover, vacuum technology was expensive and required an investment of between £40,000 and £50,000 for equipment purchase and installation in the 1870s.<sup>635</sup> A main deterrent was the increase in coal costs for steam boilers that powered the evaporators.<sup>636</sup> Further, the boilers required large quantities of fresh water that was often scarce during the dry season.<sup>637</sup> Coastal estates resorted to sea water from the Atlantic during droughts.<sup>638</sup> The manager of Plantation De Kinderen (West Coast Demerara) confirmed in 1870 that his boilers had been damaged and were “white with Salt”.<sup>639</sup>

The expense incurred with boiler use might have cancelled slight gains from closed evaporation although the adoption of economical ‘green megass’ furnaces from the 1880s finalized the shift from coal to megass. Nonetheless, even where vacuum-pans and evaporators increased sugar output, the problem of curing (drying) large

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<sup>633</sup> Scoffern, *The Manufacture of Sugar...*, pp. 90-91.

<sup>634</sup> See **Improving ‘Defecation’**, earlier this chapter.

<sup>635</sup> Beachey, *The British West Indies Sugar Industry in the Late Nineteenth Century*, p. 68.

<sup>636</sup> “Report from the Select Committee on Sugar Industries”, *Parliamentary Papers*, XIII (1878/79), p. 152.

<sup>637</sup> “Sugar King” Russell visited a Guadeloupe factory and saw the breakdowns caused by using sea water in the clarifiers. Guiana factories had already circumvented the fresh-water problem by replacing mechanical filtration (charcoal) methods with improved chemical filtration eliminating costly charcoal filters.

<sup>638</sup> Jenkins, *The Coolie: His Rights and Wrongs*, pp. 395-96.

<sup>639</sup> MS 677/115. (ICS)

quantities in the traditional hogsheads remained. The advantages of using improved technology were not fully realized until the development in the 1860s of centrifugal curing machines that hastened the drying process.<sup>640</sup>

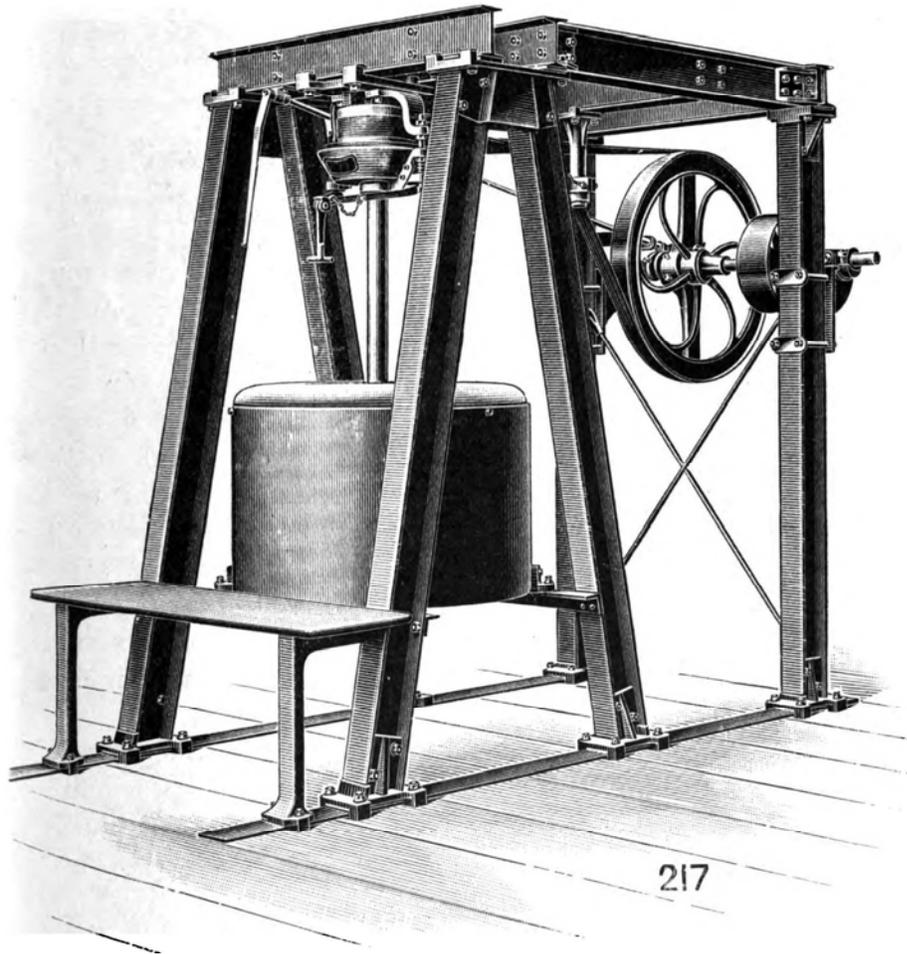


Figure 62: An early Weston sugar centrifugal.<sup>641</sup>

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<sup>640</sup> “Centenary of the Vacuum Pan”, *Louisiana Planter*, No. 19, L (1913), 294.

<sup>641</sup> A. F. Allen, *An Introduction to Chemical Engineering* (London: Sir Isaac Pitman & Sons, Ltd., 1920), p. 91.

## Sugar centrifugals

Vacuum-pan processing was enhanced by centrifugal technology. Prior to their use, sugar crystals were separated from its molasses by gravity drainage through a small opening in the bottom of hogsheads.<sup>642</sup> Molasses was also removed by air pumps attached to the drainage holes of the hogsheads.<sup>643</sup>

Centrifugals (or ‘centrifuges’) mechanically separated the crystals and molasses and produced a drier sugar. Among the earliest steam-driven sugar centrifugals in Guiana were those made by Manlove, Alliot and Company that remained popular until superseded from the by Weston models.<sup>644</sup> **(Figure 62)** A sample of centrifugal sugar made in a Finzel machine at Plantation Hope was exhibited at the Great Exhibition of London in 1851.<sup>645</sup>

By 1860 sugar centrifugals were familiar appliances in Demerara but allegedly “known only by name in Barbados”.<sup>646</sup> The New York Chamber of Commerce confirmed that the bulk of exports from Guiana in 1877, like Louisiana sugar, comprised ‘crystallized centrifugal sugar’ going directly to the consumer.<sup>647</sup>

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<sup>642</sup> A sugar centrifugal comprised a closed drum with a perforated ‘basket’ inside that could hold approximately 120 pounds of massecuite (half-formed sugar crystals and molasses discharged directly from the vacuum pans) The drum was attached to the lower end of a vertical drive shaft, its upper end attached to a power source. By spinning the drum at approximately 1,600 revolutions per minute (centrifugal speed), the massecuite separated into sugar crystals and residual molasses, the molasses removed by a pump applied to the machine’s underside. The new sugar was transferred to ‘crystallizers’, fitted with stirring arms in the form of pipes through which cold water was passed, which cooled and increased the size of the crystals. The molasses drained into a tank and was returned to the sugar-making sequence. (See J. F. Williams, “Factory Routine”, *Bookers Sugar*, pp. 52-53; Archibald Clow and Nan L. Clow, *The Chemical Revolution* (Philadelphia: Gordon and Breach Science Publishers, 1992), VIII, 529. Centrifugal technology was used in beet factories from 1843 following a British patent issued to Laurence Hardman. The technology was in general use in Europe by 1850. (Clow and Clow, p. 529)

<sup>643</sup> Adamson, *Sugar Without Slaves*, p. 172.

<sup>644</sup> Thorpe “Changes on Sugar Estates in British Guiana ...”, p. 210.

<sup>645</sup> *Official Descriptive and Illustrated Catalogue*, Great Exhibition of the Works and Industry of All Nations, II (1851), p. 979.

<sup>646</sup> Anthony Trollope, *The West Indies and the Spanish Main* (London: Chapman and Hall, fourth edition; 1860), p. 182.

<sup>647</sup> New York Chamber of Commerce, *Nineteenth Annual Report of the Chamber of Commerce of the State of New York 1876-77, 1878*, p. 15.

Conversely, sugar from other British Caribbean territories, with few exceptions, and from Dutch and Danish colonies was reprocessed in American refineries.<sup>648</sup> At the end of the 1890s only a few local plantations were manufacturing muscovado or ‘common process sugar’ using the open-pan system, a noteworthy change from the 1860s.<sup>649</sup>

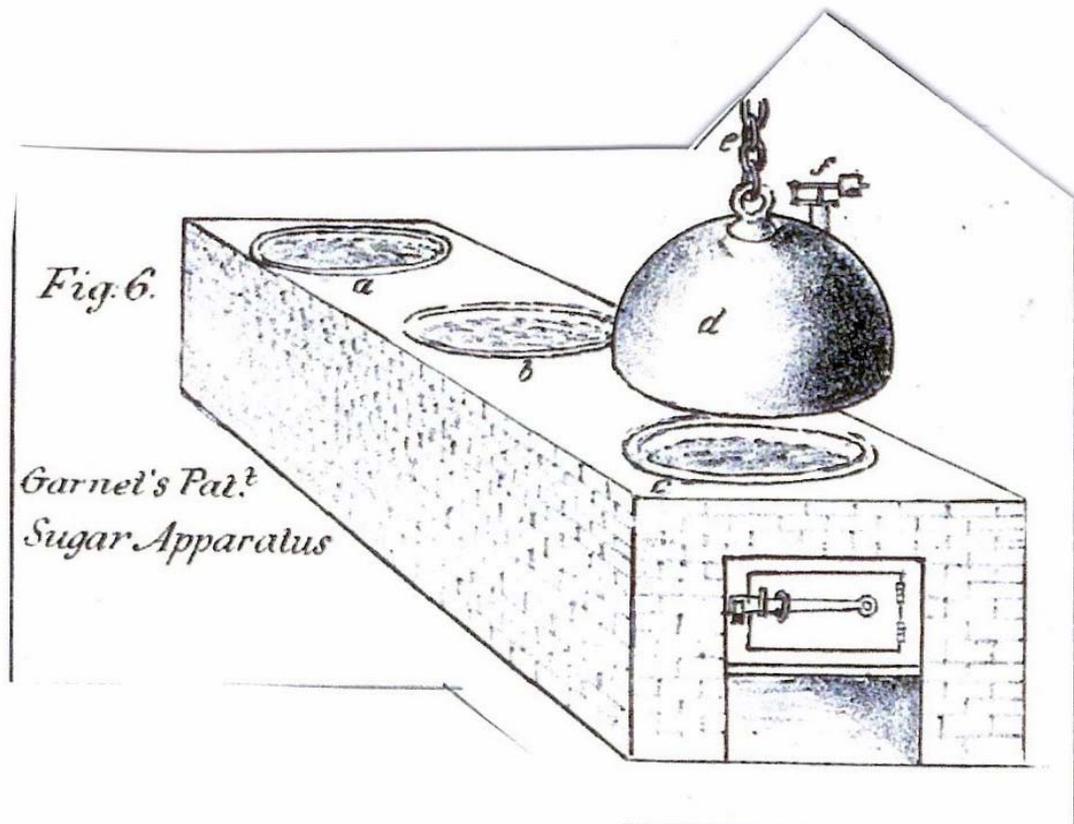


Figure 63: Garnett's hemispherical cast-iron "teache cover".<sup>650</sup>

### Miscellaneous inventions

A number of inventions were patented by persons native to or based in British Guiana. In July 1830, Abraham Garnett of Demerara proposed a “dome-shaped iron

<sup>648</sup> Ibid.

<sup>649</sup> Rodway, *Hand-book of British Guiana*, p. 32.

<sup>650</sup> L. Hebert, *Register of Arts, and Journal of Patent Inventions*, new series, (1831), V, Plate XX between pp. 292-93.

cover” for the smallest evaporating teache—the ‘strike pan’—in the copper-wall. **(Figure 63)** Historically, syrup was transferred manually from pan to pan by the enslaved armed with long ladles called ‘sugar dippers’. Garnett planned to suspend a hemispherical cover weighing 700 pounds over the pan by a winch which made raising and lowering the superheated lid easier.<sup>651</sup> The lid was fitted with a safety vent to allow steam to escape and Garnett projected that boiling syrup in his “partial vacuum” pan would shorten evaporation times saving fuel and labor. His patent—dated July 1830—coincided with Oaks and Sons’ vacuum-pan trials held in Essequibo that year.<sup>652</sup> Significantly, Garnett was the attorney in 1840 for Golden Fleece and Columbia, two plantations on the Essequibo Coast near to Richmond and Land of Plenty where Thomas Dodson first tested Oaks’ vacuum-pans.<sup>653</sup> Planters in British Guiana moved within a tightly knit social circle and news of the 1830 trials would have undoubtedly spread among them. Garnett might have based his system on the working principles of the equipment used during Dodson’s trials and following local custom by recycling materials available in the factories.<sup>654</sup>

Garnett’s patent preceded another labor-saving invention. Isaac Henry, co-inventor of the Demerara Plan (see **The ‘Demerara Plan’**, previously this chapter), indicated that he could supply the American market with a ‘sugar dipper’ which hastened transfer of the whole quantity of syrup through the copper-wall system,

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<sup>651</sup> Great Britain Patent Office, *Patents for Inventions. Abridgments of Specifications Relating to Sugar, 1663-1866* (London: Office of the Commissioners for Patents and Inventions, 1871), p. 45; *London Journal of Arts and Sciences*, second series, V (1830), 372. .

<sup>652</sup> “Garnett’s Manufacture of Sugar”, *Journal of the Franklin Institute*, new series, (1834), XIII, 193-94. See also Booth, “An Account of the Important and Successful Results...,” pp. 283-87. See also **Closed evaporation: ‘multiple effects’ and vacuum-pans**, earlier this chapter.

<sup>653</sup> Garnett was also Proprietor of Cuming’s Lodge estate in Demerara. *Parliamentary Papers*, XVI (1841), p. 136.

<sup>654</sup> A “home-made vacuum-pan” consisting of “two copper pans fastened together” was observed at Sparta (Essequibo Coast) during the 1830s. W. Alleyne Ireland, “British Guiana During the Victorian Era”, *Demerariana: Essays, Critical, Historical and Descriptive* (New York: Baldwin, 1897), p. 60. This may have been Garnett’s teache cover.

reducing crystallization times and allowing more sugar to be made.<sup>655</sup> Another improvement was Francis Hoard's "Circulating Sugar Boiler" patented in the United States in May 1837. Hoard's patent proposed adding a "metallic heating flue" passing through and under the evaporation pans.<sup>656</sup> **(Figure 64)**

Henry Moore, a Demerara resident, designed an "Improved Compensating Cane Mill, with Cane and Megas [sic] Carriers attached" circa 1851. Although Moore appears to have died before his invention could be patented, his improved mill, driven by a sixteen horse-power condensing steam engine, featured a self-regulating cane feed mechanism to prevent uneven roller wear and breakage.<sup>657</sup> **(Figure 65)**

As a counterpoint to the failures with mechanized ploughing Abraham Garnett also developed the 'tilling fork' circa 1855 which, though cumbersome at first, was subsequently improved and acknowledged as "highly valued by employer and laborer alike."<sup>658</sup> Planter, John B. Walsh Clementson of Clonbrook and Spring Hall estates designed double crushing apparatus driven "by an ingenious application of motive power entirely his own" and, although the details are unknown, Clementson's invention merited mention in the local *Argosy* newspaper.<sup>659</sup>

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<sup>655</sup> *De Bow's Commercial Review*, pp. 86-87. It is unclear if this was a new dipper, or Garnett's 1830 invention.

<sup>656</sup> Patentee Hoard came from Boston (USA) where he was involved in the maple sugar business. He relocated first to Demerara and then to Liverpool, England. *Journal of the Franklin Institute and Mechanics' Register*, new series, (1 April 1839), XXIII, 244. See also Howard Mangold, "Maple Syrup and Sugar in Randolph's Early Years", *The Randolph Legacy*, X (Spring/Summer 2006), 3; "Specification of the Patent granted to Francis Hoard, of Demerara, but now of Liverpool, Esquire, for Improvements in Making Sugar.—Sealed September 30, 1837. With an engraving", *Repertory of Patent Inventions*, new series, (June-December 1838), X, 93-96.

<sup>657</sup> Knapp et al., *Chemical Technology*, pp. 274-80.

<sup>658</sup> R. J. K., "Fifty Years of Sugar Planting in British Guiana", p. 405.

<sup>659</sup> Rodney, *Guyanese Sugar Plantations in the Late Nineteenth Century*, p. 67.

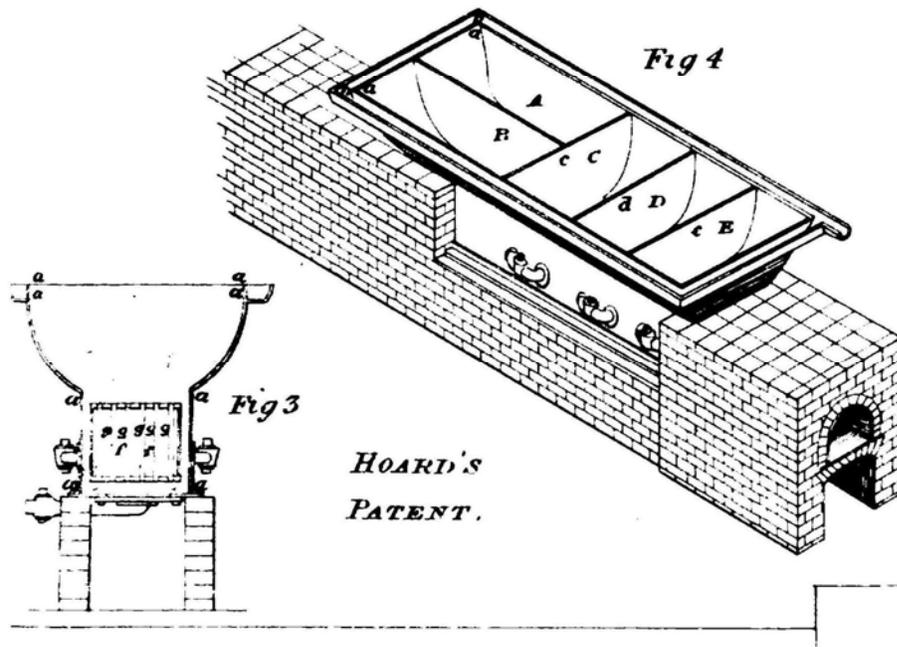
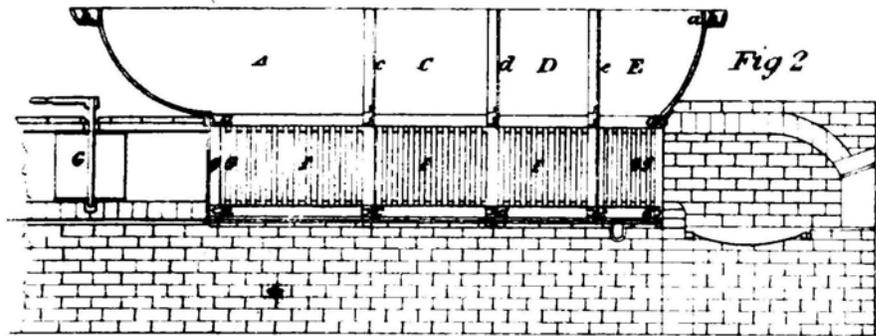
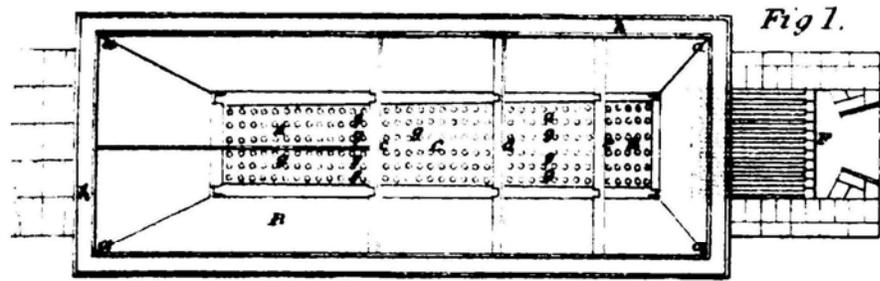


Figure 64: Francis Hoard's 'Circulating Sugar Boiler'.<sup>660</sup>

<sup>660</sup> *Repertory of Patent Inventions*, Plate VI. The illustration is copied from the 1837 patent drawing.

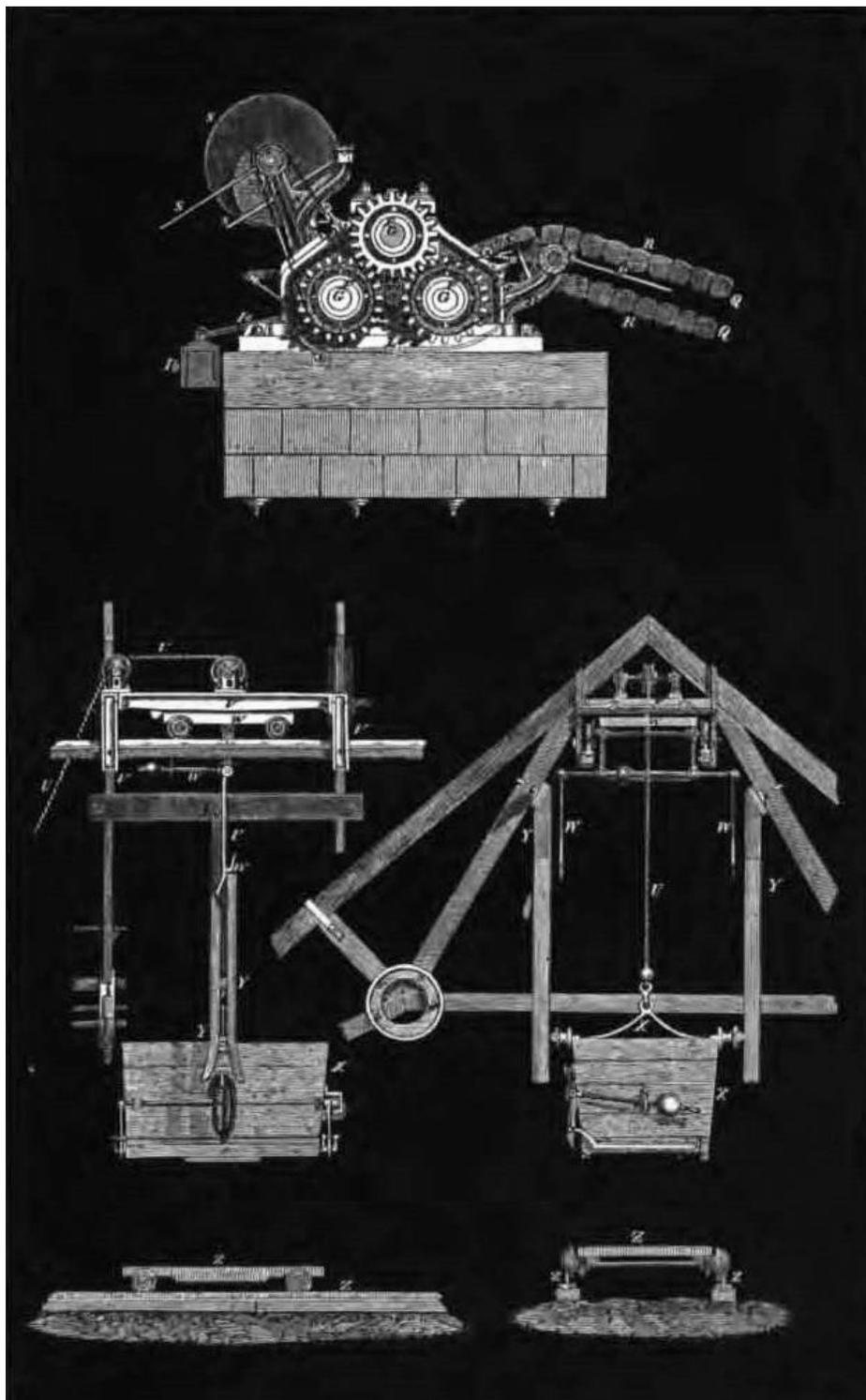


Figure 65: Henry Moore's cane mill and megass carrier.<sup>661</sup>

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<sup>661</sup> Knapp et al., *Chemical Technology*, p. 279.

## Confluences of beet and cane processing

Sugar extraction techniques may be applied to other sucrose-containing plants of which the most viable in the nineteenth century was the sugar beet (*beta vulgaris*)<sup>662</sup> Beet technology was viewed as the cornerstone for modernizing the cane-sugar industry and its techniques helped sustain the colonial cane sugar industry.<sup>663</sup> Several beet processing techniques were tried in British Guiana and some were adopted.

Historically cane processing—juice clarification, evaporation to syrup and crystallization—predates beet sugar-making but fundamental differences between the two require distinct extraction methods.<sup>664</sup> Beet cultivation lent itself readily to mechanized sowing and harvesting and producers switched easily from roller-mills to hydraulic pressing.<sup>665</sup> Extraction rates improved with the use of centrifugal separators in which slurries of sliced beets and water spun in perforated cylinders to isolate liquid

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<sup>662</sup> Beet sugar making was started by Margraff (also Marggraf) in Germany in 1745 and improved by the German chemist, Achard, in 1797. French chemists Drappier, Dombasic, Count Chaptal and others initiated commercial production. See “Beet Root Sugar”, *Journal of the Franklin Institute*, LXXVIII (July/December 1879), 120-21.

<sup>663</sup> John Perkins and Roger Munting, “Science versus Nature: The Cane-Beet Sugar Rivalry”, Pal Ahluwalia, Bill Ashcroft and Roger Knight (series eds.), *Horizons in Post-colonial Studies* (New York: Nova Science Publishers, Inc., 1999), pp. 161 and 168. The perception that beet sugar enjoyed greater scientific credibility relative to cane persisted to the twentieth century. [Eric Williams, *From Columbus To Castro: the History of The Caribbean, 1492-1969* (London: Andre Deutch, 1970), p. 380]. See also “XI. Botanical Stations in the West Indies”, *Kew Bulletin of Miscellaneous Information*, No. 6, (1887), 1. Regarding the transfer of beet techniques to cane Tomich wrote “The majority of planters lacked the means and often the inclination to apply scientific principles to colonial production and to adopt the methods developed in the beet sugar industry. Traditional routines remained, the norm, and the pace of change was slow. Dale Tomich, “Sugar Technology and Slave Labor in Martinique 1830-1848”, *New West Indian Guide/Nieuwe West-Indische Gids*, Nos. 1/2, LXIII (1989), 119.

<sup>664</sup> M. Achard, “New Method of extracting raw Sugar from the Beet-root”, *Philosophical Magazine*, XXIII (October-January 1805/6), 14-15. Chemically, cane juice was at first richer in sucrose than beets although genetic tinkering produced improved beets. Beet juice at first contained no more than 10 percent sucrose and less extraneous solids. In contrast, cane juice often comprised of between 15 to 18 percent sucrose and a greater quantity of fiber. See P. Horsin-Déon, “Comparison of the Progress of the Cane and the Beet Sugar Industries”, *Louisiana Planter*, No. 11, I (1888), 124. Cane also contained more glucose which hindered crystallization until more advanced processing techniques were invented in the twentieth century. Beet glucose, on the other hand, was negligible and the juice contained a lower percentage of solids than cane. Ferdinand Kohn, “On the Different Methods of Ex-Tracting Sugar from Beet-Root and Cane”, *Journal of the Society of Arts*, No. 956, XIX (1871), 338.

<sup>665</sup> Cane could be sliced, but not shredded like beets and, at the time, slicing left more sucrose in the waste. P. Horsin-Déon, “Horsin-Déon to Rillieux: Comparison of the Progress of the Cane and the Beet Sugar Industries”, *Louisiana Planter*, No. 11, XI (1888), 124.

sucrose from the solids.<sup>666</sup> In the 1880s scientists deduced that at least one half of the sucrose contained in cane juice remained in its megass, even at an optimum extraction rate of sixty to seventy percent. In comparison, the waste generated from beet was negligible and little sucrose was wasted.<sup>667</sup>

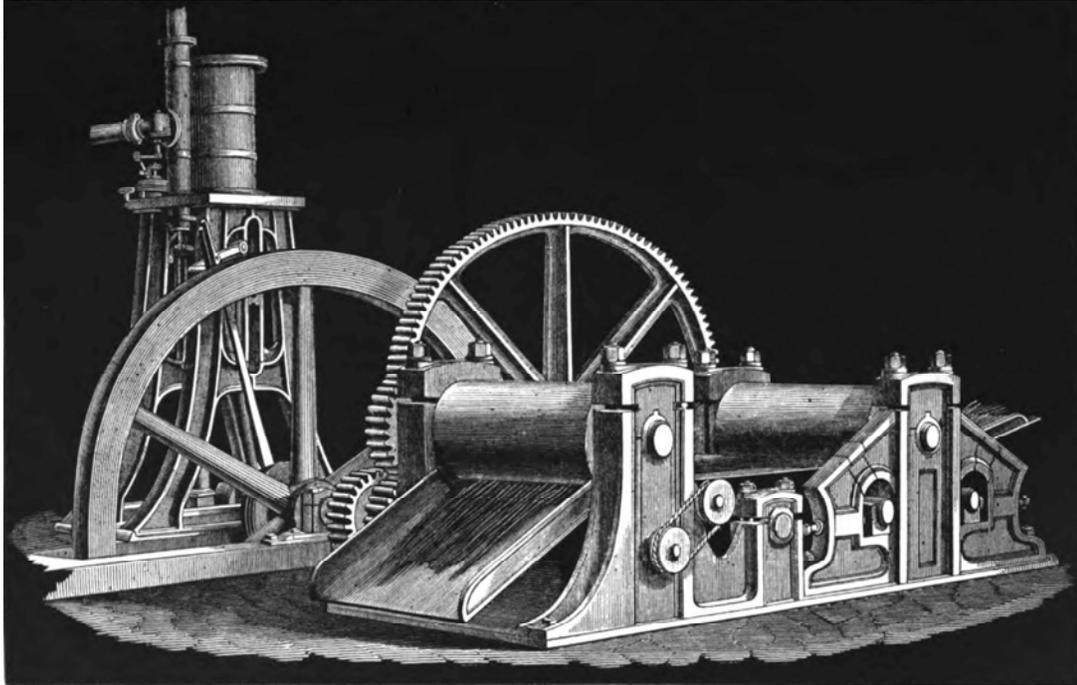


Figure 66: A cane press.<sup>668</sup>

Mechanical filter-presses, first used for beet, transferred to cane even before Henry Bessemer patented a specialized steam-driven prototype in 1849.<sup>669</sup> **(Figure 66)**

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<sup>666</sup> Kohn, p. 339.

<sup>667</sup> T. Mann Cage, “Mr. Cage on Mills and Diffusion Combined”, *Louisiana Planter*, No. 12, I (1888), 133; Horsin-Déon, “Comparison of the Progress of the Cane ...”, p. 124; Williams, *From Columbus to Castro*, p. 380. An ‘expert’ opined that the mental capacity of colonial producers to develop a scientific mandate for improving cane sugar production was compromised by a hot climate, easy living and government protection. (P. Horsin-Déon, “Horsin-Déon to Rillieux: ...”, p.124.

<sup>668</sup> Knapp et al., p. 265. Patent of Henry Bessemer.

<sup>669</sup> William Julius Evans, p. 98; Kohn, “On the Different Methods of Ex-Tracting Sugar”, p. 339.

Presses maximized the amount of sucrose extracted from the sediment that collected in the bottom of the defecation tanks.<sup>670</sup>

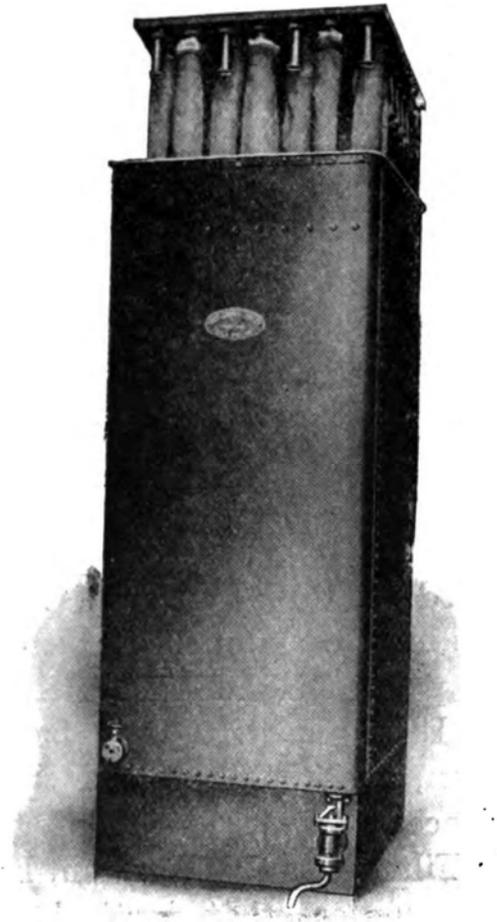


Figure 67: A bag filter press.<sup>671</sup>

There were two distinct applications of filter technology—‘scum filtration’ achieved by skimming and boiling residual syrup with lime to recover any remaining juice and isolate the solids, and ‘filtration *en masse*’—mechanically forcing scum

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<sup>670</sup> Deerr, *Sugar and the Sugar Cane*, pp. 165-66.

<sup>671</sup> A. F. Allen, *An Introduction to Chemical Engineering* (London: Sir Isaac Pitman & Sons, Ltd., 1920), 71.

through special bags or “stockings” fitted onto a perforated frame and injecting steam into it.<sup>672</sup> (**Figure 67**) ‘Filter cake’—the residue—was a valued field manure and cattle feed.<sup>673</sup> Filter presses were introduced into Guiana factories around 1875.<sup>674</sup> Bag filters were uncommon in the British Caribbean reportedly on account of the pliable rind of the Bourbon cane—the staple up to the end of the century—that clogged the internal compacters in the presses.<sup>675</sup>

The beet-inspired technique of ‘maceration’ (adding hot water to pulverized beets to hasten extraction) used steam more economically than either hydraulic presses or the centrifugal extractors which superseded them.<sup>676</sup> A further refinement, ‘diffusion’, eliminated pressing the beets.<sup>677</sup> Improved pressing, maceration and diffusion, in combination, helped the beet industry exchange its defecation tanks for filter press equipment and its crushing apparatus for diffusion tanks.<sup>678</sup>

The cane sugar industry also benefited from advances in analytical chemistry first applied to beet.<sup>679</sup> French physicist Jean Baptiste Francois Soleil’s invented a type of polariscope called a ‘saccharimeter’ in 1848 that calculated the amount of sucrose in juice by subjecting sugar syrup to polarized light and measuring the angle of its rotation against a predetermined scale.<sup>680</sup> The instrument made timing crystallization

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<sup>672</sup> Ibid.

<sup>673</sup> Francis Watts, p. 96.

<sup>674</sup> Thorpe, p. 211.

<sup>675</sup> Soames, p. 5.

<sup>676</sup> Ibid.

<sup>677</sup> Cane ‘diffusion’ is discussed earlier in this section, **Extraction technologies...**

<sup>678</sup> Horsin-Déon, “Comparison of the Progress of the Cane”, p. 124. These processes are discussed in detail later in this chapter. Although diffusion was first applied to cane on French-ruled Guadeloupe in 1843, the process languished until advanced by the Asaka Sugar Company of Madras India. (C.A. Matthey, “The Diffusion Process as Applied to the Sugar-Cane”, *Timehri*, IV (1885), 54. See also **Improved crushing methods and machinery**, earlier; and Kohn, p. 341.

<sup>679</sup> William Julius Evans, p. 22.

<sup>680</sup> Deerr, *Sugar and the Sugar Cane*, pp. 300-13; *Photographic News*, (24 June 1859), 187. Routine chemical tests and analyses determine specific gravity (density) of liquids, soluble solids, water content, sucrose, fiber, ash and acidity and alkalinity. Various instruments (hydrometers; refractometers; saccharimeters) and scales (°Brix, °Baumé [or Beaumé] and the International Sugar Scale) are used.

easier than with the string-proof method. Saccharimeters such as Duboscq's Soleil were being used in Guiana factories early in the 1880s.<sup>681</sup>

### **Guiana sugars and sugar products**

The international sugar lobby maintained its added-value monopoly via trade tariffs and duties that fixed the type, quality, price and quotas in order to keep prices low and continental European and North American refineries profitable. As a result, unrefined ('raw') sugar was in constant demand and colonial producers understood that markets were guaranteed as long as their exports could be classified as the lowest grades.<sup>682</sup> Continental refiners profited by buying raw—usually dark-colored sugar—and refining it as high quality, usually white, loaf and cube sugars sold directly to urban distributors from portside refineries.

Prior to the 1850s British Guiana sugars were among the lowest grades sold.

The staple muscovado comprised small, brown crystals made in copper-walls or larger

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Specifically for sucrose content and prior to polarimetric testing, the universal 'Dutch Standard' established the classification of sugars for tariff and duty purposes. The Standard was premised on light color as indicative of a sugar's purity and saccharine strength. Correspondingly, duties were levied on a sliding scale with the darkest sugars—below No. 7—attracting the lowest duties and the higher grades (equal than or greater than No. 20) paying the highest. The 'Dutch Standard' consisted of a case of bottles, numbered serially from 7 to 20, issued annually by sugar-brokers in Amsterdam and Rotterdam that maintained, as nearly as possible, an equal tint of color and degree for each number. The quality of a sample was determined by comparison with the Standard. In contrast, polarimetry was a science-based analysis that involved placing a sample of sugar dissolved in water, under neutral light, between two prisms of a specialized instrument—a 'saccharimeter'—that calculated the amount of sucrose in the solution based on the angle of displacement of its movable prism ('polarizer') on a graduated scale. Early saccharimeters were unreliable as accurate functioning relied on manual calibration of the instruments' lenses, preparation of the samples, neutrality of the light source—whether lamp light or daylight—the tester's eyesight, the purity of the water used to make the sample and the accuracy of related apparatus such as scales, weights and measuring flasks and tubes. Modern saccharimeters are fully automatic, use high wattage electric lamps and distilled water. (The details of polarimetric testing in the nineteenth century are described in George William Rolfe, *The Polariscopes in the Chemical Laboratory* (New York: The Macmillan Company, 1905); Harvey Wiley, "The True Meaning of the New Sugar Tariff", *The Forum*, XXIV (1897), 690; E.E.H. Francis, "Minute by Government Analytical Chemist", *Timehri*, new series, (1889), III, 294-96; Deerr, *Sugar House Notes and Tables*, pp. 145-53; Deerr, *Cane Sugar*, Chapter XXIV: The Polarimeter.

<sup>681</sup> "On the Purchase of Canes in Demerara", *Sugar Cane*, XIII January 1881), 38-41; G. H. Hawtayne, "Popular Science Lectures. Inaugural Lecture", *Timehri*, new series, (1888), II, 162-63.

<sup>682</sup> "Sugar had absolutely to be manufactured down to a certain quality of badness to pay". Soames, *A Treatise on the Manufacture of Sugar...*, p. 9. See also **The 'Dark Sugars' question**, this chapter.

grained ‘Refining Crystals’ produced with vacuum-pan technology.<sup>683</sup> Despite tailoring production to the demands of European refineries, a range of higher-quality sugars were displayed at international trade shows and exhibitions. In 1880 Leonora and La Bonne Intention estates exhibited “Best White” vacuum-pan sugar and a sample intended for European markets.<sup>684</sup> More than sixty samples were shown at the World Columbian Exposition in 1893. Two sugar companies, Booker Bros. and the New Colonial Company, as well as two private citizens and thirty-one plantations, exhibited a range of sugars and sugar-products. White, Yellow, ‘Refining Crystals’, First and Second Molasses sugars made with vacuum technology accompanied the ubiquitous muscovado as the industry confirmed that the techniques of refining were well-known and added-value capability was possible in the colony.

#### **‘Demeraras’, ‘Yellow Crystals’ and ‘Refining Crystals’**

Despite the restrictive trade conditions that enveloped colonial sugar trading, British Guiana produced high quality sugars for niche markets. Its ‘Demeraras’, especially, were world-famous.

‘Demerara Sugars’, or ‘Demeraras’, comprise a typology historically associated with Demerara in British Guiana.<sup>685</sup> Demeraras ranged from darker muscovados to light, yellow-brown crystals and, over time, these specialty cane sugars became a source of controversy in international circles.

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<sup>683</sup> See **Closed evaporation: ‘multiple effects’ and vacuum-pans**, earlier this chapter, for an exposé on Guiana’s problems with refined sugars.

<sup>684</sup> United States Centennial Commission, *International Exhibition 1876. Reports and Awards*, IV, *Groups III-VII* (Washington: Government Printing Office, 1880), p. 240 and *Official Catalog of the British Section*, Part 1, 1880, p. 311.

<sup>685</sup> See **Figures 4 and 5** and footnote 10.

An author explained their status:

The Demerara sugars have in consequence a world-wide name; they were the first West Indian sugar to be brought into the English market ready for consumption without further refining, and they have been taken as a standard by sugar-growers and refiners elsewhere.<sup>686</sup>

The term ‘Demerara Crystals’ apply to a popular brownish-yellow sugar first exported from Demerara in 1859. Aside from its color, this unrefined sugar was renowned for its sweetness, pleasing flavor and distinctive aroma.<sup>687</sup> Demerara Crystals derived its unique qualities from Bourbon cane that thrived in the specific microclimate of Demerara’s Atlantic region. Similar manufacturing processes reportedly gave very different results when tried in neighboring Essequibo and Berbice and, even within the coast, estates located on the banks of the Demerara River rather than on the Atlantic coast could not replicate the Crystals.<sup>688</sup> The characteristic color and large grain were achieved by careful defecation and clarification of Bourbon juice, using ‘lime-water’ as the temper and at a greater dilution than was customary ‘cream of lime’ (‘slaked lime’) The mixture used rain-water instead of water from estate canals and continuous testing fixed the exact amount needed to counter the natural acidity of the juice.<sup>689</sup>

‘Yellow Crystals’, in contrast, derive from a process introduced in 1871 by two planters from Louisiana, Colonels Stewart and True, who added sulphur to juice and sulphurous acid to massecuite as clarifying agents, the two substances combining to

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<sup>686</sup> Lucas, *Historical Geography of the British Colonies*, II, 288.

<sup>687</sup> J.B. Harrison, “The Field and Forest Resources of British Guiana”, *Journal of the Board of Agriculture of British Guiana*, No. 4, VIII (1915), 114. While there was no scientific basis for claims that cane sugar was sweeter than beet sugar or that white sugar was less sweet than brown, refiners, grocers and consumers advocated such distinctions to increase their profits. See Scoffern, pp. 99-100.

<sup>688</sup> Scard, “Demerara Sugar”, p. 409.

<sup>689</sup> Lock, Wigner and Harland, *Sugar Growing and Refining*, pp. 234-35

give a yellow ‘bloom’ to the sugar.<sup>690</sup> The problem with sulphurous acid was that its effects dissipated after a few months and the crystals lost their bright color. Moreover, a small amount of acid remaining in the molasses entered into the rum-distilling process and became a health hazard.<sup>691</sup>

From the 1880s, ‘tin crystals’ (chloride of tin or stannous chloride) replaced sulphurous acid as the color fixing agent and, following the installation of multiple-effect evaporators, phosphoric acid was added to imitate the “acidifying effect” of syrup achieved by boiling in open pans.<sup>692</sup> The color of the Yellow Crystals was further lightened by adding the acid in small quantities to the ‘massecuite’ (mixture of newly-formed crystals and molasses) after granulation had occurred but just before the crystals discharged into the centrifugals. The acid lightened the gray-green tinge of freshly-made sugar and gave it a pale straw hue instead.<sup>693</sup> ‘Dry-crushing’, which eliminated the dilutive effect of water-based extraction such as maceration, imbibition or diffusion, further lightened the color.<sup>694</sup> Following gradual replacement of the increasingly poor-yielding Bourbon cane with more robust varieties, Yellow Crystals replaced Demerara Crystals on the world market, although the new sugar was described as inferior to the old.<sup>695</sup>

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<sup>690</sup> Thorpe, p. 210; Scard, “Demerara Sugar”, pp. 408-09; *Report from the Select Committee on Sugar Industries*, p. 152. The process became known as ‘sulphitation’.

<sup>691</sup> “Dr. Urich, Trinidad, on Demerara Yellow Sugars”, *Sugar Cane*, XIV (1882), 21-22.

<sup>692</sup> Thorpe, p. 208. The first Yellow Crystals made in multiple effect evaporators date to 1883. Scard, “Demerara Sugar”, p. 408. Phosphoric acid is still an important clarification additive as is ‘milk of lime’ and carbon dioxide for making white sugars. See Deerr, *Cane Sugar*, 294; Chen and Chou, *Cane Sugar Handbook*, Chapter 2: Affination and Clarification, especially Phosphatation and Carbonation.

<sup>693</sup> Samuel P. Sadtler, *Industrial Organic Chemistry* (Philadelphia: J.B. Lippincott Company, fourth edition; 1912), p. 146.

<sup>694</sup> Heriot, pp. 41-42; Deerr, *Sugar and the Sugar Cane*, pp. 106-07.

<sup>695</sup> True had distributed the patent in Cuba in 1859. See “Sugar Making. The new process of Col. Stewart”, *Southern Cultivator*, XVII (1859), 204; Thorpe, p. 210. The method is also confirmed by Scard. \_\_\_\_\_, “Demerara Sugar”, *Louisiana Planter*, No. 2, LIII (1914), 408-09, **passim**; “Report from the Select Committee on Sugar Industries”, *Parliamentary Papers*, XIII (1878/79), p. 152.

Almost immediately there were claims that the Yellow Crystals process was an attempt to counterfeit Demerara Crystals using an artificial colorant. Local producers countered that the famed golden-yellow color was natural and asserted that ‘tin crystals’ merely helped retain the intrinsic color of juice arising from unique chlorophylls present in cane grown on Demerara soils.<sup>696</sup> In contrast, European Yellows were white beet crystals artificially colored with an industrial dye called ‘Golden Bloomer’, which was ‘Yellow Crystals’ made from beet reportedly lacked the pleasant aroma of Demerara sugar.

Opponents maintained that tin crystals artificially lightened the juice and opined that the desired color could be reproduced by boiling the syrup at high temperatures to a slight caramelization. In disputing the allegations, Chemist Frederic Scard was adamant that no artificial means were employed to produce the yellow color in Guiana. He maintained that raising boiling temperatures beyond that required for crystallization would cause the syrup to darken and burn. Boiling at high temperatures was therefore impossible if good Yellow Crystals were to be made.<sup>697</sup> Maintaining a

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<sup>696</sup> Heriot theorized that Demerara sugar owed its “fine yellow color” to the presence of “saccharetin, or its compounds” which, when exposed to air, oxidized to a bright red compound similar to that seen in the pith of diseased sugar-cane. It remained in the juice even after clarification and defecation. Heriot, *Manufacture of Sugar from the Cane and Beet*, p. 31.

<sup>697</sup> Scard elaborated that “The color of yellow sugar is due to the color of the juice. Every planter knows how the color of cane juice changes from green to yellow when it becomes acid. In the manufacture of yellow sugar the sulphured juice is under-tempered, so as to preserve the color as much as possible; in addition, phosphoric acid, if necessary, is added to the already acid juice to complete the change of green to yellow. The result is that the juice goes to the evaporator with a light canary yellow color, quite different to the yellowish brown produced by an excess of lime or camelization. Much of the acidity is lost by the volatile portions being driven off in the evaporator. The syrup still contains, however, salts of organic acids which absorb oxygen from the air and become dark colored. In the old days sulphuric acid [sic] was added in the vacuum-pan to decompose these salts and thus produced the same effect as if an acid state, the darkening that would result. It was found, however, that chloride of tin, which is a reducing agent, prevented this oxidization, and thus produced the same effect as if an acid were added. The sugar also kept better, from the lessened acidity of the massequite, and also probably from the actual fixing of the color by the tin. It can thus be seen that in no sense can bloomer-chloride of tin-be called a dye, and also how it came about that the color of the cane juice is utilized for the color of the sugar. It can also readily be seen that only juice of suitable original color and purity can be used for the manufacture which only the relatively high price of the sugar justifies.” Frederic I. Scard, “Genuine Demerara Crystals Versus Dyed Crystals”, *Louisiana Planter*, No. 3, LI (1913), 60.

precise acidity, however, kept the juice light and produced the yellow sugar favored by consumers. Scard testified that “A true Demerara sugar has a canary rather than an orange color. In fact the proper color has been described as “the down under a canary’s wing.”<sup>698</sup>

The problem with tin crystals advanced beyond its use as a color-fixing agent. The substance reportedly had no adverse effects if added to sugar while in the curing centrifugals but small amounts remained in residual molasses and passed to rum-making, a result condemned by those opposed to its use.<sup>699</sup> ‘Sugar King’ William Russell was perturbed by the indiscriminate use of tin crystals in Guiana. He observed the substance being used on a few estates in the 1880s and feared that misuse by untrained personnel could result in poisoning.<sup>700</sup> While Chemist Scard maintained that the substance was safe for sugar-making, Russell was adamant that his colleagues who used it were dishonest.<sup>701</sup>

Demerara sugars presented a formidable challenge to refined sugars on the world market as, although classed as unrefined, they were sufficiently light-colored with well-formed grains that rivaled the best white beet sugars.<sup>702</sup> English markets paid the highest prices for Demeraras even after duties were lowered and they became exempt from charges applicable to fine ‘table’ sugars.<sup>703</sup> Moreover, subsidies and

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<sup>698</sup> Scard, “Demerara Sugar”, *Louisiana Planter*, No. 24, LI (1914), 409.

<sup>699</sup> H. W. Wiley, “Notes on Analyses of Sugar, Molasses, Confections, and Honey”, *Journal of the Society of Chemical Industry*, No. 9, XI (1892), 761,

<sup>700</sup> MS677/345 (i) William Russell to Sanbach, Parker and Tinné, 5 July 1881. (ICS)

<sup>701</sup> *Ibid.* Tin Crystals (Stannous chloride) was introduced by Colonel True who had earlier pioneered the use of sulphurous gas defecation in Guiana factories. True called the chemical “Bloomer” and the first trials (unsatisfactory) were carried out at Hampton Court after which it was used successfully at estates owned by Bosanquet, Curtis and Company. The wealthy Quintin Hogg, a principal in the Company, later invested in the patent. “The Bloomer in Demerara”, *Sugar Cane*, No. 144, XIII (1881), 351-57. Russell was later sued for his claims against local sugar-makers.

<sup>702</sup> Scard, “Demerara Sugar”, p. 408.

<sup>703</sup> United States Department of Agriculture, *Bulletin 473*, 1920, p. 32.

bounties that made beet sugar cheaper did not mar the popularity of Demerara crystals or lessen its desirability among consumers.<sup>704</sup>

Shrewd Guianese producers were acutely aware of the value of the trade name 'Demerara' and promoted the brand as if applicable to all their sugars. G. H. Hawtayne commented in 1886:

The Sugars exported from British Guiana have justly a well known reputation, the term "Demerara Crystals" samples exhibited embrace all classes of sugars manufactured in the Colony, from the muscovado sugar, made by the old process of boiling in open kettles, and known to our ancestors as "brown" and "moist", in distinction from "lump" or "refine", to the clear white crystals polarizing at 99.50 per cent of pure sugar, obtained by boiling in vacuo, cane juice cleaned and clarified by the latest and most approved methods.<sup>705</sup>

Up to the 1920s Demeraras and Yellow Crystals were widely marketed in the United Kingdom, Canada and the United States.<sup>706</sup> The two commanded higher prices than white cane and beet sugars.<sup>707</sup>

Inevitably, non-Demeraras were dyed to resemble Demeraras and counterfeits deliberately misrepresented as the genuine article.<sup>708</sup> The imitations comprised white beet crystals colored with a thin coating of dyed molasses using an industrial dye called 'Golden Bloomer' which was a mixture of crimson and yellow aniline colorants.<sup>709</sup> Significant profits from the trade in counterfeits accrued and the makers craftily mounted a campaign to discredit genuine Demeraras claiming that the color

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<sup>704</sup> Tennant, *British Guiana and Its Resources*, pp. 3-4.

<sup>705</sup> G.H. Hawtayne, *Colonial and Indian Exhibition 1886. Special Catalogue of Exhibits in British Guiana Court with Introductory Notes* (London: William Clowers & Sons, Limited, 1886), p. 19.

<sup>706</sup> Bulletin 473, p. 32.

<sup>707</sup> Scard, "Demerara Sugars", *Louisiana Planter*, No. 2, LIII (1914), 20; and Scard, "Demerara Sugar", pp. 408-09.

<sup>708</sup> Demerara sugars cost as much as six-pence more per hundredweight than beet sugar in 1897. However, they were once so impure that "grocers' itch" resulted from mites infiltrating the cargo during shipping. ("An Interesting Sugar Prosecution." *The Chemical Trade Journal and Oil, Paint and Colour Review* (6 February 1897), 99.

<sup>709</sup> "The Case of Demerara Sugar", *Louisiana Planter*, No. 2, LII (1914), 28. See also Condé Williams, "The Future of Our Sugar Colonies", pp. 72 and 169.

was artificial and therefore did not merit any special protection. The counterfeits came primarily from factories in Silesia (Germany) that circulated so much fake sugar that British Caribbean estates were reported to be at risk for bankruptcy.<sup>710</sup>

Understandably, producers of Demeraras challenged the counterfeiters and disputes regarding authenticity reached English courts.<sup>711</sup> The evidence showed that although, scientifically, beet sugar was slightly lighter in color and sweeter than cane sugar, there was “a certain prejudice in favour of Demeraras” and that the imitation sugars were dyed “for no other purpose than to please the public”.<sup>712</sup> A few counterfeiters were prosecuted and the issue engaged the courts up to the early twentieth century.<sup>713</sup> Eventually however, the Demerara trade name was lost following the decision of the High Court of London in November 1913 to permit sugar made following the traditional method but outside Demerara to be sold as Demerara Sugar.<sup>714</sup>

Following the shift to the manufacture of Gray Refining Crystals for the United States market in the 1870s, some estates ended manufacture of the old staple to the point where the managers reportedly forgot how to make the best Yellow Crystals.<sup>715</sup> It appears that greater attention in the 1880s to increasing juice extraction resulted in more impurities—fiber and dirt—in the juice. Impure juice then required more thorough clarification and defecation and greater quantities of lime to keep its color light. The situation was made worse by labor shortages which forestalled

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<sup>710</sup> “Reciprocity with the West Indies”, *Louisiana Planter*, No. 20 XIX (1897), 315-316.

<sup>711</sup> “British Guiana. Professor Harrison on Demerara Crystals, &c.”, *International Sugar Journal*, No. 25, III (1901), 130-135, **passim**.

<sup>712</sup> “An Interesting Sugar Prosecution”, p. 113.

<sup>713</sup> *Ibid*, p. 131. Producers and vendors of genuine Demerara sugars recommended that counterfeiters be prosecuted under the British Merchandise Marks Act and by 1895 at least 2 convictions had occurred. The House of Commons heard extensive evidence on counterfeit Demeraras between 1895 and 1898.

<sup>714</sup> Barnes, *The Sugar Cane*, p. 11.

<sup>715</sup> E. C. L., “Demerara Yellow Crystals”, *Louisiana Planter*, No. 7, XIX (1897), 106.

weeding and moulding schedules required for optimal field yields and the overall quality of Guiana Yellows declined.<sup>716</sup> Although the name persists today, ‘Demerara sugar’ has come to imply a particular *process* by which sugar is made, rather than the actual *product*, an original and much-prized specialty sugar from British Guiana.

### **The ‘Dark Sugars’ question**

In the second half of the century a niche appeared on the United States market for a specific Demerara sugar. The favorable circumstances were, however, eventually curtailed by the protective might of the United States Treasury closing a loophole through which it believed it was losing significant trade revenue.

Colonial sugar producers profited from the demand created by production shortfalls during the United States Civil War. During the conflict, a favorable rate of duty had encouraged importation of raw brown sugars for refining.<sup>717</sup> American domestic output was then relatively small and imports comprised almost ninety percent of total demand.<sup>718</sup> British Guiana exported ever-increasing quantities of high-quality crystals to the United States but by the end of the War import duties were revised according to lightness of color calculated on a sliding scale known as the Dutch Standard.<sup>719</sup> The revision was supported by American refiners who lobbied against high quality ‘grocery’ sugars such as Yellow Crystals that paid low import duties but needed no further refining and went directly to consumers.<sup>720</sup>

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<sup>716</sup> B.R.B., “A Chat on Yellow Crystals”, *Sugar Cane*, No. 338, XXIX (1897), 493-95.

<sup>717</sup> During the war production in Louisiana fell to an all-time low. Colonial producers benefitted throughout the 5-year conflict from a low three cents duty on exports to the US but the situation changed as the war ended and local production resumed. The US, with its rapidly-increasing population and propensity for frost damage in its sugar fields, was an excellent outlet for colonial sugar. See Vogt, *The Sugar Refining Industry in the United States Its Development and Present Condition*, Chapters II and III, passim.

<sup>718</sup> Vogt, passim.

<sup>719</sup> See **Confluences of beet and cane processing**, earlier this chapter.

<sup>720</sup> “Demerara Sugars”, *Louisiana Planter*, No. 2, LIII (1914), 20; Rodney, *A History of the Guyanese Working People*, p. 27.

Even after the US Civil war ended, local earnings from exports to the United States continued to rise, more than doubling in value from approximately £697,000 in 1870 to almost £1,159,000 in 1871.<sup>721</sup> (Figure 68) However, an 1872 tariff adjustment increased duty on high-grades by twenty five percent and enterprising sugar-makers in Guiana adjusted their product to market demand.

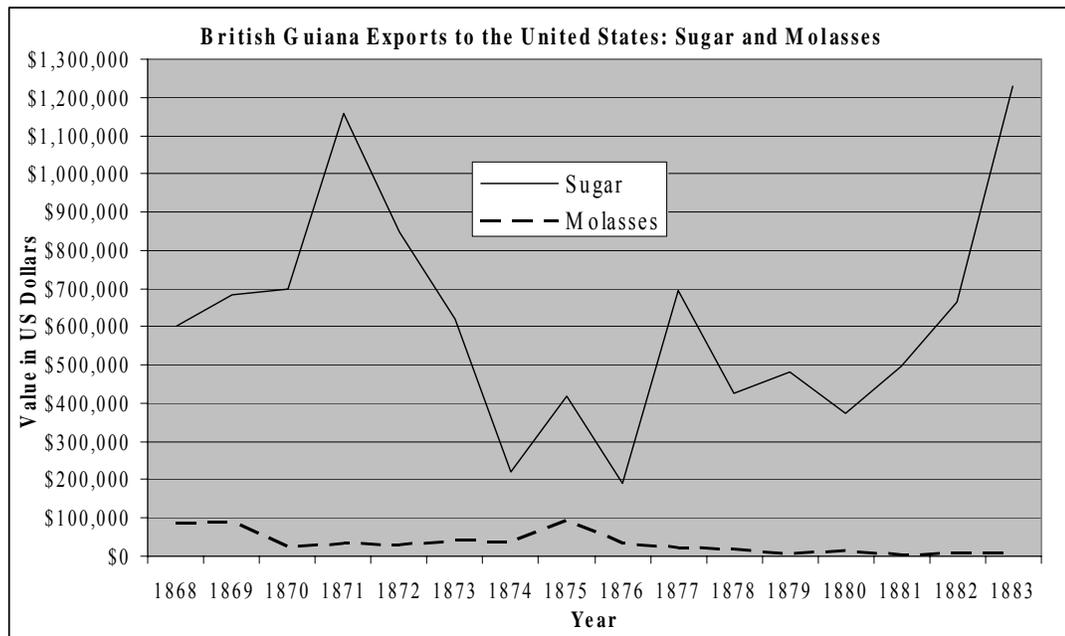


Figure 68: British Guiana exports to the United States, 1868 to 1883.<sup>722</sup>

Aiming for additional profits, local producers began producing a ‘special’ sugar for the United States market circa 1873.<sup>723</sup> The sugar, though more than ninety-eight percent sucrose, was a dark gray shade guaranteed to avoid high import duties

<sup>721</sup> Molasses exports decreased by approximately a third between 1869 and 1870 likely due to increased recovery of sugar crystals to satisfy demand.

<sup>722</sup> 1868-72 data derived from Annual Reports of British Guiana, *Parliamentary Papers*, 1874. 1873-1883 data taken from *Quarterly Report of the Chief United States Bureau of Statistics*, No. 1, 1883-84.

<sup>723</sup> Thorpe, p. 208. The Caribbean was not alone in its efforts to penetrate the US market. German beet-sugar manufacturers also altered the color of their sugars to suit the tariff requirements. See Charles F. Williams, *The Tariff Laws of the United States* (Boston: Soule & Bugbee, 1883), p. 51.

levied on all sugars over the No. 11 Dutch Standard imported into the United States.<sup>724</sup> Estates then making Yellow Crystals and standard muscovado rushed to turn out 'Gray Refining' crystals. The techniques that produced the new 'grays' and Yellow Crystals were similar save for a slight alteration to the clarification processes.<sup>725</sup> Essentially, the grays were ordinary, high-grade Yellows made without the careful defecation that produced the light colored sugar for which British Guiana was then famous. American refiners were, for a time, content to import and refine a sugar which, although nearly black in color, contained nearly 93.5 to 96 percent pure sucrose. Guianese producers were elated to realize a gain of 1.5 cents per pound on a deceptively discolored sugar and enjoy the reduction in freight that accrued from shipping it to the United States instead of Britain.<sup>726</sup>

The United States Treasury sent an investigating committee to the Caribbean in 1880 and, after observing the process at several local factories, concluded that the sugars were being artificially colored to evade the customs charges.<sup>727</sup> British Guiana exports to the United States were curtailed when American trade commissioners caught on to the gambit and replaced the Dutch Standard with science-based polarimetric tests that gave a more precise valuation of a sugar's sucrose content. Despite the setback, many estates continued to make and export the dark sugar as, despite the imposition of the discriminatory tariff, their profits were assured as more sugar could be made from an equal amount of juice used for Yellow Crystals with less residual syrup going to molasses and rum production.

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<sup>724</sup> "Demerara Sugars", p. 20.

<sup>725</sup> Rodney, *A History of the Guyanese Working People*, p. 27.

<sup>726</sup> Ibid.

<sup>727</sup> "Dark Sugar", *Sugar Cane*, No. 143, XIII (1881), 313-14.

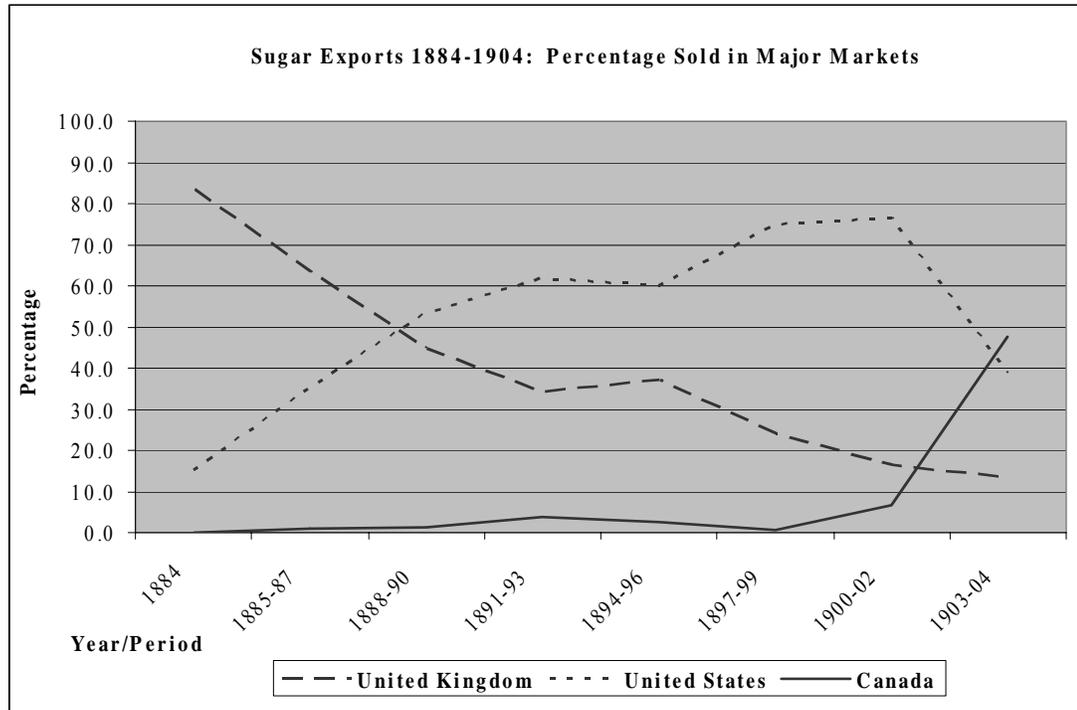


Figure 69: British Guiana sugar exports to major markets, 1884 to 1904.<sup>728</sup>

Table 3: United States sugar imports, 1885 to 1889.<sup>729</sup>

<b>United States Sugar Imports 1885 to 1889</b>					
<b>Receipts at the Atlantic Ports (in tons)</b>					
	1885	1886	1887	1888	1889
Demerara [British Guiana]	18,678	40,634	52,831	49,106	48,261
British West Indies					
Indies	71,229	63,855	106,841	108,404	98,953
Trinidad	38,852	36,051	44,971	27,215	31,598
Cuba	505,129	543,288	497,647	463,720	403,715
Domestic	6,226	1,391	8,977	1,931	1,009
Total Foreign	1,082,928	1,159,696	1,104,664	1,082,258	1,007,801

<sup>728</sup> Adamson, p. 228. See **APPENDIX 4**, this dissertation.

<sup>729</sup> *Louisiana Planter*, No. 9, IV (1890), 147.

By 1882 a restrictive tariff was imposed on all sugars categorized as ‘Demerara Crystals’ effectively reducing the value of the trade with the United States by approximately one-half of what it had been in 1871. **(Figure 68)** Guiana sugar exports to the United States recovered, however, in the fallout resulting from the lack of reciprocity treaties between that country and Cuba and Puerto Rico and following the McKinley Tariff of 1890 that abolished import duties on low grade sugars, raised duties on higher grades and imposed countervailing duties on European ‘bountied’ (subsidized) beet sugar. The Tariff lasted until 1894 and was, undoubtedly, a contributing factor to increased output in Guiana between 1890 and 1894. (See **Appendix 1**)

As American demand continued to grow, British Guiana sugars, with advantages of lower freight charges over beet crystals, dominated New York markets from 1898 until the revitalization of the industry in Cuba at the start of the twentieth century.<sup>730</sup> **(Figure 69)** Ironically, the preoccupation with making dark sugars had caused a decline in production of highly-desired Yellow Crystals, the decline then precipitated a rise in demand and price for Yellows, and Guiana eventually returned to its specialty.<sup>731</sup>

### **Other sugars: Refined Whites and ‘Clayed’ sugar**

Refined white sugars, although manufactured on a small scale in Guiana, had little commercial value for local producers.<sup>732</sup> An anomaly occurred in 1865 when

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<sup>730</sup> Ibid, pp. 228-29.

<sup>731</sup> *Westminster Review*, CXIV (April 1881), 260.

<sup>732</sup> E. F. Im Thurn, “The British Guiana Exhibition of 1882”, *Timehri*, (1882), I, 106. Deerr established that to “refine” sugar implied a product that is subjected to extensive processing that produces end-stage white beet and cane crystals—the equivalent of pure sucrose—and agreeing that “All beet-sugar factories are therefore refineries”. Deerr’s line of reasoning disqualifies the majority of colonial producers but not the original Demerara and Yellow Crystals, classified as ‘table sugars’ going to direct consumption. However, the dark-grey “refining crystals” sent to US refineries in the 1880s were undoubtedly raw crystals intended for refining. (See Deerr, *History of Sugar*, II, 449)

exports were primarily of first quality white sugar which fetched record prices on the British market.<sup>733</sup> Undoubtedly Guianese knew how to make white crystals and did so when markets were favorable. Plantation Leonora (West Coast Demerara) sent samples of “Best White Vacuum-pan Sugar” to the 1876 Centennial Exhibition in Philadelphia, and a fine white sugar made at Plantation Providence using the steam clarifier, triple effect and vacuum-pan was exhibited locally in 1882.<sup>734</sup> At the Colonial and Indian Exhibition of 1886 in London White Crystals were on show from De Willem, Tuschen de Vrienden, Uitvlugt, L’Union, Enterprise, Enmore, Hague, Peter’s Hall, Cane Grove, Met-en-Meerzog, Caledonia, Chateau Margot, Houston, Taymouth Manor and Marionville, among others.<sup>735</sup>

From time to time Guiana estates turned out small quantities of ‘clayed sugar’ made by drying the crystals in small individual conical moulds which filtered out impurities and gave white or transparent crystals.<sup>736</sup> Nonetheless, claying was reportedly unpopular in the British Caribbean owing to its labor-intensive, manual processes and significant reduction of sugar weight incurred during processing.<sup>737</sup> Guiana, in particular, had no need to produce a white crystal especially after the development of its valued Demerara Crystals from 1859.<sup>738</sup>

### **Molasses and molascuit**

The proportion of sugar made in relation to its by-products—rum, molasses and ‘second sugars’—depended on market value.<sup>739</sup> If rum prices were high, less

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<sup>733</sup> Thorpe, “Changes on Sugar Estates from 1865-1894”, p. 208.

<sup>734</sup> Im Thurn, “The British Guiana Exhibition of 1882”, p. 107.

<sup>735</sup> Hawtayne, *Special Catalogue of Exhibits in British Guiana Court with Introductory Notes*, p. 10.

<sup>736</sup> Veness, *El Dorado ...*, 121.

<sup>737</sup> *De Bow’s Review of the Southern and Western States*, X (April 1851), 386-87; Andrew Ure, *Dictionary of Arts, Manufactures, and Mines* (Boston: Little, Brown and Co., 1853), I, 768.

<sup>738</sup> See **Guiana sugars and sugar products**, previously this chapter.

<sup>739</sup> R. G. Duncan, “On the Manufacture of Rum”, *Three Essays on the Manufacture of Rum, Royal Gazette Sundry Pamphlets XII* (Georgetown: Royal Gazette, 1879), 15. (ICS)

sugar was made and vice versa.<sup>740</sup> Molasses, the thick, dark syrupy product left over from crystallization remains an invaluable by-product of sugar. It is the base for rum production, a liquid sweetener and cattle-feed ingredient. Rum and molasses were so important that it was common for estates to retain a chemist and engineer to oversee the production of both staples.<sup>741</sup>

First production of ‘molascuit’, an animal feed derived from sugar cane, is attributed to George Hughes, an English chemist and planter who received a patent in 1901.<sup>742</sup> His experiments were conducted at Rose Hall Estate in Berbice where he developed a recipe using fine-particled megass called ‘Cush Cush’—digestible cellulose—recovered from cane stalks after the juice had been extracted.<sup>743</sup> Hughes enriched the fragrant, brown, coarse powder with molasses and produced meal high in sucrose, glucose, minerals, carbohydrates and digestible fiber.<sup>744</sup> Molascuit evolved as high-grade cattle feed when combined with fats and oil.<sup>745</sup> Its distinct appeal for the sugar industry lay in its use of only the smallest megass particles, customarily discarded, to make the meal.<sup>746</sup> Production machinery for molascuit was rudimentary and consisted of a disintegrator to separate the outer rind of the megass from its inner cellulose fiber, a mixer to incorporate molasses with the megass meal and a finishing dryer, all fabricated in the United States.<sup>747</sup>

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<sup>740</sup> Ibid, p. 1.

<sup>741</sup> Rodway, *Hand-book of British Guiana*, p. 32.

<sup>742</sup> Algernon E. Aspinall, *The British West Indies* (London: Sir Isaac Pitman and Sons, 1912), p. 173. Hughes was a Consulting Chemist to the Agricultural Society of Barbados and also Director of “one of the largest estates in the British West Indies”. (*Journal of the Society of Arts*, LIII (1905), 212; and United States Department of Agriculture (USDA), *Nineteenth Annual Report of the Bureau of Animal Industry*, 1902, p. 481.

<sup>743</sup> *Journal of the Jamaican Agricultural Society*, IX (January/December 1905), 331.

<sup>744</sup> Ibid.

<sup>745</sup> Harrison, “The Field and Forest Resources of British Guiana”, p. 117.

<sup>746</sup> USDA, *Nineteenth Annual Report of the Bureau of Animal Industry*, p. 481.

<sup>747</sup> “Molascuit”, *Louisiana Planter*, No. 1, XXX (1903), 13.

Large quantities of molascuit from Guiana were sold in England in 1902.<sup>748</sup> Between 1903 and 1904 molascuit was so profitable that it drew molasses away from the rum-making sector.<sup>749</sup>

### **Rum distilling**

Rum is another staple of the sugar industry and cane alcohol was synonymous with sugar-making from the inception. Lucrative profits from rum kept plantations viable when sugar prices were low.

Rum is made by mixing leftovers from the defecation processes—the ‘skimmings’—with water, final molasses and a fermenting agent. The mixture is pumped into distilling vats, allowed to ferment and processed into rum. During the nineteenth century Guiana rums were the result of pure yeast fermentation and more mildly flavored than those produced following a more protracted fermentation process that allowed wild yeast and bacteria to flourish. Planters usually obtained 90 to 100 gallons of rum for each ton of sugar made.<sup>750</sup>

Rum-making was so popular and profitable that at the end of the nineteenth century almost every estate had its own ‘pot or ‘vat’ still. In 1914, there were twenty-seven ‘pot’ and nine vat-type distilleries and locally-made wooden ‘Coffey’ or continuous rectifying stills were common.<sup>751</sup>

### **Ethanol considered**

In response to a 1920 Colonial Office questionnaire on possible sources for the production of “power alcohol” in the British Caribbean, officials in Guiana offered that, although cane molasses could be had in adequate quantities for conversion to

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<sup>748</sup> “Privileged Sugar In Canada”, *Louisiana Planter*, No. 6, XLII (1909), 82.

<sup>749</sup> British Guiana, “Report of the Comptroller of Customs”, *Annual Administrative Reports, 1903-1904*, p. 17.

<sup>750</sup> Deerr, *Cane Sugar*, Chapter XXVIII: Fermentation with Special Reference to the Sugar House, pp. 564-88, especially 568.

<sup>751</sup> Harrison, “Field and Forest Resources...”, p. 117.

spirits, availability was conditional on the needs of the rum industry for which molasses was the primary input. Rum was already well-established as a highly profitable by-product of the sugar industry and its export earnings represented a lucrative segment of the overall takings.

Ethanol was then an emerging product of unsubstantiated commercial potential. Clearly the distillery interests would not have willingly traded guaranteed profits for speculative risks associated with ethanol. An official report concluded that molasses would be made available for ethanol production only after the needs of the rum industry were satisfied. Cassava starch was proposed as an alternative to sugar molasses.<sup>752</sup>

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<sup>752</sup> “British Guiana and the West Indies as Source of Power Alcohol”, *Journal of the Board of Agriculture of British Guiana*, No. 2, XIV (April 1921), 92-96.

## CHAPTER 5

### THE CHARGE OF “WANT OF GO-AHEADISM”: REFUTING CLAIMS OF APATHY AND IGNORANCE.<sup>753</sup>

Colonial Caribbean sugar-makers were routinely castigated for shunning scientific knowledge and being oblivious to modernization. The perception was that they had inherited mature agricultural and manufacturing technology from the Mediterranean and Brazil. Cane sugar-making also compared unfavorably with science-led beet processing and, where progress was observed, it was attributed to European innovation. Claims of an entrenched aversion to science-based methods endure to present day.

#### **The allegations against British Guiana**

Allegations of planter extravagance, wastefulness, vice and sloth were central to arguments for an end to slavery. Many decried conservatism as the bane of British Caribbean sugar producers, particularly absentee proprietors.<sup>754</sup> Progress was usually attributed to “English science”, “English machinery” and British “skill and enterprise.”<sup>755</sup>

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<sup>753</sup> Guianese industrialist Henry Davson included this phrase in his spirited response to the pessimism expressed by a critic in 1895. Condé Williams, “The Future of our Sugar-producing Colonies”, p. 78.

<sup>754</sup> Scoffern, *The Manufacture of Sugar...*, p. 119; “Prospects of the West Indies”, *Louisiana Planter*, No. 19, XXVIII (1902), 309. Absentee proprietors are condemned in Vincent A. Mahler, “Britain, the European Community, and the Developing Commonwealth: Dependence, Interdependence, and the Political Economy of Sugar”, *International Organization*, No. 3, XXXV (1981), 473; C.Y. Shephard, “The Sugar Industry of the British West Indies and British Guiana with Special Reference to Trinidad”, *Economic Geography*, No. 2, V (1929), 149; John Davy, “The West Indies before and since Emancipation”, *London Quarterly Review*, VIII (April-July 1855), 478-507, *passim*. The allegations were universally applied to the Anglophone Caribbean colonies. See *Three Essays on the Cultivation of the Sugar-Cane in Trinidad*, 19; Mayson M. Beeton, “The Wrecking of the West Indies”, *The Nineteenth Century*, LXII (July-December 1897), 157; A. Wyatt Tilby, *Britain in the Tropics 1527-1910* (Boston: Houghton Mifflin Company, 1916), IV, 23-24; “Prospects of the West Indies”, *ibid*.

<sup>755</sup> Isaac Hedges, *Sugar Canes and Their Products Culture and Manufacture* (St. Louis: self-published, 1881), viii and ix; Bryan Edwards, *History, Civil and Commercial, of the British Colonies in the West Indies* IV, p. 246. Ragatz viewed proposals to save fuel by “remodeling coppers” and the delayed introduction of the vacuum-pan as indicators of sloth on the part of West Indian planters. (Ragatz, *The Fall of the Planter Class*, p. 65) According to Tomich, traditional routines remained, the norm, and the pace of change was slow. Tomich, “Sugar Technology and Slave Labor in Martinique ...”, p. 119.

Scholars assert that more improvements took place within Caribbean sugar factories than in the fields during the nineteenth century.<sup>756</sup> Adamson, while acknowledging that cultivation methods were not on par with manufacturing, nevertheless maintained that it was impossible to distinguish between yield increases due to changes in cultivation and those due to manufacturing improvements.<sup>757</sup>

British Guiana was an early target of Robert Schomburgk, a German naturalist, who lamented in 1840 that “A spirit of apathy pervades the colonists with regards to the encouragement of scientific discoveries and enquires.”<sup>758</sup> John Davy, Inspector General of Army Hospitals in the British Caribbean from 1845 to 1848, praised land reclamation efforts but was disappointed at the “lack of skill” in cultivation.<sup>759</sup> Edward Jenkins, writing in 1871, saw a common “fear of expense and laziness”.<sup>760</sup>

Despite the condemnation, British Guiana had invested in sugar-making technologies and was making progress in factory and field. Its field-related initiatives commenced early and persisted throughout the century revolving around improving drainage and mechanizing tillage.

In 1829 the London-based Society for the Encouragement of Arts, Manufactures, and Commerce awarded a gold medal to Josias Booker of Demerara for “the most successful attempt to apply machinery worked by cattle, in aid of the labour of Slaves, in our American colonies”.<sup>761</sup> Booker and a team of enslaved men had

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<sup>756</sup> Shephard, “The Sugar Industry of the British West Indies . . .”, p. 153; Beachey, *The British West Indies Sugar Industry in the Late Nineteenth Century*, p. 87; Adamson, *Sugar Without Slaves*, p. 180.

<sup>757</sup> Adamson, *ibid.*

<sup>758</sup> Schomburgk, *A Description of British Guiana*, p. 75.

<sup>759</sup> Davy, *The West Indies, Before and Since Emancipation*, pp. 358-59.

<sup>760</sup> Jenkins, *The Coolie: His Rights and Wrongs*, pp. 38.

<sup>761</sup> Josias Booker, “On diminishing Human Labour in the Cultivation of Cotton, Sugar, &c”, *Gill’s Technological Repository; or, Discoveries and Improvements in the Useful Arts*, VI (1830), 213. The prize was offered “to induce the planters to make trial of agricultural and other simple machines adapted to their circumstances; and thus to convince themselves experimentally that of all the modes of performing agricultural operation, and bringing the rough produce into a market-able state, the labour of slaves is by far the most expensive and unprofitable” and to “mitigate the situation of the slave, by

succeeded in using an animal-drawn plough in 1820 at his plantation on the East Coast Demerara.<sup>762</sup> Aside from Booker's effort, societies for agricultural improvement were established in the 1830s and the public exhibition rooms of the chief group, the Royal Agricultural and Commercial Society, were "filled" with plans and models of new agricultural inventions by the 1840s.<sup>763</sup>

Agriculturalist Leonard Wray allowed that Demerara estates had achieved considerable progress by the late 1840s despite seemingly insurmountable problems of topography and climate. He saw "locomotive, draining machines powered by steam, wind and animals all employed in extrapolating cultivable land from the sea", as well as improved drainage, concluding that the sugar was of a "vastly improved quality".<sup>764</sup> Others also noticed canal excavators and steam ploughs on many estates and the local legislature appropriated money in 1842 to improve a steam-powered canal excavator.<sup>765</sup> William Reed, a sugar specialist, acknowledged in 1865 that Demerara plantations were making a superior product using "science and skill" to overcome adverse conditions of topography and soil.<sup>766</sup> By the end of the century local botanic research yielded new, higher-yielding cane varieties while manurial experiments proved the need for fertilizers and confirmed the value of the historical practice of flood-fallowing.<sup>767</sup>

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transferring the severest labour to cattle and machinery." (L. Herbert (ed.), *The Register of Arts, and Journal of Patent Inventions*, new series, (1830), IV, 271.

<sup>762</sup> See **Implemental and mechanical tillage, CHAPTER 3**, this dissertation.

<sup>763</sup> Premium, *Eight Years in British Guiana*, p. 180. See **Table 4** for summary of patents granted between 1800 and 1900 to inventors resident in or associated with Guiana.

<sup>764</sup> Wray, *The Practical Sugar Planter*, pp. 114-16.

<sup>765</sup> *Parliamentary Papers*, XXIX (1842), p. 153

<sup>766</sup> William Reed, *A History of Sugar Yielding Plants* (London: Longmans, Green and Company, 1866), p. 40.

<sup>767</sup> See **CHAPTER 3: FIELD TECHNOLOGY**, this dissertation.

Lowell Ragatz's claim that rampant conservatism prevented West Indian planters from adopting steam technology between 1768 and 1833 is unsubstantiated for British Guiana.<sup>768</sup> A steam-powered sugar engine was in operation at Demerara in 1801 and several plantations had begun to use steam technology by the 1820s.<sup>769</sup> Routine factory tasks were mechanized and cane-carriers, megass elevators, vacuum-pan and multiple-effect evaporators, centrifugals and other steam-driven machines were installed before the 1850s.<sup>770</sup> There was a "cutting machine for packing sugar" on an estate in Berbice and at this time, Albion Estate (Corentyne Coast) had installed a railway to move its cane to the factory.<sup>771</sup>

Nevertheless, up to the 1880s, the colony was lumped together with other British Caribbean territories supposedly following obsolete production practices.<sup>772</sup> In retrospect, local producers were neither conservative—given the complexity of steam technology and the risk attached to its use—nor ignorant of its potential. With respect to factory improvements, an 1881 observer confirmed that:

British Guiana, or Demerara, is probably the furthest advanced of cane-growing countries. Vacuum pans have been in use here for up-wards of thirty years, and are now the rule, not the exception. Demerara sugars have always ranked high in popular esteem, and a large proportion goes into direct consumption.<sup>773</sup>

By 1883 the Colonial Company's had installed "the very best machinery" made by Fletcher and Company and Mirrlees, Watson and Company at Hampton Court (Essequibo Coast) This estate had two vacuum-pans and a complete set of four pairs of Weston's centrifugals, "all appliances for making first-class yellow crystals",

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<sup>768</sup> Ragatz, *The Fall of the Planter Class in the British Caribbean*, p. 63.

<sup>769</sup> See **Steam technology and fuel economy, CHAPTER 4**, this dissertation.

<sup>770</sup> [Brumell], pp. 32-35; Premium, pp. 92-93; Mac Rae, pp. 36-43 and 52-53.

<sup>771</sup> *Parliamentary Papers*, XXIX (1842), p. 153.

<sup>772</sup> Beachey, "Sugar Technology in the British West Indies in the Late Nineteenth Century", pp. 170-71.

<sup>773</sup> Hedges, ix.

as well as steam and locomotive generators, and Marie furnaces.<sup>774</sup> Neighboring Anna Regina had double crushers and vacuum-pans complemented by well-ordered drainage and shipping infrastructure.<sup>775</sup> Amalgamated Reliance was also well drained and furnished with vacuum-pan technology and a system for direct shipping. Modern operations flourished on the West Coast of Demerara at Philadelphia, Vergenoegen, Tuschen de Vrienden, Zeelugt, De Kinderen, Met-en-meerzorg, Uitvlugt (merged with DeWillem and Zeeburg), and Stewartville.<sup>776</sup> During years of higher sugar prices wealthy estates allotted engines for each phase of processing. Improved multi-roller, cast iron mills of superior crushing capacity were in use in British Guiana from the 1850s.<sup>777</sup> Centrifugals, mills and clarifiers all had separate steam engines ably subsidized during periods of boom but costly to operate and uneconomical during price depressions.<sup>778</sup> The resident United States consul reported in 1884 that local agriculturalists and businessmen encouraged all patents to economize the making of sugar and desired neatness and style in their machinery.<sup>779</sup>

Corroboration of Guiana's technology drive also derives from numerous awards and recognition accorded local producers. The Irish Industrial Exhibition of 1853 compared Demerara sugars with Irish beet and judged them "by far the most advanced of the British Colonies".<sup>780</sup> At the United States Centennial Exhibition in

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<sup>774</sup> Rodney, *Guyanese Sugar Plantations in the late Nineteenth Century*, pp. 17-18.

<sup>775</sup> Ibid, pp. 18-19. By this time, Anna Regina was an amalgamated estate comprising La Belle Alliance, Richmond, Henrietta and Bush Lot. Reliance had merged with Mainstay, Land of Plenty and Three Friends.

<sup>776</sup> Rodney, *Guyanese Sugar Plantations...*, pp. 23-44, **passim**.

<sup>777</sup> The mills were also used in Trinidad, Suriname and French Guiana. Ure, *A Dictionary of Arts...*, I, 760; Beachey, "Sugar Technology in the British West Indies...", pp. 170-71. See **Improved crushing methods and machinery**, earlier this chapter.

<sup>778</sup> Bellairs, "Twenty Years' Improvements in Demerara Sugar Production. Part II", p. 6.

<sup>779</sup> United States Consular Reports, *Reports from the Consuls of the United States on the Commerce, Manufactures, Etc. of their Consular Districts*, No. 45, (September 1884), p. 684.

<sup>780</sup> John Sproule, (ed.), *The Irish Industrial Exhibition of 1853* (Dublin: James Mc Glashan, 1854), p. 144.

1876 several estates were lauded for vacuum-pan sugar of “excellent quality”. La Bonne Intention and Leonora Estates were praised for high quality, crystals produced by the maceration process.<sup>781</sup>

Improved chemical techniques were adopted by the 1840s based on the research by chemist John Shier and his team.<sup>782</sup> Planter Quintin Hogg installed French-made refining equipment on one of his estates in the late 1870s and hired a French chemist to tend it. Hogg testified that his experiments imitated beet-processing so successfully that exports to France were seized on suspicion of being beet sugar.<sup>783</sup> Hogg, who owned several estates in British Guiana and was a partner in the large, multinational Colonial Company, maintained such high standards in processing that fellow planter William Russell conceded that he was in awe of the magnitude of Hogg’s operations.<sup>784</sup>

Chemist Frederic Scard, employed by the New Colonial Company in 1884, conducted manurial experiments and Ziegesar, a German, came to Nonpareil in 1890 specifically to share his knowledge of diffusion extraction.<sup>785</sup> Tuschen de Vrienden established its chemical laboratory in 1883 and by 1893 many estates had resident engineers as well as chemists.<sup>786</sup>

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<sup>781</sup> United States Centennial Commission, *International Exhibition 1876. Reports and Awards, Vol. IV, Groups III-VII* (Washington: Government Printing Office, 1880), p. 240.

<sup>782</sup> See **Soil enhancement experiments, CHAPTER 3**, previously this dissertation.

<sup>783</sup> “Minutes of Evidence Taken before the Select Committee on Sugar Industries”, p. 202.

<sup>784</sup> MS 677/178 (ii) Letter dated July 1876, (ICS) Planter Seaforth Bellairs reported in 1892 that “I know a proprietor, but I am glad to say not of British Guiana, who thought that Litmus papers were some essays written by Mr. LITMUS on the subject of clarification”. Bellairs, “Twenty Years’ Improvements in Demerara Sugar Production Part II”, p. 14.

<sup>785</sup> [‘Argonaut’], “Demerara Letter”, *Louisiana Planter*, No. 15, IV (1890), 254.

<sup>785</sup> Rodway, *Hand-book of British Guiana*, p. 32. In addition to Government Analyst J. B. Harrison, scientists William Douglas, Agricultural and Technical Chemist at Plantation Diamond and Scard, who held a similar position with his company, attended the first West Indian conference on agriculture in Barbados in January 1899. (*West Indian Bulletin*, I (July-October 1899/1900), 9.

<sup>786</sup> Rodney, *Guyanese Sugar Plantations in the Late Nineteenth Century*, p. 32.

Planters economized by retaining chemists only during the grinding period. A roving chemist, J. E. Mestier, supervised the 1913 crops at Blairmont and Providence after which he went to Usine St. Madeline in Trinidad to oversee its 1914 season.<sup>787</sup> Ziegesar moved on to St. Lucia after his stint in Guiana.<sup>788</sup>

Select reviewers, especially those who understood the idiosyncrasies of the industry, prudently tempered their criticism with acknowledgment of the repressive colonial tariff system.<sup>789</sup> Notwithstanding the gradual elimination of preferences previously afforded the colonies by Britain, a flood of cheaper sugar from Cuba, Brazil and the Pacific islands constrained the market for British Caribbean sugar. British funding helped subsidize and regularize indentured immigration after the 1850s but a downside was that a relatively cheap and plentiful supply of labor hindered rather than helped mechanization.<sup>790</sup>

British Guiana, nevertheless, was such an obvious exception to the prevailing stigma of technological backwardness that Justice Condé Williams conceded in 1896 that he avoided classing it among colonies whose machinery was outdated.<sup>791</sup> Laymen, however, tended to ignore the restrictive milieu and were overwhelmingly unforgiving causing a sympathizer to seethe:

That the extinction of the sugar industry is due to imperfect and obsolete processes of manufacture is a charge often leveled in English newspapers against the West Indian planters. As a matter of fact, one finds exemplified in the West Indies almost every phase of development, from that of the tiny windmill-driven factory of a hundred acre estate in Barbados, content to produce its hundred tons of low grade Muscovado in the year, to that of the immense Demerara and Trinidad 'usines', equipped with the finest machinery that Science and Capital can furnish, handling their thousands of tons of cane, and

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<sup>787</sup> "Personal", *Louisiana Planter*, No. 11, LI (1913), 188.

<sup>788</sup> ['Argonaut'], "Demerara Letter", *ibid.*

<sup>789</sup> Scoffern, *The Manufacture of Sugar in the Colonies and at Home*, p. 119.

<sup>790</sup> William Russell was one of a few planters who believed that mechanized cultivation and irrigation was profitable. Adamson, *Sugar Without Slaves*, p. 183.

<sup>791</sup> Condé Williams, "The Future of Our Sugar Colonies", (1895/96), 86.

turning out their hundreds of tons of high grade crystals in the week. The conditions of manufacture are found to vary, as in every other industry under the sun, inversely with the natural advantages incidental to the industry in each locality.<sup>792</sup>

Not unexpectedly, Guiana's sugar-making operations were closely monitored abroad. Summaries of trials with diffusion techniques, for example, featured in the prestigious *Sugar Cane* and *Louisiana Planter* journals, the latter admonishing its readers in 1888 to carefully peruse the results of experiments in Demerara as they might learn from them.<sup>793</sup> Contemporary assessments perpetuate and refute claims of technological sloth on estates. Some gloss over local accomplishment opining that "Inhabited and productive [British Guiana] [was] an artificial man-made environment brought into existence by outside capital and outside [foreign] technical skills."<sup>794</sup> Guyanese economist Clive Thomas qualified his assessment:

[The] extensive use of land and capital was reflected in the low level of development and application of technology. Most tasks in the field were done by hand with the aid of the most rudimentary agricultural implements. Even factory technology developed elsewhere was only slowly exploited economically by the plantations in Guyana. To take one major example, the vacuum pan, which was invented in 1813, was not introduced into Guyana until 1833.<sup>795</sup>

The evidence renders Thomas' conclusion unfounded. His and Lowell Ragatz's fixation with the vacuum-pan fails to consider the mitigating effect of the colony's peculiar geography and the characteristic erratic diffusion of sugar technology.<sup>796</sup> On account of its historiographical conspicuousness, the alleged indifference to technology merits closer examination.

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<sup>792</sup> Beeton, "The Wrecking of the West Indies", p. 157.

<sup>793</sup> "Diffusion", *Louisiana Planter*, No. 26, I (1888), 310.

<sup>794</sup> Seecharan, *Sweetening Bitter Sugar*, p. 317.

<sup>795</sup> Clive Y. Thomas, *Plantations, Peasants, and the State A Study of the Mode of Sugar Production in Guiana* (Los Angeles and Jamaica: UCLA Publication Services Department, 1984), pp. 11-12.

<sup>796</sup> Ragatz, *The Fall of the Planter Class*, p. 65

This research establishes that local vacuum-pan experiments began in 1830.<sup>797</sup> The *Louisiana Planter* attributed its early adoption to the fact that, like Louisiana, British Guiana's molasses was of a relatively poor quality and with a high salt content drawn from the coastal clay soils. The *Planter* opined that Guiana's planters were "led to make all the sugar they could and that of high quality" and to ignore molasses as a viable by-product."<sup>798</sup>

Alan Adamson and Michael Wagner properly situate delayed vacuum-pan use within an economic framework that considers the high costs of specialized equipment and skill needed to successfully work the pans, as well as the prohibitive duties applied to high grades of sugar the pans produced.<sup>799</sup> Moreover, although Howard's patent dates to 1813, difficulties with adapting vacuum technology for sugar-making purposes constrained its application worldwide, even in the science-guided European beet sugar factories.<sup>800</sup>

France failed in its attempts to evaporate juice in vacuo during 1821 and 1822 for want of reliable steam power and had no functioning pans up to 1824.<sup>801</sup> German beet refineries first used the apparatus in 1835, five years after it was put into operation in British Guiana.<sup>802</sup> Years after patenting the technology was still "veiled in secrecy" and understood only by a few technicians, mostly Germans hired at

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<sup>797</sup> Vacuum-pan technology was introduced late in 1830 and not in 1832 or 1833. See **Closed evaporation: 'multiple effects' and vacuum-pans, CHAPTER 4**, this dissertation.

<sup>798</sup> "Demerara Sugar", *Louisiana Planter*, No. 2, LIII (1914), 20. The *Planter* added "So in the late fifties [1850s] and early sixties British Guiana and American Louisiana were practically paralleling each other in sugar manufacture. The [US] Civil War stopped production in Louisiana and Demerara sugars were in demand."

<sup>799</sup> Governor Barkly confirmed that if one rate of duty were charged on all sugars without prejudice against high quality, then vacuum-pan usage would have been more widespread. Adamson, *Sugar Without Slaves*, p. 173. See also Wagner, *Structural Pluralism ...*, pp. 49-50.

<sup>800</sup> Edward Howard patented the process in 1812 and the equipment in 1813 but it is unclear when both were first applied to sugar-making.

<sup>801</sup> John Geddes McIntosh, *Technology of Sugar* (London: Scott, Greenwood and Co., 1903), p. 180. McIntosh saw locomotive technology as instrumental in bringing portable steam engines into French beet factories.

<sup>802</sup> Deerr, *History of Sugar*, I, 561.

exorbitant salaries.<sup>803</sup> Guiana plantations Devonshire Castle and Supply had employed German sugar boilers by 1838, presumably for vacuum-pan tasks.<sup>804</sup> The Anglican Archdeacon of British Guiana hired a German sugar-boiler 1839, again presumably to attend to the vacuum-pans, but the man soon abandoned his job.<sup>805</sup>

Difficulties with transitioning to larger pans, managing high pressure steam boilers safely and learning how to effectively transfer latent heat from one pan to another (multiple effect evaporation) were factors that influenced adoption of the technology. Sugar centrifugals, which resolved the problem of curing increased quantities of crystals made in the vacuum-pan, were perfected in the 1840s, used commercially in Europe from 1850 and installed in Guiana early in the 1850s.<sup>806</sup> Previously, local producers waited several weeks for residual molasses to drain from sugar packed in barrels.

British Guiana, therefore, could not be faulted for failing to use vacuum-pans commercially before the 1830s and there is only a seventeen-year lapse between the issue of Howard's patent in England and its appearance on local sugar estates. Problems with adapting imported technology for local use was a daunting setback to the modernization thrust. An observer noted in 1832 that local planters had been so "injured, and not unfrequently [sic] ruined by following various specious plans which had been imposed upon them" that they had become extremely wary of any new initiatives.<sup>807</sup> The record reveals numerous instances of misrepresentation of technology and overt fraud perpetrated by con artists with bogus and imperfect machines.

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<sup>803</sup> Geddes McIntosh (1903), p. 361. Deerr maintains that the system was first employed in a Vienna refinery in 1818. \_\_\_\_\_, *History of Sugar*, II, 560.

<sup>804</sup> *Sessional Papers*, VII (1839), pp. 12-13

<sup>805</sup> *Parliamentary Papers*, XVI (1839), p. 59.

<sup>806</sup> Adamson, *Sugar Without Slaves*, p. 172.

<sup>807</sup> Booth, "An Account of the Important and Successful Results of Experimental Trials...", p. 283.

In 1846 expatriate engineer, Moody, after inducing the owner of Goedverwagting and Enmore to install vacuum-pans, left the estates to “work out its new plant as best it could” after using up almost all of its coal and megass in a costly and fruitless trial.<sup>808</sup> Guianese planters were also swindled by a firm purporting to have discovered a method of refining raw sugar in a single step using electricity.<sup>809</sup> Planters themselves contributed to failure by choosing cheaply-made, deficient machinery that malfunctioned at great cost to their operations.<sup>810</sup> Given the setbacks, the industry would have been justifiably wary about unknown inventors and their products especially when these were expensive and the technology untested.

A tangible impediment to uninhibited adoption of new technology was the environmental variation in the sugar-production zone. To those familiar with Guiana, each plantation or estate presented an entirely unique complement of topographical characteristics—soil fertility, access to fresh water and degree of severity of drainage problems—that, when added to its specific labor demands and financial condition, precluded a standardized production technique.<sup>811</sup> Planters would have been understandably hesitant to invest in new machines without adequate trial and only larger operations could offset the investment required. Estates with ready access to capital up to the 1850s tried a plethora of new ideas and equipment but were forced to discard many as unsuited to their purposes.<sup>812</sup> Especially after the second half of the nineteenth century, modern machinery was adopted only after extensive tests as occurred with crushing mills, diffusion equipment and fertilizers, for example.<sup>813</sup>

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<sup>808</sup> R. J. K, “Fifty Years of Sugar Planting in British Guiana”, p. 405.

<sup>809</sup> Lubbock, “Diffusion of Sugar Cane, Compared With Double Crushing in Mills”, p. 1.

<sup>810</sup> Rodney, *Guyanese Sugar Plantations...*, p. 29.

<sup>811</sup> Llewellyn Jones, “A Few Popular Facts about Diffusion”, *Timehri*, new series, (1894), VIII, 32.

<sup>812</sup> [Brumell], *Demerara After Fifteen Years of Freedom*, p. 32; Adamson, *Sugar Without Slaves*, especially pp. 173-77.

<sup>813</sup> See **CHAPTERS 3** and **4**, earlier.

Significantly, some critics did not visit the colony at all and were essentially unqualified to assess the local industry with certainty. Llewellyn Jones, engineer at Non Pariel in 1894, decried commentaries that showed ignorance of local conditions.<sup>814</sup> An earlier counter-thrust had come in 1854 from engineer and patentee Robert Purbrick who began his address to a meeting of the Society of Arts in London by establishing that the sugar-making was “not very generally understood in this county” [England]<sup>815</sup> Clearly, although science had been variously tried and technology laboriously tested, few measures could have overcome the plantation environment especially when higher costs were implicated and markets were uncertain and dependent on the vagaries of international trade.

### **Labor and technology in slavery and indentureship**

The incompatibility of enslaved labor and technological progress is a recurrent theme within the historiography of the plantation. Supposedly, enslavement hindered efficiency as a cheap and abundant captive workforce forestalled the use of labor-saving machines.<sup>816</sup> Following Ragatz’s lead, Moreno Fraginals and Shahabuddeen upheld that slavery was a hindrance to innovation in agriculture and processing in the colonial Caribbean sugar industry.<sup>817</sup> A few scholars have recast the allegations in conjunction with multiple, related socio-economic and political variables.

Rebuttals to claims that only Europeans carried out complex mechanical tasks were aired from the nineteenth century.<sup>818</sup> Some claimed that planters learned sugar-

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<sup>814</sup> Llewellyn Jones, p. 32.

<sup>815</sup> R. B. Purbrick, *Journal of the Society of Arts*, p. 279.

<sup>816</sup> Lowell Ragatz, *The Fall of the Planter Class...*, **passim**; Eric Williams, *Capitalism and Slavery* (London: Deutch, 1944; reprint 1981)

<sup>817</sup> Moreno Fraginals, *El Ingenio*; Shahabuddeen, *From Plantocracy to Nationalisation*, p. 29.

<sup>818</sup> “Sugar-Making in the West Indies”, p. 69. Antecedents of the slavery versus technical progress debate are revealed in an 1867 exposition of the operations of certain Jamaican estates where the “idleness of the negro” was purportedly prevalent. The accusations stemmed from the loss of power over the ex-slave by the planter who attempted to conceal his mismanagement and indebtedness by

making and rum-distilling from their captives.<sup>819</sup> Tomich found that there were many steam engines in the British and French colonies operated by Blacks who typically supervised the milling operations.<sup>820</sup>

Contemporary writing insists that many forms of work stoppage on plantations constituted overt and covert resistance to the brutality inherent to enslavement and indentureship. The grueling and relentless circumstances of plantation work in Guiana are well documented.<sup>821</sup> Captive Africans of every age planted ratoon, tended fields, moved the harvest to the factory and processed sugar, molasses and rum for the benefit of the plantocracy. The severity of the plantation routine killed a disproportionately large numbers of enslaved and indentured workers annually.<sup>822</sup> The tasks associated with empoldering the plantations, especially, were most arduous.<sup>823</sup>

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falsely claiming that his laborers were inept and unwilling to work. (“Jamaica”, *The Westminster Review*, American edition. LXXXVIII (July 1867), 89.

<sup>819</sup> “Jamaica”, p. 90. The commentary isolates another important factor. “The ignorance of the slave is an essential condition to the maintenance of slavery, and one well understood by slave-owning planters. The Jamaica slave-owners were compelled to partially educate, or at least give a training developing the intellect, to a few of their slaves, notwithstanding the danger incurred by this. These were the estates’ carpenters, coopers, masons, sugar-boilers, distillers, and others; while the numerous slave domestic servants could not fail to acquire some share of that intelligence from which the praedial [field] slaves were altogether excluded. The mass of the slaves, however, were kept in as degraded a condition of ignorance as possible.” (89)

<sup>820</sup> Tomich, “Sugar Technology and Slave Labor in Martinique 1830-1848”, p. 125.

<sup>821</sup> Thompson, *Colonialism and Underdevelopment in Guyana*, **passim**; \_\_\_\_\_, “Enslaved Children in Berbice, with Special Reference to the Government Slaves, 1803-31”, in Alvin O. Thompson (ed.), *In the Shadow of the Plantation* (Kingston: Ian Randle Publishers, 2002), pp. 164-95; Thomas, *Plantations, Peasants, and the State...*; Barry Higman, *Slave Populations of the British Caribbean, 1807-1834* (Jamaica: The Press, University of the West Indies, 1995), Chapters 5 to 10.

<sup>822</sup> The high death rate for the enslaved on plantations owned by John Gladstone, father of the British Prime Minister, is given in Richard B. Sheridan, “The Conditions of the Slaves on the Sugar Plantations of Sir John Gladstone in the Colony of Demerara, 1812-49”, *New West Indian Guide/Nieuwe West-Indische Gids*, Nos. 3 & 4, LXXVI (2002), 262-64. The struggles of indentured servants are described in Menezes, *The Portuguese of Guyana...*, and \_\_\_\_\_, *Scenes from the History of the Portuguese in Guyana...*; Ruhoman, *Centenary History of the East Indians in British Guiana*; Secharan, “Tiger in the Stars”...; Bisnauth, *The Settlement of Indians in Guyana...*; Sue-A-Quan, *Cane Reapers...*, and other works.

<sup>823</sup> Gert Oostindie and Alex van Stipriaan discuss the “hydraulic qualities” of Suriname’s slavery in “Slavery and Slave Cultures in a Hydraulic Society”, Stephen Palmié (ed.), *Slave Culture and the Cultures of Slavery* (Knoxville: University of Tennessee Press, 1995), 78-99. The authors acknowledge the strenuous demands of empoldering but admit there is no conclusive evidence that these made for harsher working conditions.

The enslaved and indentured workers protested the inhuman conditions by refusing to work, delaying work, feigning illness, sabotaging equipment, engaging in arson and absconding from field and factory.<sup>824</sup> Covert resistance, especially, is a useful filter that might be applied to claims of technological backwardness on the part of the enslaved in British Guiana.

Accounts by planters highlight their perception that the enslaved resisted the introduction of even the most basic farm implements. The use of cane-carriers to move megass to the drying sheds was reportedly “invariably defeated by the obstinated adherence of the Negroes” preferring to carry loads on their heads. Planter Premium opined that former slaves preferred the old way of carrying the enormous bundles, although he was certain that they could carry twice using wheelbarrows and other methods.<sup>825</sup> Premium’s explanation is undoubtedly simplistic and biased as the preferences of enslaved or newly-emancipated laborers could not have directly influenced the decisions to modernize. For the free laborer in the post-1840s plantation milieu thwarting attempts by the ruling class to alter traditional work modes might have constituted a form of passive resistance to the once-pervasive authority of the planter elite. By extension, emancipated workers might have viewed resistance as a means of consolidating their own dominance of the atrophied labor market by controlling how and when plantation work was accomplished. Moreover, if the worker was paid a daily wage, then he or she stood to profit from prolonging the tasks

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<sup>824</sup> Managers and overseers on plantations where indentured workers were stationed were known to brutalize immigrants in their employ. Absconding, for example, was punishable by tying the immigrant to a post and flogging him and rubbing his back with salt pickle. See “The Hill Coolies in British Guiana”, *Sessional Papers*, VII (1839), 1-130, passim. Labor disputes were viewed as harbingers of ruin for an estate. “Report of the Commissioner of Inquiry into the Treatment of Immigrants”, *Parliamentary Papers*, IV (1871), 133.

<sup>825</sup> Premium, pp. 93-94. Race and class prejudice was openly aired and widespread in the post-slavery period. Kirke saw “ill-educated and prejudiced, rough-mannered young men who had been nurtured in the evil days of slavery”. (Kirke, p. 29) but revealed his own bigoted sentiments in the book.

assigned. Clearly, there are hidden imports to the claims of refusal to modernize as far as this relates to those who survived enslavement and indentureship.

Notwithstanding the undercurrents, an early writer directly endorsed the work of the enslaved. Edward Bancroft, a medical doctor, declared in 1769:

Agriculture, and all other labour, in these colonies, is almost wholly performed by the Negroes ... as the White inhabitants undertake no laborious employment; and even the mechanics do little more than oversee and direct the Slaves, which [sic] are at least five times more numerous than the Whites ...<sup>826</sup>

His first-hand observations highlight the central role of the enslaved and confirm the profundity of their involvement with sugar-making. Planter Josias Booker praised a young man, Douglas, who competently operated an imported wheeled plough in 1820 and managed its cattle team and, with assistants, trained several counterparts from Berbice and Demerara and their cattle in the techniques of ploughing. The expert enslaved ploughmen reportedly received more than twenty-five shillings apiece for their mastery of the tasks of implemental tillage even before the end of slavery.<sup>827</sup> In 1855, John Davy countered charges of laziness made against Afro-Guianese and stated that he had witnessed their tenacious industry on their own farms and was convinced that they neither hated work nor were “naturally indolent”.<sup>828</sup> Whereas the post-Emancipation worker was willing to try new implements, a manager at one of Quintin Hogg’s estates threw a new vacuum-pan into a canal claiming that “it couldn’t make sugar”.<sup>829</sup>

The post-Emancipation workforce continued the trend begun during slavery and ably manned the factories. Free African-Guianese and indentured Chinese were

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<sup>826</sup> Bancroft, *An Essay on the Natural History of Guiana...*, p. 366.

<sup>827</sup> Booker also confirmed that he himself was unfamiliar with how to work an animal team. Booker, “On diminishing Human Labour ...,” pp. 211- 223, **passim**.

<sup>828</sup> Davy, “The West Indies before and since Emancipation”, *London Quarterly Review*, p. 496.

<sup>829</sup> Ethel Hogg, p. 321.

reportedly “good engineers”.<sup>830</sup> Black people also worked as superintendents, coopers, carpenters, sugar boilers, distillers, watchmen, boatmen and hospital nurses.<sup>831</sup> At Plantation Montrose (East Coast Demerara) circa 1871 Edward Jenkins observed a steam plough at work explaining that:

A clever Negro alternately held the stilts, or rode on one to balance the machine, occasionally, at an obstacle, getting a "cropper", which seemed to give him no trouble.<sup>832</sup>

Field-hands of all races continued to skillfully work ploughs in the 1890s. Alexander Crum-Ewing wrote to the *Louisiana Planter* that “No men at home could work the engines and implements, better than [his] estate’s people.”<sup>833</sup> In the factories Chinese and East Indian men prepared the juice, manned the clarifiers and coppers, worked the centrifugals and generally attended to the manufacturing of sugar, from start to finish.<sup>834</sup>

Aside from the plantocracy, a few African-Guianese established sugar processing operations, albeit on a small scale. By the 1880s, Pharaoh Chase and Mr. James of Golden Grove Village on the East Coast of Demerara had set up “village sugar factories”, as had William Parkinson at Rome on the East Bank of Demerara.<sup>835</sup> Madeiran migrants served primarily as cane-cutters on the estates and although specifics on their work in factories are not readily available, some detail is gleaned

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<sup>830</sup> Jenkins, p. 40; Premium, p. 138;

<sup>831</sup> [Brumell], p. 36.

<sup>832</sup> Jenkins, pp. 67-68.

<sup>833</sup> E. C. Luard, “Steam Husbandry...,” p. 97. Crum-Ewing was a Glasgow-born absentee whose family owned sugar estates in British Guiana, Jamaica and the Leeward Islands. (Bonham C. Richardson, *Igniting the Caribbean’s Past: Fire in British West Indian History* (North Carolina: The University of North Carolina Press, 2004), p. 174.

<sup>834</sup> Jenkins, p. 40.

<sup>835</sup> H. V. P. Bronkhurst, *The Colony of British Guyana and Its Labouring Population* (London: self-published, 1883), p. 103.

from general observations on the industry.<sup>836</sup> Planter Premium, for instance, declared them to be “capital” sugar boilers.<sup>837</sup>

Clearly, the enslaved as well as free laborers were adept practitioners of agricultural and industrial sugar technology. They were skilled in the use of various implements and techniques and possessed sufficient knowledge as to require only minimal supervision, a trend that persisted after Emancipation. Overwhelmingly, while the desire to modernize was omnipresent, solutions were less certain and dependent on factors such as state of the world’s markets, availability of labor, geography and financing. Historian James Rodway conceded in 1893 that although farming implements had been improved, manual labor still prevailed in the fields:

[T]he greater portion of the field work of the sugar estates is done by hand. The canes are planted by hand, weeded by hand, trashed by hand, cut by hand, and carried from the field into the punt for transportation to the factory by hand.<sup>838</sup>

Notwithstanding the difficulties, some changes were conspicuous and, as with agriculture in the United States, improvement occurred when economic incentives were at their peak.<sup>839</sup> Seaforth Bellairs was adamant in 1889 that:

Lest there be any doubt as to the meaning of the word ‘Improvements,’ I may as well assert at once that I mean it only from the dollar and cents point of view, and shall only regard that as an improvement which enables the producer to turn out a ton of sugar at less cost; or to put it in few words, anything is an improvement that pays, no regard being had to science or art, philanthropy or comfort.<sup>840</sup>

This incisive and uncompromising admonition to the readers of the *Timehri* journal by Planter Bellairs aptly contextualizes an ideological posture not uncommon

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<sup>836</sup> *Parliamentary Papers*, XXXIX (1851), p. 58.

<sup>837</sup> Premium, p. 236; “No. 1 Sugar Manufacture”, *De Bow’s Review*, p. 399.

<sup>838</sup> Rodway, *Handbook of British Guiana*, pp. 6-7.

<sup>839</sup> Rasmussen, “Technological Change in Western Sugar Beet Production”, p. 31.

<sup>840</sup> Bellairs, “Twenty Years’ Improvements in Demerara Sugar Production. Part I”, p. 328.

among his colleagues at the time.<sup>841</sup> Bellairs exemplified a discerning and pragmatic planter clique, aware of its inherent capabilities and failings and shrewd and unwavering in the commitment to capitalism.

Table 4: Guyana (British Guiana) patents related to sugar production.

<b>Guyana (British Guiana) patents related to sugar production, 1830-1888</b>			
<b>Year</b>	<b>Patentee</b>	<b>Patent</b>	<b>Details</b>
1830	Abraham Garnett	"Certain improvements in manufacturing sugar."	No. 5962; Patent granted 07/24/1830; specifications enrolled 01/24/31
1837/ 38	Francis Hoard	"Circulating Sugar Boiler."	English patent 09/30/1837; US patent granted 05/30/1838.
1839	Alexander MacRae	"Steam Plough."	No. 8329: Thomas Edington and Sons, Phoenix Ironworks, fabricators.
1845	Robert Barr Purbrick	"Purbrick and Yeates' Patent Sugar Pans."	No. 10,557; 03/13/1845. Isaac Henry of La Penitence contributed to the patent.
1846	John Tulloch Osborn	"System of Steam Ploughing."	No. 11,304
1851	Francis Hoard  Henry Moore	"Improvements in making sugar" "Improved Compensating Cane mill with Cane and Megass Carriers Attached."	Expired 9/30/1951  Date unknown; machinery fabricated by Pontifex and Wood (London), circa 1851
1855	Abraham Garnett	"Garnett's Tilling Apparatus."	Unknown.

<sup>841</sup> Beachey affirmed "a noticeable trend in most of the British West Indian colonies towards a purely commercial and speculative attitude in regard to sugar production" in the 19<sup>th</sup> century, distinct from the formerly "traditional sentimental attitude to old family estates" which had been dampened by the economic crises of the post-emancipation period. Beachey, *The British West Indies Sugar Industry in the Late Nineteenth Century*, p. 118.

Table 4 (Continued)

<b>Guyana (British Guiana) patents related to sugar production, 1830-1888</b>			
<b>Year</b>	<b>Patentee</b>	<b>Patent</b>	<b>Details</b>
1860	Donald Skekel	"Regulating the draught in the tubes of multi-tubular boilers."	No. 1374
	Donald Skekel	"Improved pistons for steam engine cylinders and buckets for pumps."	No. 1735
1869	Donald and Alexander Skekel, John Fletcher	"Improvements in feeding begass [sic] furnaces and in begass furnaces, and in apparatus applied thereto."	No. 476
1874	William Russell and G. Walters Risien	"Improvements in the method of and apparatus for extracting the juice and crystallisable matter from sugar cane, and after manipulation of the same." (Imbibition)	No. 4094
1874	G. Walters Risien	"An improved feed water heater and furnace covering for steam boilers, more particularly adapted for 'multitubulars' used on copper walls."	No. 1466
1877	John Rhodes Tilley	"Cultivator."	US patent, no. 190,796
1881	Donald Skekel	Water-powered "Hydraulic arrangement" for weighing Cane.	Unknown
1888	Donald Skekel	"An Improved Three Roller Mill."	US patent, no. 480522, 1892.

## SUMMARY AND CONCLUSIONS

This research examined the historical activities of the sugar industry in colonial Guyana (British Guiana), focusing on its agricultural and industrial trajectory within a global operating framework. Specific attention was accorded its labor systems, physical environment and insertion into the international economy of the nineteenth and early twentieth centuries. The aim was to identify significant milestones of achievement in field and factory, relate output to changes in sugar technology and use of technology and to investigate allegations of backwardness levied against the industry.

During the 130-year review period, sugar discarded its artisanal, small-business foundations and morphed into a science-guided industry financed by large, joint-stock companies. Abolition removed its dependence on enslavement and forced it to employ wage labor and mechanize. Following a post-slavery labor crisis and another caused by gradual loss of preferential access to British sugar markets, a third predicament appeared in the form of a formidable competitor, European beet sugar. Compounding the difficulties were the inescapable environmental limitations of the coastal zone, the primary location of the sugar industry in Guiana.

The rise of Demerara, Essequibo and Berbice as new sugar frontiers hinged on their transfer from Dutch to British rule in the early nineteenth century. An influx of migrants from the Caribbean—enslavers and enslaved—experienced in cane agriculture and sugar-making and with strong business connections to Britain, boosted the plantation-based economy that had existed since the seventeenth century. Peasant-type upriver farms started by Dutch immigrants in the seventeenth century were succeeded by vast factory-in-field operations relocated along the sea-coast bordering the Atlantic.

Demerara, the last of the three contiguous colonies opened up to cane cultivation, became the focal point for the sugar industry at the start of the nineteenth century. With its fertile soils and relatively undeveloped landmass, it took advantage of growing consumer markets for sugar in Europe and North America and, by the 1820s, cane monoculture was entrenched.

As the sugar industry grew, its labor supply dwindled. Plantation hands, relatively adequate during slavery, became scarce after Abolition and more so after the enslaved gained unconditional freedom following a period of quasi-slavery (Apprenticeship) that lasted from 1834 to 1838. Many ex-slaves deserted the plantations and the exodus decimated the worker pool and compelled the industry to seek alternative sources of labor. Local planters collaborated with the British government to import contract workers and subsidized 'Indentureship' schemes brought Madeiran Portuguese, Indians, Chinese, Caribbean ex-slaves and small groups of free Africans and Europeans to British Guiana beginning in 1834. By 1917, the official end of government-aided immigration, more than 300,000 immigrants had been pressed into service in the colony. The labor problems, though alleviated by indentureship, persisted and were compounded by expanding production in South Asian and Pacific sugar colonies, the Hispanic Caribbean and Brazil where slave-labor persisted until the 1880s.

From the 1840s, British Guiana confronted a persistent free trade lobby that urged an end to the protectionist policies that had guaranteed British markets for colonial sugar. Though the loss of preferences was eased by the imposition of a graduated scale of duties based on quality, subsequent amendments prompted price depressions that exasperated the malaise. As a direct consequence of the combined crises, joint stock companies replaced individual ownership and large amalgamated estates evolved in attempts to match the economies of scale achieved by competing

territories. The burdens of scarce labor, overseas competition and end of trade preferences were eclipsed by the problems with the land.

The expansion of agriculture had a profound and enduring impact on the pre-existing natural environment of the Guiana coast. The topographical peculiarities of the sub-sea level sugar belt—encompassing the most arable lands of the colony—presented an almost insurmountable challenge to cultivation. Commercial agriculture was possible only after considerable and costly intervention to install and maintain drainage and irrigation infrastructure.

Notwithstanding the geographic and economic impediments, sugar remained a lucrative export staple throughout the nineteenth century. After the initial depression of the 1830s and 1840s, mechanization was mooted as a way to sustain viability and a plethora of new machines and processing techniques helped expand production. By mid-century, British Guiana had embarked on a path of experiential and science-based practice that transformed agriculture and processing.

Agriculture strategies were among the first to be revised. The changeover from planting in holes to sowing in furrows and, finally, to cultivation on large, raised beds followed years of trial-and-error to adjust to dense, sticky alluvial clay soils and episodic severe droughts and floods. An indigenous technique—‘cambering’—satisfied the specific demands of agriculture in the sub sea-level environment. The manual nature of field tasks, a condition imposed by the peculiar geography of the coast, was an insurmountable deterrent to mechanized cultivation and harvesting.

Animal-drawn ploughs were tried from 1820 and Alexander MacRae and John Osborne of Demerara patented steam-driven ploughs adapted to local conditions. MacRae, in particular, was regarded internationally as the pioneer of “amphibious” steam ploughing. Despite many trials—and some isolated successes—traditional field

layout and dense soils constrained mechanized cultivation throughout the nineteenth century. Customary reliance on manual labor and the particular demands of cane harvesting appear to have been the chief obstacles to mechanization.

Agricultural improvements also encompassed laboratory and field research, prioritized from the 1880s after yields began to decline and various diseases and pests laid siege to the staple Bourbon cane. Researchers at government-subsidized experiment stations and private estates collaborated and George Jenman, John Harrison and Ernest Francis succeeded in breeding new seedling canes and ratoon varieties by selection and hybridization. Pest control campaigns employed innovative biological and chemical methods and estates helped test organic manures and new industrial fertilizers and soil additives.

In the factories, main objectives were to improve juice extraction rates and increase the amount and size of sugar crystals derived from syrup. While a few beet-processing techniques transferred adequately to cane, systematic adoption was forestalled by high costs of fossil fuels and equipment as well as inherent physiological differences between beet and cane. Notwithstanding the problems, the beet sugar industry had a marked impact on modernizing sugar-making in Guiana.

Certain aspects of in-factory processing attracted more attention and energy economy was a focus of the modernization thrust. Steam engines, introduced into Demerara in 1801 and a first for British sugar colonies anywhere, revolutionized all phases of sugar-making. Refinements of the technology over time allowed for more efficient use megass (bagasse) and costly fossil fuels and newer mills and milling techniques helped improve crushing rates and maximize juice extraction.

Evaporation tasks were standardized as new machines and devices patented by resident engineers and technicians underpinned the shift from traditional, open-pans to

fuel-efficient closed vessels. From the 1850s, changes revolved around mechanization, the installation of labor-saving devices and control instruments and the beginnings of automation that would become the defining feature of the industry in the twentieth century.

The first vacuum pans used anywhere in the colonial sugar-making world were successfully tested on two British Guiana plantations in 1830. The perception that the delay with adopting the technology substantiates the colony's technological backwardness is unfounded. Rather, vacuum pans and related technology were adopted where the scale of operations ensured profitable returns to offset high installation and operating costs and where there were adequate markets and sustained high prices for sugar. Abraham Garnett's mechanical 'teache cover', Robert Purbrick and Isaac Henry's redesigned evaporating pans and Francis Hoard's fuel-efficient circulating sugar boiler are included on a roster of noteworthy patents that emanated from the colony during the productive nineteenth century. Imbibition—a local adaptation of maceration—patented by William Russell and George Walters Risien of Demerara diffused worldwide and remains a key element of modern sugar-making. Their 1874 patent is outstanding among more than thirteen sugar-related inventions attributed to residents of British Guiana between 1830 and 1888.

British Guiana's discerning sugar fraternity devised innovative ways to market raw and high quality sugars as market demands changed and despite restrictive duties and tariffs. The celebrated Demerara and Yellow Crystals were implicit trademarks even before the concept of branding was popularized in the twentieth century. The infamous 'Dark Sugars' episode revealed a cadre of shrewd local entrepreneurs who, bolstered by well-honed industrial skills and knowledge of the sugar trade, were able

to take advantage of opportunities that arose from time to time in a prohibitive world market.

The merits of substituting machines for men featured prominently when labor was scarce but intervention, whether by indentured immigration or new machinery, depended on financing. Industrialists strove consciously and continually to maintain an economic advantage and the record reveals a consistent pattern of science-based improvements, even during economic downturns. Many planters, by their own accounts and from the evidence, favored using science-based methods to improve their profits. They viewed science and technology as a challenge to be met directly and their plantations, manned by competent enslaved and free persons steeped in the traditions of cane agriculture and sugar manufacture, were ideal ‘proving grounds’. Invariably, where there was adequate financing and business was profitable, new technology was introduced. A case in point is the increase in sugar machinery purchases from the United States between 1894 and 1902 that coincided with a surge in sugar exports from Guiana to that country.

The nexus of colonial labor and technology is an intrinsic focus of plantation-themed research and this study highlights important local facets. Significantly, the record of a trial of an implemental plough in 1820 and its proficient use by enslaved Guianese field workers as well as accounts of the activities of the free labor force in the post-Emancipation period provide valid counterpoints to allegations that the enslaved were technically inept and ignorant.

The overall record of achievement debunks claims that the British Guiana sugar fraternity lacked scientific and technological acumen or were slow to adopt modern methods. Technology, however, diffused erratically and British Guiana like its sister colonies, benefitted from exchanges among planter cliques at home and abroad.

In retrospect, comparisons between the industries in British Guiana and her Caribbean counterparts are unproductive, at best, and impractical given the disparities of geographic scale and scope of production and available resources.

British Guiana sugar enjoyed its most vibrant phase—qualitatively and quantitatively—during the ‘long’ nineteenth century from 1800 to the 1930s, a time-frame that coincides with many significant alterations to the physical environment that sustained production. Local producers tapped into a pool of experiential knowledge founded in centuries of sugar-making. Planters, the enslaved, free and indentured workers contributed ideas, new techniques and machines, some of which diffused worldwide. The period was, undoubtedly, its ‘Golden Age’ as, despite many crises, the industry evolved and maintained its status as a thriving, indigenous entity producing the chief export staple. The succinct irony contained in the *Louisiana Planter’s* 1909 summation is, undoubtedly, most fitting:

British Guiana is a very conservative colony and at the same time has really been a very progressive one, but possibly so for cause.<sup>842</sup>

Given the constraints, the profundity of interest in science and technology and the extent of experimentation in field and factory in Guiana were unmatched and exemplary in the nineteenth century British Caribbean.

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<sup>842</sup> “Cane Culture in British Guiana”, *Louisiana Planter*, pp. 162-63.

## APPENDIX 1

Chronological summary of major events affecting the British Guiana sugar industry, 1800 to 1920

Year	Yield (metric tons)	Technology	Highlights
1800	-		A single sugar plantation (Kitty) exists on the Demerara coast
1801	-	First steam-powered sugar mill used successfully in Demerara	239 cotton, 173 coffee and 78 sugar estates operating; 39 timber grants exist
1802	-		Treaty of Amiens ends hostilities between France and Britain; Guiana colonies return to Dutch rule
1803	-		Start of Napoleonic Wars (Britain and France at war until 1814); Britain retakes Demerara, Essequibo and Berbice from the Dutch
1804	1,433		
1805	-		
1806	-		French 'Continental System' prohibiting trade between Britain, her colonies and the European mainland begins in November
1807	-		Legislation prohibits trade in enslaved persons in British territories
1808	-		Official end to British trade in enslaved persons
1809	-		
1810	-		
1811	-		Plantation Perseverance advertised for sale
1812	-		Demerara and Essequibo colonies merged; Haarlem sold
1813	-		

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1814	12,410		End of Napoleonic Wars (May) and Continental System of trade exclusion; Treaty of Paris cedes Demerara, Essequibo and Berbice to Britain; Britain returns colonies captured after 1792 (French Guiana, Guadeloupe) to France but retains sugar-producing Tobago, St. Lucia and Mauritius
1815	16,786		Congress of Vienna (1814-15), trade in colonial sugar resumes to Europe. After 1815, London price for muscovado declines sharply owing to competition from South Asian colonies and Mauritius and from slave-grown sugar produced in Cuba, Brazil and Puerto Rico
1816	17,072		
1817	19,962		
1818	22,248		France abolishes slave trade
1819	25,964		Yellow Fever epidemic in Guiana colonies
1820	30,544	Animal-drawn plough tried successfully at Broom Hall, East Coast Demerara	Sugar becomes staple following decline in cotton and coffee; wartime high prices decline sharply; blight attacks plantain crop in Essequibo; significant mortality from Yellow Fever
1821	27,707		
1822	29,581		
1823	33,623		Cotton production begins to decline; Demerara Uprising begins, martial law is imposed and the enslaved are prohibited from moving among plantations
1824	34,576		Martial law lifted; world prices for cocoa fall ending exports from the Guiana colonies
1825	36,000		Inter-colonial trade in the enslaved prohibited

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1826	44,074		Severe drought in Guiana
1827	63,271	Flood-fallowing practiced	
1828	56,647		Destructive fire in the main urban center, Georgetown
1829	59,528		230 sugar factories existing; plantation mergers begin
1830	60,749	Abraham Garnett patents 'teache cover'; vacuum-pan trials begin at Land of Plenty and Richmond (Essequibo Coast)	British Caribbean sugar crisis begins and continues to 1832; beet cultivation expands in Europe
1831	58,990		Berbice, Demerara and Essequibo united as 'British Guiana'; world sugar prices extremely low; cotton cultivation resumes for a brief period
1832	55,844	Vacuum-pan processing on 6 estates in Guiana; sugar chemistry school started in Cuba	Lamaha Canal completed and brings fresh water to Georgetown; British Reform Bill ameliorates conditions of enslavement
1833	55,464	High quality vacuum-pan crystals first exported to Bristol, England. Attracts high import duties and part of the shipment is returned for sale in Guiana	Slave Emancipation Act passed and British Caribbean planters compensated for loss of slaves; Apprenticeship begins and Stipendiary Magistrates appointed to oversee the welfare of apprentices; wage levels rise; Society of Demerary and Berbice established to promote commerce
1834	47,912		Emancipation Act become legally binding; first Madeiran and free African indentured immigrants arrive
1835	58,501	Cane carriers and megass elevators introduced	More Madeirans and laborers from Barbados and St. Kitts arrive

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1836	49,785		Sugar from South Asian colonies and Mauritius achieves equal tariff status with British Caribbean sugar
1837	55,543	Francis Hoard patents “Circulating Sugar Boiler”	Serious Yellow Fever outbreak
1838	48,753		Emancipation (1 August) of enslaved as Apprenticeship ends; East Indians arrive; Metairie (sharecropping) starts; Yellow Fever rages
1839	34,220	Cane yield low; Alexander MacRae patents his steam plough	Yellow Fever epidemic ends; village movement begins with ex-slaves purchasing Plantation Northbrook in November; Sunday markets prohibited
1840	36,191	First attempt at mechanical drainage ends in failure; Norbert Rillieux patents multiple-effect evaporation in the US	Rise in sugar prices; 3,000+ Barbadian immigrants arrive; ex-slaves intensify land purchases; unsuccessful Metairie schemes end; European beet industry improves under favorable tax policies
1841	30,405	Demerara planter shares ideas on agriculture and manufacturing in Jamaica	Sugar prices high worldwide
1842	32,193	Mechanized cane carriers and megass elevators in general use	First 6-week labor strike in follows attempts to reduce wages; US begins to tax molasses by weight rather than volume
1843	32,789	Mechanical drainage (scoop-wheel) successfully installed at Plantation Turkeyen; local Astrological & Meteorological Society formed	Indentured immigrants from Sierra Leone arrive
1844	34,673		Move to equalize sugar duties begins; Royal Agricultural & Commercial Society (RACS) of British Guiana formed

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1845	35,238	Dr John Shier, Colonial Agricultural Chemist, arrives from England and begins research to improve sugar production; manure trials begin as field yield declines; Purbrick and Yeates' Patent Sugar Pans produce lighter colored sugar using less fuel	Severe, prolonged drought (July 1845 to August 1846) cause irrigation/navigation waterways to dry up; entire cane crop is damaged
1846	23,303	Shier directs trial with subsoil drainage at La Penitence but initiative fails; John Osborne patents locomotive steam plough	Drought continues; Sugar Duties Act equalizes duties on all colonial sugar imported into Britain; two classes of unrefined sugar adopted - "equal to white clayed" and "not equal to white clayed" favors exports of vacuum-pan crystals; 308 plantations abandoned between 1838-46; central factory idea discussed but not adopted
1847	41,970	Coastal railway extended from Bel Air to Plaisance and used to bring sugar to port in Georgetown	World sugar prices plummet; workers strike in Guiana; plantation owners mandated to provide medical care and hospitals for immigrants
1848	47,535		12-week sugar strike; suspicious logie fires; anti-Portuguese riots in Guiana; French abolish slavery
1849	30,148	Dr. Shier and Wilton Turner declare sub-acetate of lead in sugar poisonous after experiments at Plantation Hope	180 sugar factories operating

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1850	33,217	First centrifugal pump installed; Litmus Test introduced in factories; high-pressure steam clarifiers imported during this decade; organic fertilizers tried	Minor Yellow Fever outbreak; 230 separate estates existing; work to extend railway to Belfield (East Coast Demerara) draws plantation labor and many plantations sold at execution; ordinance against willful trespass passed to contain petty larceny and restrict fishing and hunting on abandoned frontlands; beet sugar quality improves after 1850 and competes with cane sugar on world markets
1851	38,259	Francis Hoard patents improvements in sugar making; Henry Moore designs improved cane mill with megass carriers attached	British Guiana parliamentary loan of £250,000 funds immigration; rice grown at Klein-Pouderoyen (West Bank Demerara)
1852	49,519	Economizing 'double batteries' (boilers) in widespread use	Severe drought; 'excessive' deaths of Portuguese at La Penitence and Houston; Boards of Health to manage village development established but laws prohibit joint land purchases by ex-slaves
1853	39,425		180 separate estates; Chinese indentures arrive; McInroy, Sandbach and Co. dissolved & Sandbach and Tinné formed
1854	49,412		Differential duties on colonial sugar equalized and only grade-based scale remains; slave-grown sugar still competing with sugar produced with free labor; Crimean War Begins
1855	49,224	'Garnett's Tilling Apparatus' patented	Serious flooding on East Coast Demerara devastates plantations between Thomas and Cumings Lodge although the railway embankment protects a few; first international Colonial Exhibition held; ordinance to regulate indentured immigration passed; Crimean War continues
1856	45,881		Restrictions on land purchases; Cholera outbreak; Portuguese shops attacked amidst rioting; Crimean War ends

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1857	52,245	Thomson's centrifugal drainage pump ordered for James Ewings' Guiana estates	
1858	52,379	Cane seed noticed in Barbados	
1859	48,843	"Demerara Crystals" first exported to Britain	
1860	55,296	Centrifugal curing common in Guiana; lees water added to land during ploughing; vacuum juice heaters introduced; Donald Skekel patents boiler regulators and steam-engine piston improvements	Severe outbreak of cane disease in Mauritius, Reunion and Java from the 1860s
1861	64,321	Fowler's Balancing Steam Plow worked at Plantation Houston	Price of Crown land doubled to \$10/acre but abandoned plantation land available for 1/5 less; legislature authorized to grant free land to post-indenture, self-sufficient immigrants; legislature agrees to fund importation of Africans impounded from foreign slave vessels; US Civil War begins raising demand for foreign sugar; Morill Tariff raises duties on sugar imported into the US
1862	57,788		Another anti-Portuguese period; Governor Walker travels to the US to negotiate hire of ex-slaves slaves but fails
1863	68,545		Dutch colonies abolish enslavement
1864	65,279	Juice-heaters introduced at Ogle estate improve clarification and economize steam use; railway extended to Mahaica (East Coast Demerara)	Ongoing railway construction since 1846 continually siphoning estate labor; new British sugar duty scale splits rates for lowest grades easing entry of high-grade colonial sugars into Britain; lowest grades still enjoy tariff advantage

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1865	76,565	Light colored sugar made using sulphurous acid attracts record prices in Britain; fertilizers tried at Haarlem and Rotterdam estates	Vacuum-pan estates reportedly in the minority; US Civil War ends and enslavement is abolished
1866	81,418		Colonial Company, a sugar conglomerate, established
1867	73,547		Demerara sugars seized in Baltimore suspected of being artificially colored to mimic low grade crystals and evade payment of duties; Dutch Standard of testing supplemented by polarimetric evaluation
1868	80,040	Guianese planter goes to Martinique to observe sugar-making and returns to try charcoal filtering unsuccessfully	Drought; some estates resort to using salt water for irrigation
1869	67,667	Donald and Alexander Skekel patent bagasse furnace improvements	Another dry year
1870	76,280	Sugar machinery purchases surge	Polarimetric test mooted as replacement for Dutch Standard; new British tariffs reduce duties by one-half; tariff on high-grade sugars increased by 25% percent; Franco German War lasts from 1870-71
1871	93,657	Sulphur clarification process patented by Stewart and True from Louisiana used locally	Telegraph connection with New York established
1872	78,331		United States imposes prohibitive tariff against high-grade Demerara sugar and only low-grades such as dark-colored Refining Crystals profitable; riot at Devonshire Castle estate (Essequibo Coast), 5 workers killed

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1873	84,729	Experiments to produce ‘dark sugars’ begin; “The Great Demerara Experiment” proves Russell’s maceration “an unqualified success” at Leonora and La Bonne Intention; filter presses introduced; fatal accident at De Willem (West Coast Demerara) kills 4 as Weston’s centrifugal explodes	Panic of 1873; international competition causes sugar prices fall; US investment in Cuba and Hawaii grows, Great European Depression begins and lasts until 1879; Puerto Rico abolishes slavery
1874	87,967	William Russell and George Walters Risien patent “Maceration Plant” (Imbibition); Risien patents improvements to boilers separately	Colonial sugar preferences eliminated and British markets opened up to all sugars; last marginal advantage of lower-grade crystals eliminated
1875	83,514	Another fatal accident involving Weston’s centrifugals made by Mirrlees and Tait at Belle Vue (West Bank Demerara) kills Manger, J.J.B. Elliot, and injures a laborer	European Sugar Conference held and English propose refining in bond, France and Belgium disagree and Dutch agrees to proposal if no alternative found for analyzing sugar for duties other than by color
1876	106,347		British Caribbean faces increased competition from bounties given to European beet sugar; sugar prices begin to fall, the industry is ‘depressed’ and estates in Guiana ‘almost unsaleable’; partial failure of beet crop in France causes rise in price of muscovado
1877	98,822	John Rhodes Tilly patents improved cultivator; European conference on saccharimetry held	Severe drought begins; coal prices fall; British Caribbean protest French sugar bounties
1878	76,525		Drought continues; many estates abandoned and only 119 remain

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1879	93,919	Moth-borers pests appear in canefields; Central Botanic Station and Gardens established;	Drought continues; Demerara sugars seized in Baltimore (Maryland) on suspicion of being intentionally artificially colored to cheat revenue collection and claim substantiated following protracted trial; use of the polariscope test mooted but found unreliable; lawsuits against US Customs follow and are successful; use of Dutch Standard revived
1880	96,900	Revival of flood-fallowing to control spread of Stem Borers	Dark sugar production resumes despite decline in profits; French sugar production falls due to partial failure of beet crop; height of American sugar refining with “white sugarmills” producing granulated and cube sugars
1881	91,286		Floods; coal shortage in Guiana
1882	122,590	24 centrifugal drainage pumps and 13 scoop wheels in operation	Drought; shortage of Demerara Crystals results in price increase; devastating hurricane hits Cuba
1883	115,216	Multiple-effect evaporators introduced at Vryheid’s Lust; tests to assess crushing capacity on various estates carried out	Polarimetric testing prompts restrictive duties on high-grade sugars entering the US; 11 estates remaining on Essequibo Coast; good weather prevails
1884	123,795	Green bagasse furnaces installed; Yellow Crystals made with triple effect apparatus at Windsor Forest	Bumper crop; Britain begins subsidizing beet sugar with prohibitive import duties and export bounties; world sugar prices fall to all-time low; price of Yellow Crystals halved
1885	94,889		Sugar exports to the US double
1886	110,493	Quintin Hogg builds first cane diffusion plant at Non Pariel, East Coast Demerara between 1886-87	Floods and locust infestation on the coastlands, especially in Berbice; sugar output increases despite economic crisis in British Caribbean; Guiana sugar exports to the US increase steadily; slavery abolished in Cuba

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1887	133,231		Optimum growing conditions; adequate but not excessive rainfall
1888	106,805	Donald Skekel patents improved 3-roller sugar mill and cane weighing apparatus; polarimetric testing employed in Guiana factories	Floods; Harrison and Bovell propagate cane by seed in Barbados; Brazil abolishes slavery; more Guiana sugar going to the US than to the UK
1889	114,179	J.B Harrison, seconded from Barbados, begins cane breeding experiments with G.S. Jenman at the Botanic Gardens	
1890	104,199	Fertilizer trials begin to counter 'Bourbon Sick'; Rind Fungus outbreak forces restrictions on cane imports; 'green megass' furnaces in widespread use; factories using electric lighting	McKinley Tariff (US) abolishes import duties on low grade sugars, raises duties on higher grades and imposes countervailing duties on European 'bountied' (subsidized) beet sugar. The Tariff lasts until 1894
1891	115,544		Plantation Lusignan has 2,735 employees
1892	114,691	D625 developed and later becomes the most cultivated variety in Guiana	
1893	109,500		
1894	104,147	Guiana reverts making to Yellow Crystals for UK markets; another outbreak of Rind Fungus and flood-fallowing restarted to combat the disease in Bourbon cane	Sugar prices fall drastically and second world sugar crisis lasts from 1894 to 1897; provisions of McKinley Tariff (1890) ends; US tax on low-grade sugar imports reinstated via Wilson Tariff that imposes 40% ad valorem duty; Philippine sugar production grows

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1895	102,681	Juice low in sucrose; Guiana resumes making dark crystals for US markets	1894 price differential ends; Philippine sugar production peaks but forestalled by Insurrection; Second War of Independence begins in Cuba and lasts until 1898 almost obliterating its sugar industry
1896	108,791	D74 cane sent for trial in Louisiana ; megass replaces coal as main fuel source on local estates	Good weather, sugar prices halved 64 sugar factories operating; wage riots at Non Pariel (3 killed)
1897	102,512	Damp causes ratoons to die off and new plants fail to thrive; 1 muscovado estate remaining in Guiana	Floods; crop partly destroyed by ‘arsonists’ and ‘thieves’; Royal Commission (Norman) appointed to examine conditions in British Caribbean; US Dingley Tariff Bill raises taxes to all-time high but imposes ‘countervailing’ duty on European beet sugar equal to its bounty; US replaces UK as chief British Caribbean sugar market as optimum price paid despite the duties; approximately $\frac{3}{4}$ of British Caribbean production goes to the US
1898	98,199		Floods; Treaty of Paris gives the US control of Cuba, the Philippines, Puerto Rico, Hawaii and Guam; US grants preferential access to sugar from the annexed territories; Canada grants preferential duty on British Caribbean raw sugar
1899	86,144		Drought; sugar prices at record low; Guiana signs reciprocity agreement with US to export sugar, fresh vegetables and kaolin
1900	96,265		Drought continues; 64 estates in cultivation, many others abandoned or turned over to rice cultivation; Canada sugar preference increases
1901	107,390	Molascuit animal feed first produced	Giant Moth Borer epidemic begins; Canada preferences increase again; Puerto Rico sugar allowed duty-free into US

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1902	122,055	Mechanical cane hoist installed at Albion Estate in Berbice, the first in the British Caribbean	Guiana sugar exports to the US peak; Brussels Convention agrees to abolish beet bounties; first British Caribbean agricultural conference held in Barbados; Philippine sugar production at all-time low
1903	127,970		Major riot at Plantation Friends (Berbice) - 5 killed; local small-pox epidemic; Brussels Convention abolishes European Bounty system; Reciprocity Treaty between US and Cuba gives Cuba monopoly on US sugar market; exports from Guiana to the US decline sharply
1904	108,428		Giant Moth Borer devastates Enmore; nearly half of Guiana sugar exports go to Canada; small-pox continues
1905	127,247		Wharf-workers "Centipede" Riots start at Plantation Ruimveldt and spread throughout British Guiana
1906	122,265		Severe flooding; Central Board of Health established; first distribution of quinine to combat Malaria
1907	101,330		Adequate rainfall and favorable weather reported; Canada preferences increase
1908	119,056	Hardy D625 variety planted as 20% of total crop; Diamond 10 becomes popular and POJ 2878 variety also cultivated	
1909	117,711	Uitvlugt gets mechanical cane hoist; decision taken to buy US-made animal-drawn ploughs and to abandon steam ploughing	Heavy rain inhibits cultivation; Philippine sugar gets preferences on US market under Payne-Aldrich Tariff arrangements

<b>Year</b>	<b>Yield (metric tons)</b>	<b>Technology</b>	<b>Highlights</b>
1910	102,574	Hoist installed at Enmore	Sugar production falls; quinine distributed to prevent malaria; Botanist Quelch hired by Booker Brothers to investigate Giant Moth Borer
1911	87,627		Severe drought curtails grinding in May and October; many estates ruined; 40 factories operating
1912	78,521	Poor quality juice results in low crystallization rates; American-made hoist installed at Port Mourant	Drought continues; additional Canadian preference for British Caribbean sugar; Canadian home-refining protection repealed
1913	88,817	First fully electrified sugar factory in Cuba	'Demerara Sugar' brand name lost following British High Court ruling; unrestricted entry of Philippine sugar into the US continues to 1934; Britain withdraws from 1902 Brussels Convention
1914	108,857		Gunpowder explosion destroys 8,000 tons of sugar at the Demerara Company warehouse; WWI inspires temporary production boom; Britain resumes cane sugar preferences
1915	118,109		WWI continues
1916	103,281	Machinery upgrades by Sandbach Parker and Davsons companies	WWI; good harvest owing to abundant rainfall
1917	115,836		WWI; immigration from India ends, non-indentured arrivals continue
1918	95,409		WWI ends; Froghopper pest outbreak; sugar exports decline; Britain, having withdrawn in 1913 from the Brussels Convention, resumes tariff preference for colonial sugar
1919	84,474	Sophia Station started in July	
1920	85,109	Cane breeding becomes responsibility of Sophia Sugar Experiment Station	Canadian sugar preferences reinstated and complete grade-based duties reapplied; British Caribbean sells low-grade sugar in Canada

## APPENDIX 2

British Guiana annual sugar production, 1800 to 1930.<sup>843</sup>



<sup>843</sup> Deerr, *History of Sugar*, I, 230. **Figures 1, 2 and 3** compare British Guiana with its main competitors.

### APPENDIX 3

Sugar, cotton and coffee production in Demerara, Berbice and Essequibo, 1823 to 1837.<sup>844</sup>

<b>Production of Staples Compared 1823-1837 (1000/pounds)</b>			
<b>Year</b>	<b>Sugar</b>	<b>Coffee</b>	<b>Cotton</b>
1823-25	152,500,000	12,700,000	4,864,000
1826-28	171,000,000	9,927,000	5,278,000
1829-31	187,649,000	5,042,000	1,609,000
1832-34	276,400,000	71,535,000	3,031,000
1835-37	315,100,000	12,865,000	2,325,000

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<sup>844</sup> Data for Figure 6.

#### APPENDIX 4

British Guiana sugar exports 1884 to 1904, percentage sold in major markets.<sup>845</sup>

<b>Period</b>	<b>United Kingdom</b>	<b>United States</b>	<b>Canada</b>
1884	83.5	15.3	0.0
1885-87	63.5	35.1	1.0
1888-90	44.9	53.2	1.3
1891-93	34.2	61.9	3.7
1894-96	37.1	60.1	2.5
1897-99	24.0	75.0	0.7
1900-02	16.4	76.5	6.7
1903-04	13.3	38.8	47.6

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<sup>845</sup> See Figure 69.

## APPENDIX 5

Sugar, rum and molasses production in Demerara, Essequibo and Berbice combined,  
1824 - 1839.<sup>846</sup>

<b>Year</b>	<b>Sugar (cwt.)</b>	<b>Rum (gallons)</b>	<b>Molasses (gallons)</b>
1824	866,096	2,011,320	2,985,570
1825	830,608	1,762,380	2,883,930
1826	793,504	1,946,380	2,509,240
1827	1,055,008	2,685,080	3,133,560
1828	1,015,184	2,612,000	3,137,250
1829	1,063,024	3,165,720	2,408,460
1830	1,094,656	4,010,950	2,266,750
1831	1,041,104	3,946,740	2,973,130
1832	1,003,696	2,630,210	4,361,940
1833	1,009,408	2,197,590	4,866,380
1834	872,000	2,367,310	3,652,550
1835	1,063,872	3,248,450	2,965,580
1836	1,126,672	2,955,280	4,142,230
1837	990,672	2,120,157	3,419,960
1838	865,128	2,223,150	2,773,030
1839	621,800	1,911,050	1,304,380

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<sup>846</sup> Data from *Parliamentary Papers*, XVI, 1839. 1 hundredweight (cwt.) = 112 pounds.

## APPENDIX 6

British Guiana sugar yield, 1879 to 1930.

<b>British Guiana: sugar yield per acre 1879-1930</b>	
<b>Period</b>	<b>Tons per acre</b>
1879-83	1.60
1884-88	1.75
1889-93	1.75
1894-98	1.60
1899-1903	1.90
1904-08	1.95
1909-13	1.75
1914-18	1.90
1925	1.93
1926	1.76
1927	2.01
1928	2.17
1929	2.08
1930	2.35

## APPENDIX 7

British Guiana: drought and flood years, 1826 to 1912.<sup>847</sup>

<b>Drought</b>	<b>Flood</b>
1826	
1845	
1846	
1852	
	1855
1868	
1869	
1877	
1878	
1879	
	1881
1882	
	1886
	1888
	1897
	1898
1899	
1900	
	1906
	1909
1911	
1912	

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<sup>847</sup> Compiled from various historical sources.

## APPENDIX 8

Sugar production, select countries and British Guiana compared annually, 1800 to 1930.<sup>844</sup>

Year	British Guiana	Cuba	Puerto Rico	Philippines	Mauritius	Fiji	Brazil	Hawaiian Islands	Louisiana	Java
1800	-	28,875	-	-	-	-	-	-	-	-
1801	-	32,481	-	-	-	-	-	-	-	-
1802	-	41,537	-	-	-	-	-	-	-	-
1803	-	32,122	-	-	-	-	-	-	-	-
1804	1,433	39,413	-	-	-	-	-	-	-	-
1805	-	35,469	-	-	-	-	-	-	-	-
1806	-	31,804	-	-	-	-	-	-	-	-
1807	-	36,836	-	-	-	-	-	-	-	-
1808	-	25,579	-	-	-	-	-	-	-	-
1809	-	58,713	-	-	-	-	-	-	-	-
1810	-	37,933	-	-	-	-	-	-	-	-
1811	-	-	-	-	-	-	-	-	-	-
1812	-	-	-	-	477	-	-	-	-	-
1813	-	-	-	-	264	-	-	-	-	-
1814	12,410	-	-	-	498	-	-	-	-	-
1815	16,786	-	-	-	1,207	-	-	-	-	-
1816	17,072	40,740	-	-	4,000	-	-	-	-	-
1817	19,962	44,112	-	-	3,174	-	-	-	-	-
1818	22,248	42,142	-	-	3,812	-	-	-	-	-
1819	25,964	39,167	-	-	2,738	-	-	-	-	-
1820	30,544	43,811	-	-	7,485	-	76,200	-	-	-
1821	27,707	48,093	-	-	9,810	-	84,328	-	-	-
1822	29,581	53,199	-	-	11,283	-	92,456	-	-	-
1823	33,623	61,005	-	-	13,211	-	100,584	-	15,472	-
1824	34,576	49,852	-	-	11,732	-	-	-	16,504	-

<sup>844</sup> - Figures unavailable. Quantities computed in metric tons.

Year	British Guiana	Cuba	Puerto Rico	Philippines	Mauritius	Fiji	Brazil	Hawaiian Islands	Louisiana	Java
1825	36,000	-	-	-	10,481	-	-	-	15,472	-
1826	44,074	-	-	-	20,485	-	-	-	23,209	1,178
1827	63,271	-	5,511	-	19,584	-	-	-	36,618	1,918
1828	56,647	-	13,840	-	23,311	-	-	-	45,385	1,565
1829	59,528	74,375	19,684	-	28,172	-	-	-	24,755	4,061
1830	60,749	-	-	-	32,750	-	-	-	-	6,467
1831	58,990	-	-	-	32,848	-	-	-	-	7,204
1832	55,844	-	-	-	38,483	-	-	-	36,101	14,632
1833	55,464	-	-	-	32,536	-	-	-	38,681	12,556
1834	47,912	-	-	-	34,301	-	84,328	-	51,573	22,196
1835	58,501	-	-	-	31,279	-	-	-	15,472	26,158
1836	49,785	167,531	-	-	30,535	-	-	-	36,101	30,367
1837	55,543	-	-	-	32,918	-	-	2	33,523	41,003
1838	48,753	149,359	-	-	34,715	-	-	40	36,101	44,589
1839	34,220	132,289	30,422	-	33,061	-	83,312	45	59,310	51,823
1840	36,191	163,473	35,938	-	36,559	-	-	161	44,869	47,040
1841	30,405	165,031	-	-	38,074	-	-	27	46,416	45,901
1842	32,193	-	40,382	-	34,340	-	-	511	72,203	51,128
1843	32,789	-	31,213	-	26,530	-	-	-	51,573	56,436
1844	34,673	-	-	-	35,030	-	-	229	103,147	63,421
1845	35,238	-	-	-	42,217	-	-	135	95,927	90,962
1846	23,303	-	-	-	64,488	-	-	134	72,203	87,647
1847	41,970	-	-	-	57,033	-	-	265	123,776	82,738
1848	47,535	-	-	23,572	55,279	-	-	223	113,462	89,931
1849	30,148	-	49,267	29,567	64,326	-	-	282	127,862	105,126
1850	33,217	226,726	110,231	29,161	55,163	-	-	334	108,924	86,519
1851	38,259	267,626	68,894	26,925	66,595	-	-	10	121,995	120,345
1852	49,519	255,647	-	36,070	71,622	-	-	312	166,032	76,007
1853	39,425	327,167	-	44,909	91,722	-	140,208	286	231,732	111,727
1854	49,412	380,002	-	35,562	84,913	-	86,360	257	174,736	112,094
1855	49,224	398,290	-	48,161	127,324	-	107,696	130	115,471	103,963

Year	British Guiana	Cuba	Puerto Rico	Philippines	Mauritius	Fiji	Brazil	Hawaiian Islands	Louisiana	Java
1856	45,881	353,584	-	36,374	117,964	-	89,408	248	36,910	125,101
1857	52,245	360,697	-	27,230	116,153	-	110,744	311	139,573	106,157
1858	52,379	391,178	-	50,904	118,717	-	86,360	540	188,148	132,824
1859	48,843	544,601	-	49,786	123,901	-	121,920	815	115,719	133,682
1860	55,296	454,173	-	46,027	134,048	-	57,838	644	120,231	136,153
1861	64,321	453,157	-	61,979	106,370	-	178,816	1,149	239,643	136,889
1862	57,788	533,425	-	52,022	129,292	-	119,888	1,340	43,763	145,047
1863	68,545	515,136	-	45,112	132,371	-	241,808	2,360	38,329	131,799
1864	65,279	584,227	-	46,840	112,551	-	241,704	4,780	4,899	140,224
1865	76,565	629,949	-	41,252	130,191	-	137,271	6,840	9,026	137,893
1866	81,418	621,821	-	56,187	118,273	-	152,418	7,920	19,459	142,290
1867	73,547	606,580	-	75,391	96,860	-	96,815	7,740	18,779	133,049
1868	80,040	761,019	-	67,872	95,754	-	115,166	8,170	43,115	178,784
1869	67,667	737,650	-	79,658	102,065	-	104,727	8,168	41,623	182,461
1870	76,280	737,650	103,342	88,904	98,742	-	103,125	8,385	76,602	152,595
1871	93,657	555,778	-	97,032	118,843	-	146,279	9,720	66,635	190,866
1872	78,331	701,072	88,141	85,348	122,288	-	160,334	7,690	56,855	209,299
1873	84,729	787,436	86,156	101,300	111,718	-	128,417	10,300	46,830	199,068
1874	87,967	691,928	70,622	128,022	93,387	-	155,384	10,970	61,011	201,252
1875	83,514	729,522	70,989	129,851	87,448	98	104,149	11,200	74,124	193,634
1876	106,347	599,468	68,910	123,043	118,810	269	151,112	11,640	86,506	237,870
1877	98,822	528,344	90,882	122,129	136,292	490	136,615	11,140	66,725	245,814
1878	76,525	541,553	83,015	131,984	130,732	557	122,853	17,240	108,625	224,689
1879	93,919	680,751	75,204	181,568	103,576	798	164,377	21,870	90,248	233,302
1880	96,900	538,505	56,156	210,322	108,475	603	222,079	28,400	123,823	216,179
1881	91,286	500,911	60,740	150,477	108,798	699	197,628	41,800	72,519	279,207
1882	122,590	604,548	78,801	197,113	115,279	1,759	133,499	51,000	137,468	292,005
1883	115,216	467,714	76,406	122,129	113,976	5,246	237,627	51,000	130,504	324,704
1884	123,795	567,901	97,048	208,290	123,677	8,869	334,443	64,500	95,890	394,247
1885	94,889	641,126	-	190,509	113,834	10,857	193,040	77,500	130,011	380,046
1886	110,493	743,465	62,905	171,712	116,148	11,904	253,818	96,500	82,156	356,022

<b>Year</b>	<b>British Guiana</b>	<b>Cuba</b>	<b>Puerto Rico</b>	<b>Philippines</b>	<b>Mauritius</b>	<b>Fiji</b>	<b>Brazil</b>	<b>Hawaiian Islands</b>	<b>Louisiana</b>	<b>Java</b>
1887	133,231	656,954	-	161,653	95,401	13,017	274,972	95,000	160,506	375,784
1888	106,805	667,257	-	228,611	125,018	17,187	234,070	105,000	147,203	355,334
1889	114,179	-	-	145,295	139,550	13,389	121,920	108,000	130,403	352,997
1890	104,199	642,516	-	138,182	130,220	15,536	178,214	116,000	219,307	399,999
1891	115,544	830,090	-	252,996	113,813	20,799	161,544	123,000	163,519	406,800
1892	114,691	991,662	55,116	261,124	68,519	19,186	193,954	110,000	221,016	422,000
1893	109,500	828,987	42,321	210,322	139,752	16,246	210,820	136,000	270,102	479,660
1894	104,147	1,071,131	47,734	341,392	113,793	27,703	271,455	148,000	322,426	530,963
1895	102,681	1,020,379	54,131	233,691	142,646	23,582	228,600	134,000	241,536	581,569
1896	108,791	238,996	53,147	205,241	152,678	26,655	178,717	202,000	286,562	534,390
1897	102,512	215,454	54,131	175,776	121,694	27,424	203,686	223,000	315,429	586,299
1898	98,199	310,446	53,147	93,680	186,487	34,704	153,919	204,000	249,451	725,030
1899	86,144	341,054	34,447	63,503	157,025	28,859	177,800	253,000	149,526	762,447
1900	96,265	288,203	61,997	115,318	175,025	33,490	325,120	258,000	280,001	744,257
1901	107,390	622,608	84,996	107,766	147,828	31,675	354,673	321,000	326,838	803,735
1902	122,055	877,653	103,995	145,925	150,350	36,482	193,167	307,000	334,510	897,130
1903	127,970	1,019,982	129,994	142,891	218,532	47,092	201,999	391,000	232,143	944,789
1904	108,428	1,069,159	144,993	147,318	137,899	52,975	200,894	328,000	361,236	1,055,943
1905	127,247	1,202,336	209,990	147,860	191,765	57,394	283,312	181,000	342,156	1,039,178
1906	122,265	1,249,469	193,991	178,698	211,464	39,141	276,352	383,000	233,691	1,067,798
1907	101,330	1,467,487	215,984	176,224	169,161	67,666	220,472	393,000	345,456	1,210,127
1908	119,056	984,829	244,989	189,999	191,271	67,210	280,416	465,000	360,697	1,241,885
1909	117,711	1,546,238	308,986	177,489	235,184	61,801	298,704	478,000	330,215	1,247,260
1910	102,574	1,833,303	294,986	155,080	217,413	62,752	337,058	463,000	310,910	1,278,420
1911	87,627	1,492,827	312,346	247,825	162,761	74,003	307,106	505,995	320,118	1,466,569
1912	78,521	1,619,444	355,343	259,326	213,069	62,719	341,778	488,213	139,591	1,406,569
1913	88,817	2,468,222	325,104	318,058	249,703	96,230	363,613	553,923	265,531	1,465,975
1914	108,857	2,638,610	308,164	376,367	277,360	93,600	403,445	577,183	220,174	1,404,492
1915	118,109	2,624,292	431,315	388,212	214,530	86,936	406,738	529,896	124,738	1,319,087
1916	103,281	3,054,871	448,546	379,993	208,970	122,462	461,202	575,512	275,693	1,629,827
1917	115,836	3,068,397	413,939	391,970	220,600	98,897	489,226	515,038	211,374	1,822,118

<b>Year</b>	<b>British Guiana</b>	<b>Cuba</b>	<b>Puerto Rico</b>	<b>Philippines</b>	<b>Mauritius</b>	<b>Fiji</b>	<b>Brazil</b>	<b>Hawaiian Islands</b>	<b>Louisiana</b>	<b>Java</b>
1918	95,409	3,499,880	362,601	437,573	252,750	64,021	524,731	538,911	189,511	1,788,207
1919	84,474	4,030,754	433,805	417,850	235,190	65,381	706,386	496,184	109,769	1,336,112
1920	85,109	3,788,814	438,474	430,355	259,870	74,156	739,322	495,695	153,429	1,543,923
1921	110,007	3,998,585	362,425	543,285	197,420	73,789	874,228	529,000	294,219	1,685,334
1922	92,024	4,060,315	338,440	491,441	231,190	72,882	662,891	479,464	267,706	1,808,036
1923	84,502	3,659,400	399,957	443,590	201,550	44,816	876,109	676,279	133,829	1,792,871
1924	87,183	4,122,963	491,312	482,181	224,710	59,410	936,980	692,804	80,270	1,996,237
1925	99,282	5,202,588	541,460	500,911	241,220	98,303	761,626	716,636	126,444	2,263,479
1926	86,018	4,955,729	509,506	640,110	192,590	57,869	950,518	705,350	42,788	1,941,649
1927	111,375	4,510,144	670,800	671,607	218,000	73,924	847,127	724,403	64,221	2,341,538
1928	116,527	4,040,015	530,092	793,533	253,430	122,623	957,071	807,175	119,796	2,901,751
1929	102,061	5,239,979	773,274	843,319	238,100	89,087	1,194,893	815,778	181,082	2,858,054
1930	116,380	4,746,280	703,355	847,383	220,960	94,347	1,036,085	825,413	166,643	2,969,269

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### Abbreviations

CUL	Cornell University Libraries (Ithaca, New York)
ICS	Institute of Commonwealth Studies (London)
PRO	Public Record Office (The National Archives, United Kingdom)
SHL	Senate House Library (University of London)
TNA, UK	The National Archives, United Kingdom

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## GLOSSARY

Amerindians	The indigenous people of Guyana.
Apprenticeship	Proposed as a transition between the end of slavery (Abolition) and Emancipation, during which the enslaved were mandated to serve as unpaid apprentices for three-quarters of each work day and as paid labor for the remainder. Expected to last from 1 August 1834 to 1838 (for non-field slaves) and to 1840 (for field slaves), Apprenticeship in British Guiana ended on 1 August 1838.
Continental System	The maritime blockade instituted by France during the Napoleonic Wars aimed at stifling shipping trade between Britain, her colonies and continental Europe.
Copper-wall	A battery of pans of varying sizes used for evaporating cane juice to crystals. Pans were usually made of cast-iron and copper was used only for the smallest in which the sugar crystals formed. The pans were called, variously. 'teaches', 'taches', 'tayches', or 'kettles' (United States).
Countervailing duties	Duties applied to correct imbalances in trade caused by subsidies or 'bounties'.
Emancipation, Emancipation Day	Refers to the day (1 August 1838) on which the enslaved in the British-ruled colonies achieved full and unconditional freedom.
Façade	Usually an architectural term denoting the vertical front of a building, in Guyana façade refers to the boundary of a plantation that fronts onto a waterway.
Hogshead	Also 'tierce'. Wooden barrel or cask in which sugar was shipped. The capacity of a hogshead varied between 1,600 and 2240 Imperial Pounds.

Holing-and-banking	Planting technique common in the British Caribbean. Lines of squared ‘holes’ dug to receive plants alternated with ‘banks’ of excavated earth heaped on two sides of each hole.
Indentureship	A collective term for various schemes instituted to relieve the scarcity of labor precipitated by the termination of slavery. Even before slavery ended, importation of plantation workers began and the first group, Africans freed from captured slave ships, entered British Guiana in 1834. Madeiran Portuguese came in 1835 and arrivals from India (‘East Indians’) began in 1836. Chinese immigrants followed in 1846. Other recruits came from the Caribbean islands and small numbers of Europeans, Americans, and immigrants from the Azores, Malta and Cape Verde were also contracted to work plantations in British Guiana.
Koker	Dutch-Guianese for sluice. The term is still used in Guyana.
Megass or bagasse	Fibrous cane stalks remaining after juice extraction. Megass was the term used in the nineteenth century. Depending on the number of the mill it is referred to as first mill bagasse, second mill bagasse, etc. The final residue from a milling train or the leftovers from water-based extraction is called ‘final bagasse’ or simply, bagasse.
Muscovado	The nineteenth century plantation staple, ‘raw’, unrefined, brown sugar containing a high proportion of residual molasses.
Portuguese	Usually descendants of immigrants from Madeira, but may also include persons from the Azores, Malta and Cape Verde.
Punt	Small iron barge (or pontoon) used to haul cane to the mill on sugar estates. Wooden punts were towed by draught animals (usually mules) in the nineteenth century.

Ratooning

Propagation by replanting top segments of mature cane stalks.

Setts

Also called 'stem cuttings', 'seed pieces' or 'seed cane'. Segments of the cane stalk usually with three or four 'eyes' from which new shoots sprout. Setts are normally taken from the tops of mature stalks.