The import of European sugar machinery to offset the sugar crisis in Bahia, 1875-1914

A importação de maquinário de açúcar para debelar a crise do açúcar na Bahia no período de 1875 - 1914

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Abstract:

The construction of central sugar factories in Bahia (1880-1914) using imported sugar-processing machinery was undertaken to solve the province's sugar crisis by moving from the system of engenho/slave labor to factory wage/labor. The initiative succeeded in creating a commodity chain linking impoverished workers in Bahia's usinas with the traditional European working class in Paris, Lille, Glasgow and Liverpool. The output of sugar in Bahia increased markedly but it was sold in the protected markets of Brazil's Center-South.

Keywords: Bahian central sugar factories/usinas. Sugar machinery imports. British and French enterprises. Commodity chain.

Resumo:

A construção de fábricas centrais de açúcar na Bahia (1880-1914) utilizando-se da importação do maquinário de processamento foi uma medida tomada para resolver a crise do açúcar na Província, pela troca de um sistema do engenho com trabalho escravo para a fábrica com trabalho assalariado. A iniciativa foi bem sucedida em criar uma cadeia de *commodities* ligando os trabalhadores empobrecidos das usinas da Bahia com a classe trabalhadora tradicional em Paris, Lille, Glasgow e Liverpool. A produção de açúcar da Bahia aumentou marcadamente, fosse vendida nos mercados protegidos do Centro-Sul do Brasil.

Palavras-chave: Fábricas/usinas centrais de açúcar da Bahia. Importações de maquinário de açúcar. Empresas britânicas e francesas. Cadeia de commodities.

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Introduction

The great success of the central sugar factories established in Brazil has been demonstrated by the large amount of their net earnings… the Companhia Agrícola de Campos Sugar Factory, which crushed 25,602 tons of cane… earned a net profit of 10s per ton. The Quissama Sugar Factory which crushed 62,798 tons of cane earned… about 10s per ton net profit - British consul in Pernambuco, 1883.

Provincial governors, planters, and foreign consuls recognized Bahia's sugar sector was in severe crisis by the mid-1870. Sugar output had fallen from 60,043 tons in 1850/1 to 33,212 tons in 1873/4 (from 47,150 tons in 1872/3).[1] Bahia's sugar exports fell from an annual average of 48,000 tons during 1847-55 to an average of 43,325 tons during 1866-75.[2] The problem in Bahia was part of a broader decline in the Brazilian sugar sector. Brazilian sugar exports during 1826-30 accounted for on average 38% of the nation's export revenue but only 5% by 1896-1900.[3] Despite a large increase in worldwide sugar consumption during 1872-1902, the world market price of sugar declined.[4] Brazilian producers were hurt by this price decline, but also by the loss of traditional export markets (e.g., the North American one to Cuba and the European one to European beet producers). Beet sugar's share of world sugar output rose from a mere 8% in 1840 to 48% by 1880.[5] Given the relatively low productivity of sugar production in the Brazilian Northeast, the price squeeze was felt particularly there rather than in the modernized Cuban sugar industry.

World sugar price trends after 1835/44 certainly provided little incentive for Brazilian sugar producers:

	London cif price in Shillings per cwt	Brazilian fob export price in milreis/m. ton	Brazilian fob export price in shillings/cwt
1795-1804	55.4	-	-
1805-1814	49.4	-	-
1815-1824	42.7	111 (1821-24)	20.6 (1821-24)
1825-1834	30.4	160	20.0
1835-1844	38.3	119	14.2
1845-1854	24.9	129	12.9
1855-1864	24.6	175	17.3
1865-1874	18.5	161	13.6
1875/6-1879/80	n.a.	139	n.a.

Source: Robert Joseph Kestell, *An Analysis of the Locational Shift of the Brazilian Sugar Industry* (Madison: unpublished Ph.D dissertation, University of Wisconsin, 1973): 56, 68-9

The decline of Reconcavo sugar production in the mid-nineteenth century prompted a search for ways to restore its vitality. The planters were expressing increased concern over labor shortages as the inflow of slaves was perceived to shrink and as slaves were shifted southward to the coffee plantations.[6] One response was to establish large centrally-located sugar mills. The factory with its machinery would compensate for the decline of slavery.[7] Such thinking accelerated in 1871 with the promulgation of the *Lei do Ventre Livre*. The Imperial Government promoted such large-scale central mills as more efficient than the old, estate-based engenhos and it provided guaranteed annual interest on capital provided to the owners as a way of encouraging the transition to wage-labor.[8] The federal government provided subsidies of 200 contos to modern mills in the early 1880's.[9] In Bahia, in the late 1870's the Provincial Assembly granted guaranteed interest of 7 per cent on the capital spent for the erection of six central sugar mills in different districts of Bahia. But in 1879, only one had begun being built at Bom Jardim by the Cie. Fives-Lille with a capital of 700-800,000$000 reis.[10] The factory based upon a factory built in Guadelupe was planned to grind the cane of shareholders owning some 30 large adjacent sugar plantations, having a grinding capacity of 120 tons of sugar cane in 24 hours. Such efforts represented the first attempt in Brazil of what would become a long tradition of state-sponsored industrialization. The foreign community was enthusiastic (see quote above) having long deplored the condition of sugar-growing in Bahia.[11]

The planned sugar factories *required* the importation of sugar machinery and foreign engineers. Such trade in machinery has remained a mostly unexplored research topic other than being noted as a category of imports in trade statistics.[12] For example, Richard Graham demonstrated that the share of capital goods in total British exports to Brazil rose from 10.1% on average during 1860-64 to 39% during 1895-99.[13] The agents remain faceless, the enterprises nameless and the journey from Liverpool, Glasgow or Le Havre to the Reconcavo uncharted.

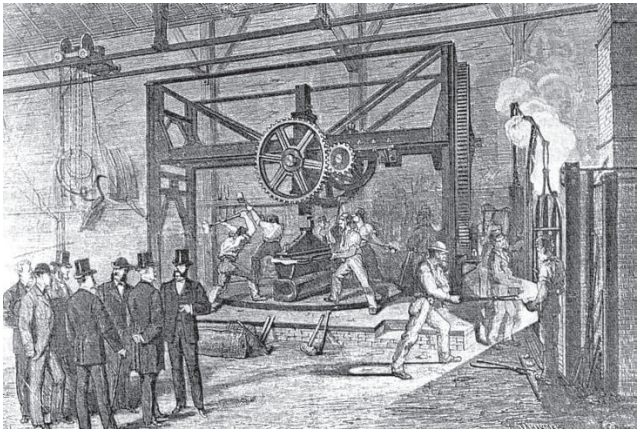
Up until 1880, the sugar plantation had its own in-house mill (the *engenho*). These were generally small production units; in 1833, 603 sugar mills existed in Bahia, with only 46 employing steam engines and having a labor force of 48,240 slaves (that is, on average, 80 slaves per engenho).[14] Up until 1875, relatively few engenhos had introduced the series of innovations – like the stream engine, vacuum pans, centrifuges, and filters – which made possible a sugar mill both larger and more efficient. The emergence of innovations increased the optimal size of sugar refineries and required substantial capital investment which, in turn, spurred on a process of industry firm concentration after the 1840's. Technological change in the sugar cane industry involved:

1768	Steam engine to replace animal and water power. Steam replaced direct fire in heating the vats. Sugar crystallized when cooled in the vats.
1794	Classic, three-roller mill allowing greater sucrose extraction
1813	Vacuum pan which reduced fuel consumption in the evaporation process. In these air-tight vats the water is boiled off from the cane juice under diminished atmospheric pressure until the sugar crystallizes out
1843	Centrifuge which accelerated and improved sugar crystal making by separating molasses
1850/56	Filter technology first out of wood, then Danek replaced wood with cast iron

The first centrifuges were installed in 1860 in the engenhos Sao Lourenzo and Bom Successo in Bahia.[15]

The real precursors of Bahia's later industrialization were the *usinas* (plantations with modern, fully-mechanized sugar mills) *or initially engenhos centrais* formed after 1880.[16] The engenho centrais was a large-scale central factory, strategically located, designed to mill the cane of many plantations, thereby raising the efficiency of sugar production. The annual outlay typical on sugar machinery (estimated in 1909) was one pound sterling per ton of sugar produced.[17]

Tough competition raged during 1880-1910 between French and British enterprises to sell such machinery to Brazil, part of the greater competition in Brazil between these two powers in the fields of finance, railway building and management and infrastructure development. French equipment from the Cie. Fives-Lille was used in the first central sugar factory built in Brazil at Macae, Quissama (R.J.) worth 1'000 contos, owned by the Barao de Vila Franca and the Visconde de Ururahy (part of the prominent local Araruana family) built in the province of Rio de Janeiro in 1877,[18] and in two others opened in Bahia 1880-6: the Bom Jardim and the Pojuca factories were equipped with modern sugar-making machinery from the Cie. Fives-Lille. Felix Vandesmet, a French engineer in the employ of Fives-Lille oversaw construction of the Pojuca factory. The Usina do Limão in Campos (R.J.) was re-outfitted during 1877-79 into a central sugar factory using Cail machinery.[19]



Interior of the Cail factory in Grenelle, 1870 (source: http://www.paris15histoire.com/UsinecailZ.htm)

Sugar machinery was made in such classic working-class cities as Paris, Liverpool, Glasgow and Lille. Industrial employment at the Cail factories in Grenelle (Paris) rose from 50 in 1834 to over 2,500 in 1848.[20] Derosne and Cail pioneered the central sugar factory concept in 1838 on the French island of Reunion. The first central sugar factory in Guadeloupe began operating in 1844. The Derosne and Cail enterprise supplied equipment to refiners of Belgian sugar beet and East Indian cane sugar as of the late 1830's.[21] During the next two decades, the Cail enterprise remained France's foremost manufacturer of refining equipment, specializing in complete factories - or turnkey plants – that it set up for sugar refineries all over the world, e.g., in Guadelupe, the island of Reunion etc.[22] Cail et Cie had been the first supplier of vacuum pan sugar technology – superior to the open pan technology - to Bahia when in 1847 it installed such a unit at the Engenho Periperi just outside of Salvador proper.[23] In 1849, Cail was shipping sugar machinery to Brazil.

The Cie Fives-Lille, an important enterprise of France's industrial revolution, was part of the Banque de Paris et des Pays-Bas group itself prominent in financial matters in Bahia,[24] provided machinery to and built five sugar factories in Pernambuco (including the Caxanga, Cucau, Itapitinguy, Mussurepe, Pumati), the Brasileiro in Alagoas, five in the state of Rio de Janeiro (Cupim, Itapemirim, Quissama, São Jose, Sapucais), two in Bahia (Bom Jardim, Cinco Rios), and ten in the state of São Paulo (Esther, Guatapará, Itaguaré, Junqueira, Lorena, Piracicaba, Porto Feliz, Tocas-Paraíso, Vassamunga, Vila Raffard).[25] The Societe des Etablissements Barbet built another 25 usinas in Brazil (6 in Pernambuco, 7 in Sao Paulo, 11 in Rio de Janeiro and one in Minas Gerais.[26] In Minas Gerais, the first central sugar factory, Usina Anna Florencia, was built in 1885 by the French Barbet firm with machinery imported from the British firm, Thomson Black & Co.[27] French activity

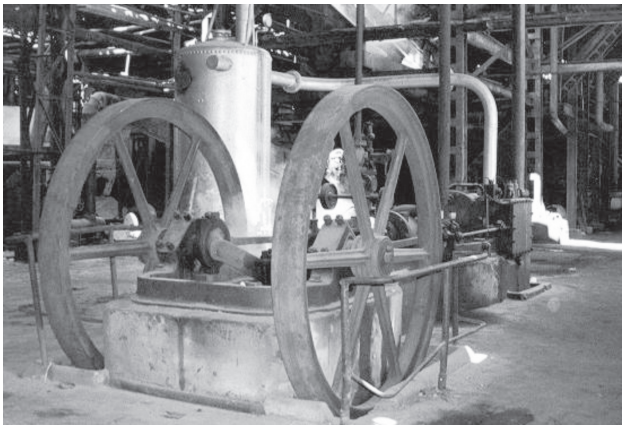
was preponderant in terms of both supplying machinery and in the actual running of the new sugar factories.[28]

Interior of the Fives-Lille factory in Lille, 1910 (source: http://yves.c.free.fr/vie-ouvriere/vie-ouvriere2.htm)

The case of the French engineer (and later Barao), Felix Vandesmet, illustrates the intimate connection between machinery supplier and expatriate engineer. Vandesmet oversaw the construction of the Usina Pojuca with equipment from the Cie. Fives-Lille at Catu, Bahia, located right next to the British-built Bahia São Francisco Railway. The planning and construction spanned four years (1878-1882). The usina's capitalization amounted to 300 contos de réis (1882) with Vandesmet owning 106 contos (followed by Coronel Jose Freire de Carvalho with 34 contos, Conselheiro José Antônio Saraiva with 32 contos, Coronel José Antônio Sepúlveda de Vasconcellos with 23 contos and Guilherme de Meirelles Vianna with 22 contos etc.).[29] The Pojuca's administration and operation was in the hands of Vandesmet. By the end of the decade, Vandesmet was in Alagoas overseeing the building of a major new usina at Atalaia, the Usina Brasileiro which began operations in 1892 (-1957/8).[30] The usina became a major producer of sugar and was known locally as the "Usina do Francês."[31] The French engineer, Isidore Moreau, who had installed sugar factories on the French island of Reunion, then worked in Egypt and subsequently in the late 1870's became the representative of Fives-Lille in Brazil being heavily in engaged there in both railway construction and the building of central sugar factories. Huetz de Lemps noted other French engineers who installed themselves in the Brazilian Northeast as of 1840, names like Millet, Boulitreau, Morel, Portier, Vauthier and Rigaire.[32] For example, Pierre Victor Boulitreau (1812-82), a graduate of France's prestigious Ecole Polytechnique engineering school, arrived in Recife in 1840, taking the post of engineer-in-chief for the municipality, responsible for the urban development of Recife. In 1844, Boulitreau resigned and

became a prosperous 'senhor de engenho', owning three engenhos in Pernambuco (Cahypio, São João and São Caetano). He died at age 70 on the engenho São João.[33]

The British enterprise, Bahia Central Sugar Factories Ltd., was organized in 1881 to purchase concessions granted earlier to the Englishmen Frank Dennis and James Edward Blair for the construction of eight central sugar factories. The British engineering firm of Hugh Wilson & Son was contracted to build the mills with machinery from Duncan, Stewart & Co. Ltd (Glasgow) but had only completed two of them (the usinas Iguape and Rio Fundo) by 1886 when further construction was terminated though operations continued at least until 1904 at Rio Fundo and Iguape.[34] The British engineer, David Webster Yates, worked for Duncan, Stewart in Bahia helping set up the imported machinery. He died at Iguape in March 1886. Another British engineer, James Foster (1845-1905) worked in China and Java which he left in 1888, then entering the employ of Duncan, Stewart & Co. in whose interests he served in Nicarágua, Antigua and Bahia during 1888-95.



Stationary steam power machine of Fives-Lille built in Engenho Central de Quissamã in 1877 and still operating in 2003

(Source: http://pt.wikipedia.org/wiki/Ficheiro:Engenho_Central_de_Quissam%C3%A3_-_M%C3%A1quina_a_Vapor_Estacion%C3%A1ria_1.jpg#filehistory)

A U.S. report 1887 noted that the leading export then of Bahia was sugar, but production was lackluster not for want lack of very rich soil, but because of oversupply on world markets from West Indian cane and European beet sugars (and consequent low market prices).[35] During 1883/4 exports of raw sugar through the port of Salvador totaled 74,000 tons and in 1885/6 some 35,000 tons. The sugar produced by the vacuum pan system was in crystallized form and mostly consumed within Brazil. The raw sugar packed in bags of 60 kgs was shipped to foreign ports (mostly to Britain (Liverpool) and its colonies with a small amount going to the United States (New York)).

National central sugar factories employing national capital though often with government guarantees were also formed and generally fared much better in the market than the foreign enterprises. The national companies served mostly the domestic Brazilian market while the foreign-owned ones exported sugar.[36] Graham noted about the British companies, "these companies were universally a failure and the British adventure in sugar factories was short-lived."[37] The reasons for failure of the 'engenhos centrais' included gross mismanagement by the directors and local managers, the high cost of cane in relationship to the price of sugar, poor construction and often out-dated and/or inappropriate equipment, and contractual difficulties with cane suppliers.[38] A gradual absorption by the new usinas of former engenho lands took place during 1980-1920, thereby securing a regular cane supply.

By the beginning of 1888, 36 *central sugar factories* were operating in Brazil with all but one receiving guaranteed interest (usually at 6-8% on invested capital for 25 years) by the Imperial government. Most of them used machinery imported duty-free from France[39] (from two companies, Cie Cail and Cie Fives-Lille). A French report (1900) noted that modern sugar factories were few in Brazil and that machinery has been furnished principally by Cail, Fives-Lille, and some German makers.[40] Both Cail and Fives-Lille were very active in supplying sugar machinery in Egypt.[41] Friedrich Krupp A.G. of Germany had established a well-known name for itself providing sugar-making machinery in the Orient (e.g., Java and India). In Java, British sugar machinery makers began being displaced at the time of the Boer War by Dutch and German competitors.[42] Alain Huetz de Lemps stated that by the end of the nineteenth century, 12 *usinas* had been financed by French capital, 8 by the British and 2 by Germans, but 19 owed their origins to Brazilians.[43] The usina owners or *usineiros* formed a new elite made up almost entirely of planters who had managed coming to own usinas by forming associations with neighbors which in turn raised monies with the aid of government guarantees of interest on their loans.[44]

By 1900, Cie Fives-Lille had built five central sugar factories in Pernambuco and Bahia, all under a government contract of guaranteed interest.[45] By 1889, ownership of the usinas centrais had shifted from British capital to Brazilians. In Pernambuco, a similar shift was noted. Josemir Castillo de Mello argued that the British were more interested in selling industrial machinery and railway equipment than in producing sugar.[46] Other contributing factors included the usinas centrais being built near railways rather than on the best lands and the difficulty of establishing the necessary regular supply of cane. In 1890, the Visconde do Campo Alegre, Paulo Amorin Salgado, bought the bankrupt central mills for 4.5 million contos de réis.

British sugar machinery originally played a major role although the French had always had a share of the world market but by the early twentieth century "American, Dutch, and German engineers have sought and obtained some share

(although their home markets are generally protected against foreign sugar machinery)."[47]

A French report on the Brazilian sugar industry at the turn of the century indicated that 97 sugar factories (includes central factories and usinas) existed, producing 4,040,000 bags of sugar (or 242,000 tons).[48] It included data by province (Table 1). But the data for Bahia seems faulty as the *Diário da Bahia* in 1902 reported 21 usinas existed.[49]

Table 1 - Brazilian Sugar Factories at the Turn of the Twentieth Century

Brazilian state	Number factories	Bags sugar produced
Pernambuco	30	2,000,000
Parahyba	1	90,000
Campos (R.J)	40	450,000
São Paulo	5	200,000
Bahia	12	300,000
Alagoas	2	800,000
Sergipe	1	80,000
Minas Gerais & R.J	6	120,000
Total…..	97	4,040.000 bags

Source: O.P. Austin, op. cit.: 2677

These 97 factories produced one-third of Brazil's sugar output[50]. The numbers of usinas in Brazil continued rising: 167 in 1910, 215 in 1917, 233 in 1920, 240 in 1925 and 307 by 1931.[51] By 1920, 233 usinas were operating in Brazil, up from 187 in 1910. The three largest producing states were Pernambuco, Rio de Janeiro and Bahia (Table 2) The size and numbers of usinas differed markedly across states with the largest ones being in São Paulo, followed by Rio de Janeiro, Pernambuco and Bahia (column 5 of Table 2).

Table 2 - Brazilian Sugar Usinas in 1920

State	Number of usinas	% of total number (1)	% of total Brazilian sugar output (2)	Ratio of (2)/(1)
Sergipe	70	30 %	4.9 %	.16
Pernambuco	54	23.2	34.1	1.47
Rio de Janeiro	42	18	26.6	1.48
Bahia	20	8.6	10.6	1.23
São Paulo	12	5.1	10	1.96
Alagoas	15	6.4	5.5	.86
others	20	8.7	8.3	.95
Total	233	100.0	100.0	-

Source: Derived from Alain Huetz de Lemps (1977), op. cit.: 71

The following Table 3 presents annual output data for Bahia's usinas for two years, 1905/6 and 1920/1. The decade of the 1890s was a boom time for Brazilian sugar factories, an era of unbridled prosperity as prices for Brazil's sugar exports rose from 136 mil réis/m. ton in 1889 to 416 mil réis in 1899.[53]

With the outbreak of World War I, a substantial reorganization of sugar processing in the Recôncavo took place. Raymundo Pereira de Magalhães acquired near monopoly control of Bahia's sugar trade, buying up the Usina Terra Nova, Usina Alliança as well as the São Carlos, São Bento and the Cinco Rios. In 1920/1, these five Magalhães sugar factories produced 48% of Bahia's usina sugar crop.[54]

The Usina Cinco Rios in the 1950's (source: A Tarde)

Table 3 - Production in Bahia's Central Sugar Factories, 1899 – 1920/21

Name of the usina	Location	Began producing	1899 cane crushing capacity [tons/day]	1902 crushing capacity [tons/ day]	1905/6 annual output [bags]	1920/21 annual output [bags]
Alliança	Santo Amaro	(1892)* 1893	400(?)	250	78,800	66,000
Aratu	Paripé	1894	240	240	26,700	39,000
Acutinga	Cachoeira	189_	120	120	8,400	6,000
Água Boa	Santo Amaro	?	n.a.	-	-	-
Vitória do Para-guassu	Cachoeira	1915_	250	250	42,773	85,868
Bom Sucesso	Bom Jardim	1880	250	250	13,320	(in Cinco Rios)
São Carlos	Santo Amaro	(1897)	240	240	49,200	48,000
Capimirim	Santo Amaro	pre-1905	280	200	18,130	38,000
Colônia	Santo Amaro	189_	70	70	15,200	21,000
Maracangalha (Cinco Rios)	Candeis	189_	80	80	13,500	(in Cinco Rios)
Cinco Rios	Santo Amaro	1912	-	-	-	30,000
Capanema	Santo Amaro	190_	-	-	3,400	5,000
Itapitinguy	Santo Amaro	1898	240	240	10,000	32,000
Dom João	São F do Conde	1898	180	180	12,483	35,000
São João	Salvador	1884	150	150	4,200	8,000
São Lourenço	São F. do Conde	1909	-	-	-	32,000
São José	Salvador	?	?		n.a.	-
São Miguel	Salvador	189_	100	100	2,000	-
Malembar	Santo Amaro	1896	100	100	11,210	15,000
Passagem	Candeis	1884	100	100	23,574	45,000
Paranaguá	Santo Amaro	(1905)	-		-	30,000
Pitanga	N. S das Candeis	1897	240	240	30,000	12,500
Iguape	Cachoeira	1886-1904	17,262**	400	-	-

Name of the usina	Location	Began producing	1899 cane crushing capacity [tons/day]	1902 crushing capacity [tons/ day]	1905/6 annual output [bags]	1920/21 annual output [bags]
Conde	Santo Amaro	1882	400 - Never completed	-	-	-
Cotegipe	Matta de São João	1882	240 - Never completed	-	-	-
Rio Fundo	Villa de São Francisco	1886-1904	6,563**	400	-	-
Pojuca	Catu	1880	300	400	3,800	?
Terra Nova	Santo Amaro	(1893) 1898	400	400	56,228	67,500
Vitória	Cachoeira	192_	-		-	7,000
Carapia	Santo Amaro	1882	70	70	n.a.	-
Totals…..	-	-	5,020 tons/ day capacity		422,918 bags or 25,375 tons	622,868 bags or 37,372 tons***

Source:
* figures in (___) represent date factory was formed.
** output in bags for 1898
** usina output in Bahia in 1921 was 47,016 tons (de Lemps, 1977: 205)

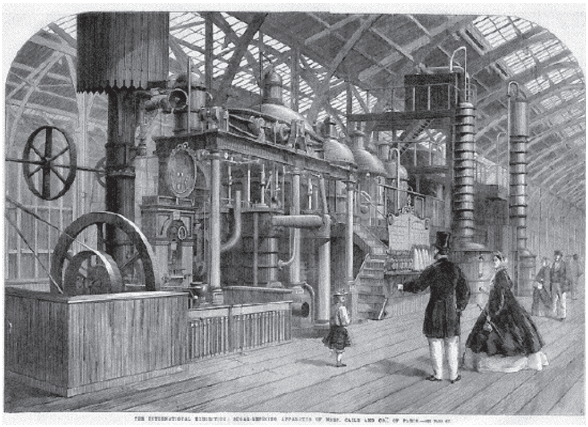
The experience of the central sugar factories in Brazil (and Bahia) during the 1880's had a substantial effect upon the socio-economic landscape (and environment with heavy use of wood as fuel contributing to deforestation). The liquidated physical properties were purchased for small sums by Brazilian interests who made them into profitable operations because of their very small investment.[55] Secondly, Brazilians learned from the British and the Imperial government supported new factories with generous loans. In Bahia alone, such landmark usinas as the Alliança, Acutinga, São Carlos, São Miguel, São Bento, Malemba and Pitanga came into production during the 1890's (Table 3). By one count, in 1899 twenty-three usinas were functioning in Bahia with a total output *capacity* of 5,020 tons per year of crystallized sugar.[56] A French report estimated that 12 sugar factories in Bahia in 1900 produced 300,000 bags of sugar (or 18,000 tons). The yields were a low 7% while with the more modern diffusion process (not employed in Bahia) it rises to 11%.[57] The only sugar factory in Brazil using the diffusion process, the Usina Esther, was built on plans of Fives-Lille and completed in 1905 in São Paulo province[58] for Artur Nogueira. It had a daily sugar grinding capacity of 160 tons and in 1920 it was still the only such factory in the country. Another report published in 1902 mentioned that there were 18 vacuum pan equipped sugar factories in Bahia capable of producing high-grade crystal sugar and many small establishments with open trains making ordinary Muscovado sugar.[59]

The new factories boosted the rate of sugar extraction from raw cane from 5-6% to 9-10%. The central sugar factory also changed the relationship between employer and employee. Wage-labor replaced the patron system as ties between landowner and laborer loosened.[60] The planter who was paid by the factory according to sugar content became more production-conscious. For the factory laborer, daily life became far more controlled and regimented (e.g., the sugar worker could no longer take home cane syrup, no longer plant foodstuffs on the plant property etc.).[61] The shift from the old engenho to the usina did not change the social position of rural workers, though it did produce a decline in their material condition.[62] In a sense, the life on the engenho wit its *senzala* and *casa grande* was replaced by the impersonal life in the capitalist factory, or in the memorable wording of Richard Graham, "man-and-machine replaced man-and-land."[63] Putting this in a broader historical context, Pomeranz and Topik wrote,

> …the scale, complexity, and social organization of sugar mills made them the first factories…sugar mills became the first factories ruled by the discipline of industrial time…sugar was the first industrial product and a cruel master to the hundreds of thousands of slaves who labored to turn out sweet delights.[64]

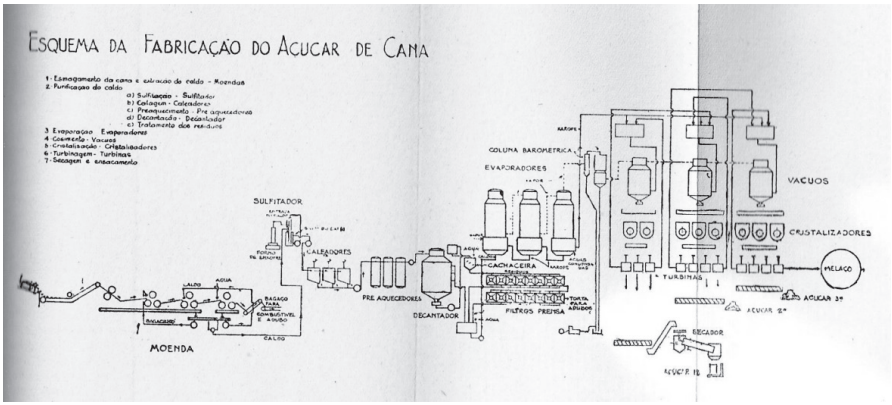
With the substitution of machinery and wage labor for slaves on engenhos, the sugar equipment makers in Europe foresaw lucrative business opportunities and lost no time in promoting their machinery. The degree to which the new technologies used in sugar-making were compatible with slave labor remains debated but need not concern us here.[65] Certainly in the Northeast of Brazil, tenants and wage laborers replaced slaves.

In 1874, the world's major maker of sugar machinery, the French enterprise of Cail et Cie, published details about its equipment: one machine could crush 120 tons of cane per 24 hours and the other 250 tons giving a daily sugar output respectively of 10-12 tons and 20-25 tons.[66] Thirty years earlier, Derosne e Cail had published an article in Brazil's *Revista Auxiliador da Indústria Nacional*, promoting its sugar machinery.[67] French engineers established themselves during the 1840's in the Northeast of Brazil.[68] Two wholly mechanized plants operating in the Campos region of Brazil in 1859 were equipped with Derosne et Cail machinery: one mill owned by Baptiste Pereira d'Almedia and the other by the Barão de São João da Barra.[69] A report on the Universal Exhibition of 1876 in Philadelphia said that Bahia then possessed a sugar refinery being operated on the Derosne-Cail system, no doubt the one in Itapagipe, Dous de Julho, advertised in 1874 in the *Jornal da Bahia*.[70] The Dous de Julho, owned by Sergio e Cia, was capitalized at 200:000$000 (or US$110,000 in 1875).



The International Exhibition: Sugar-Refining Apparatus of Cail and Co., of London. Wood engraving from *The Illustrated London News* dated 1862 (source: http://www.philographikon.com/tropicalplants.html)

The making of sugar from cane is a process involving many step for which separate machines are used, e.g., crushers in mills, filters, evaporators and heaters, centrifugal separators, boilers, defecators, condensers and crystallizers. The process of making sugar from cane was well captured in a diagram by Mattos. [71]



The U.S Consul in Bahia, H.W. Furniss, provided a rare glimpse into the sugar industry of Bahia in 1902.[72] He stated that the 18 operating sugar factories in Bahia are divided into two classes: the central factories with vacuum pans and centrifuges and the small, open-kettle system factories. In the former group, one finds factories in which the government pays guaranteed interest on the capital invested and factories which depend upon private resources. The former was made

up of the two factories completed by Bahia Central and two incomplete factories (the usina Conde and Cotegipe). Both factories were barely operating having not covered expenses during1900-2. The second group of usinas was made up of three factories, all located in the Santo Amaro area and though consul Furniss does not name them, they are the Alliança, the São Bento and the Terra Nova. The second class comprised thirteen factories; some were being run by Scotchmen for the owners. Consul Furniss mentions a last group, the large number of small factories with open-kettle boilers for which no reliable statistics existed.

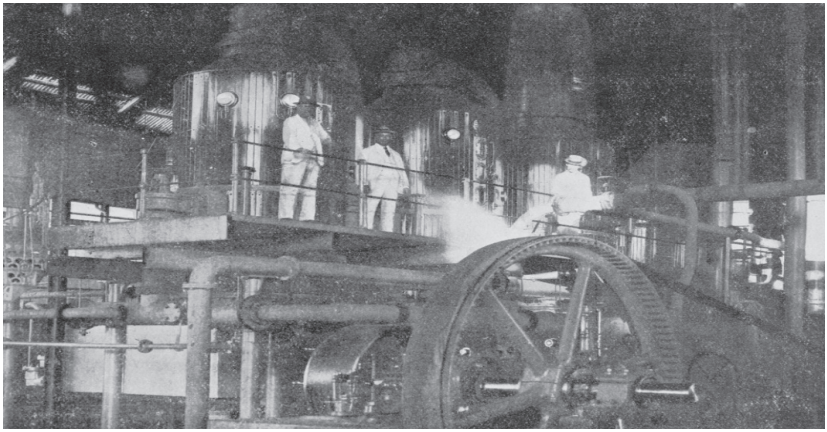
The machinery makers of Glasgow (Duncan Stewart) and northern France (Derosne et Cail, Fives-Lille) were major suppliers during the late 1870's-1890's.[73] British machinery was shipped to Bahia from Liverpool (no doubt on steamers of Lamport & Holt[74]) and French from Le Havre (on the Chargeurs Reunis steamship enterprise which maintained regular bi-monthly service with Bahia) and, in return, sugar from Bahia was destined for New York, Liverpool and Le Havre. French machinery suppliers granted more favorable longer-term credit to equipment purchasers. Whereas the British sugar machinery provide demanded one-third of the payment upon signing the order, another third upon shipment and the last third 90 days after shipment, the French supplier advanced the machinery on mortgage until the first or even second crop was produced.[75] Duncan, Stewart & Co. equipped two usinas and remained a supplier of parts for them well into the 1890's. U.S. Consul Furniss noted in 1902 that one of the three new usinas entering production around Santo Amaro during 1899-1902 was fully equipped with German machinery.[76] Data limitations prevent a comprehensive tabulation of sugar machinery suppliers to Bahia's central sugar factories.

Table 4 - Sample of Usinas in Bahia and Sugar Machinery Suppliers

Name of usina	**Year production began**	**location**	**Sugar machinery supplier(s)**
Rio Fundo	1886	Santo Amaro	Duncan, Stewart & Co. Ltd (Glasgow)
Iguape	1886	Santiago do Iguape	Duncan, Stewart & Co. Ltd (Glasgow)
Bom Sucesso/ Cinco Rios	1880	Bom Jardim - Santo Amaro	Cie Fives-Lille (Lille)
São Bento	189	Santo Amaro	McOnie & Co. (Glasgow); Babcock Wilcox boilers
Pojuca	1886	Catu, Pojuca	Cie Fives-Lille (Lille)

Name of usina	Year production began	location	Sugar machinery supplier(s)
Alliança	1892	Rio Jacuípe, Santo Amaro	Pollock & MacNab Ltd (Manchester)
Passagem	1884	Vila Viçosa, Santo Amaro	From Britain and the U.S.
?	190?	Santo Amaro	Exclusively German machinery (Krupp?)
Terra Nova	1902	Santo Amaro	U.S. machinery (pumps, clarifiers) supplied through W.R. Grace trading enterprise

Source: The following photos convey a sense of the large size of the sugar machinery employed in Bahia's usinas.



The top photo shows the interior of the Usina Paranaguá and the bottom that of the Usina São Carlos. Source: Jose Coelho, *Centenário da Independência da Bahia, 2 de Julho 1823-1923* (Rio de Janeiro: Empreza Brasil Editora Castro Mendonça & C., 1923): 130 and 195

The internal Brazilian market for sugar began growing during the second half of the nineteenth century, spurred on by the explosion of the coffee export complex. By 1900, the sugar factories of Pernambuco and Bahia were selling to the Center-South, especially Rio de Janeiro and São Paulo. During 1905-14, Brazilian sugar output averaged 273,880 tons of which all but 41,082 tons (or 15%) were consumed domestically.[77] During these years, average domestic Brazilian per capita consumption was about 20 pounds, a low figure in comparison to the U.S., the U.K., Argentina and Cuba. The dramatic revaluation of the Brazilian currency – from 25.3 mil réis per pound sterling to 14.8 mil réis per pound sterling in 1910 – simply priced Brazil out of the world sugar market.[78] The only stimulus to Brazilian sugar production came from the internal growth of income and population in the Center-South (the huge immigration inflows boosted such internal market demand for sugar). Brazil's population soared from 17.3 million in 1900 to 30.6 million in 1919.[79] The new domestic market was particularly attractive (and profitable) as it was sheltered from international competition during 1900-20.[80] During 1910/11 – 1914/15, over 90% of Brazil's sugar output was consumed internally.[81] Bahia's sugar output from central factories making the "Uzina" type of sugar consumed domestically rose substantially during 1905/6 and 1920/1, from 25,375 tons to 37,372 tons (Table 3). Yet, Bahia's sugar yield simply could not compete with that found in Java, the Sandwich Islands, Cuba, Campos or São Paulo:

Table 5 - The Relative Productivity of Bahia's Sugar Production, c.1920

	Sugar tons per hectare	**Per cent sugar yield**
Sandwich Islands	82	15-15.5
Java	80	14-15.5
Cuba	50	13-15
São Paulo	50	13-14.5
Campos	50	14.5-15.5
Alagoas	55	12-15
Bahia	45	11-12

Source: Arno S. Pearse, *Brazilian Cotton Being the Report of the Journey of the International Cotton Mission. Through the States of São Paulo, Minas Geraes, Bahia, Alagoas, Sergipe, Pernambuco Parahyba, Rio Grande do Norte* (Manchester: Taylor, Garnett, Evans & Co., 1922): 178

Technological innovations in Java served to raise sugar production from a mere 5,000 tons in 1810 (about 3% of world production) to 744,000 tons in 1900 (14% of would production).[82] In the end, the growth of modern usinas in Bahia could not stem secular decline of Bahia's sugar sector. Whereas in the later 1850's,

annual sugar output hovered around 2.5 million arrobas (or 36,900 tons) in 1900-1 it was 22-25,000 tons.[83] In 1902, only 1,294 tons of sugars were exported out of an annual output of 15,456 tons, that is, a mere 8%, most of the state's sugar was being consumed domestically (in Bahia and Rio de Janeiro).

What had begun as a euphoric embrace of a technological solution to Bahia's sugar crisis in the late 1870's was frustrated by socio-cultural limitations, poor coordination between cane suppliers and the central sugar factory and simply an insufficient lack of resources devoted to modernizing Bahia's sugar industry (as a comparison with the massive investments made in Cuba reveals). The trade in sugar machinery did create a commodity chain linking Europe's old industrial working class with steamship enterprises and railroad and water transportation in Bahia which ultimately delivered the machinery to the usinas where impoverished "free labor" toiled often supervised by foreign engineers.

Notas

1 From Consul Richard A. Edes, "Bahia [November 1, 1874]," Annual Report of the Commercial Relations Between the United States and Foreign Nations Made by the Secretary of State for the Year Ending September 30, 1874 (Washington: Government Printing Office, 1875): 166. Data demonstrating the decline of Bahia's sugar production and exports after peaking in the early 1850's may be found in B.J. Barickman, A Bahian Counterpoint. Sugar, Tobacco, Cassava, and Slavery in the Reconcavo, 1780-1860 (Stanford: Stanford University Press, 1998): 35, Figure 4 which plots data for 1789-1860.

2 Consul Morgan, "Brazil. Bahia," in Commercial Reports Accounts and Papers: Forty-Four Volumes. Vol. 34 (February 8 – August 15, 1876): 754

3 Instituto Brasileiro Geographico Economico (IBGE), Annuario Estatistico, 1939-40 (Rio de Janeiro: Imprensa Nacional, 1941): 1379

4 Noel Deerr, The History of Sugar (London: Chapman and Hall, 1949): 505

5 Alain Huetz de Lemps, La Canne a Sucre au Bresil (Talence: Centre d'Etudes de Geographie Tropicale (CNRS), Universite de Bordeaux, 1977): 65

6 Another concern was the huge increase of European beet sugar output. Peter L. Eisenberg, "The Consequences of Modernization for Brazil's Sugar Plantations in the Nineteenth Century," in Kenneth Duncan and Ian Rutledge (eds), Land and Labour in Latin America. Essays on the Development of Agrarian Capitalism in the Nineteenth and Twentieth Centuries (Cambridge: Cambridge University Press, 1977): 343-367

7 Roberta Barros Meira, "Os Novos Aparelhos de Fabricar Açúcar: os Engenhos Centrais e o Processo de Modernização da Agroindústria Açucareira" (São Paulo: paper presented at Anais do XIX Encontro Regional da História: Poder, Violência e Exclusão, ANPUH/SP – USP, September 8-12, 2008) at http://www.anpuhsp.org.br/downloads/CD%20XIX/PDF/Autores%20e%20Artigos/Roberta%20Barros%20Meira.pdf Also Gabriel A.M. Bittencourt, "A Política Brasileira dos Engenhos Centrais: 1875-1915. Economia e Legislação," Revista do Instituto Histórico e Geográfico Brasileiro 343 (1984): 7-15

[8] The role of technology in Bahia's sugar industry during 1790-1860, is analyzed in F.W.O. Morton, "Growth Innovation: The Bahian Sugar Industry 1790-1860," Canadian Journal of Latin American Studies 5, 10 (1980): 37-54. See also Gadiel Perruci, A República das Usinas: Um Estudo de História Social e Econômica do Nordeste, 1889-1930 (Rio de Janeiro: Paz e Terra, 1977), 246 pp.

[9] Steven Topik, "The State's Contributions to the Development of Brazil's Internal Economy, 1850-1930," Hispanic American Historical Review 65, 2 (1985): 217

[10] Consul Morgan, "Bahia," in Reports from Her Majesty's Consuls on the Manufactures, Commerce, &c of Their Consular Districts. Part I. (London: Harrison and Sons, 1880): 460.

[11] as for example expressed by an engineer in the employ of the Cie Fives-Lille, Isidore Moreau, "Indústria Saccharina do Brasil," Correio da Bahia (November 6, 1877): 1-2

[12] The diffusion of textile machinery has received some treatment, e.g. as by David J. Jeremy, Transatlantic Industrial Revolution: the Diffusion of Textile Technologies between Britain and America, 1790-1830s (Cambridge: MIT Press, 1981). The foreigner in Brazilian technology is analyzed in Joseph R. West, "The Foreigner in Brazilian Technology, 1808-1900" (Chicago: unpublisged Ph.D dissertation, University of Chicago, 1949). The export of sugar-making machinery from Scotland is examined in A.A. Ramos Mattei, "The Role of Scottish Sugar Machinery Manufacturers in the Puerto Rican Plantation System, 1842-1909," Scottish Industrial History 8,1 (1985): 20-30. A single study examines the diaspora of foreign enginners, see R.A. Buchanan, "The Diaspora of British Engineering," Technology and Culture 27, 3 (July 1986): 501-524. A recent publication provides a thorough exploration of foreign engineers and machinery in the Cuban sugar industry using a commodity chain framework, see Jonathan Curry-Machado, " 'Rich Flames and Hired Tears': Sugar, Sub-Imperial Agents and the Cuban Phoenix of Empire," Journal of Global History 4 (2009): 33-56.

[13] Derived from Graham (1968), op. cit.: 332

[14] Data from Amaral cited in Edward Cooper Haskins, An Agricultural Geography of the Reconcavo of Bahia (Minneapolis: unpublished Ph.D dissertation, University of Minnesota, 1956): 77

[15] Alain Huetz de Lemps (1977), op. cit.: 99

[16] In the engenhos centrais, the mill purchased cane from suppliers, whereas in the usinas the cane came from its own lands. The irregularity of cane supply prompted the move from engenhos centrais to usinas. The engenhos centrais are described in Tatiana Brito de Araujo, Os engenhos centrais e a produção açucareira no Reconcavo Baiano (Salvador: Federacao das Industrias do Estado da Bahia, 2002) at http://www.fieb.org.br/premioeconomia/engenhos.pdf .

[17] Benjamin Taylor, "The Brussels Sugar Convention," The North American Review 190, 646 (September 1909): 354

[18] See Gabriel Augusto de Mello Bittencourt, "Açúcar e Modernização: O Caso de Vila Franca," Revista do Instituto Histórico e Geográfico Brasileiro 349 [1985]: 91-113. The sugar factories in the province of São Paulo during 1875-1889 are analyzed in Roberta Barros Meira, "Processo de modernização da agroindústria canavieira e os engenhos centrais na Província de São Paulo," História e Economia Revista Interdisciplinar 3, 1-2 (2nd semester 2007): 39-53

[19] The history of Cail's sugar-making machinery in the French Caribbean is analyzed in Jean-Louis Thomas, Jean-Francois Cail Un Acteur Majeure de la Premiere Revolution Indusrtrielle (Deux-Sevres: Association C.A.I.L., 2004):165-216

[20] Jeanne Gaillard, "Les usines Cail et les ouvriers metallurgists de Grenelle," Le Mouvement Social No. 33/34 October 1, 1960): 35-53.

[21] Michael Stephen Smith, The Emergence of Modern Business Enterprise in France, 1800-1930 (Cambridge: Harvard University Press, 2006): 210

[22] ibid

[23] Mentioned in Barickman (1998), op. cit.: ftn 44 on p. 240.

[24] The Banque de Paris et des Pays-Bas worked alongside the Cie Fives-Lille to secure the construction contract for the railroad linking San Cristobal and Tucuman. Its international operations are examined in Armand Kingue, "La strategie internationale de la Banque de Paris et des Pays-Bas" (Paris: these en gestion financiere et fiscalite, Universite de Paris 1, 1982) and in Henri Claude, Histoire, Realite et Destin d'Un Monopole. La Banque de Paris et des Pays-Bas et Son Groupe (1872-1968) (Paris; Editions Sociales, 1969) :22.

[25] Perruci, op. cit.: 75 and details in Francisco Foot, Victor Leonardi, Historia da Indústria e do Trabalho no Brasil: Das Origems aos Anos Vinte (São Paulo: Global Editora, 1991): 69 and Zoia Vilar Campos, Doce Amargo. Produtores de Açúcar no Processo da Mindanca Pernambuco (1864-1941) (São Paulo: Annablume, 2001): 33 ff

[26] Perruci, op. cit.: 75

[27] "As Usinas de Açúcar" at http://www.pontenova.com.br/usinas.html

[28] Perruci, op. cit.: 75

[29] "Decreto No. 8395 de 4 de Fevereiro de 1882," in Collecao das Leis do Imperio do Brazil de 1882 vol. I (Rio de Janeiro: Typographia Nacional, 1883): 142

[30] Professor Carlos Abreu, "Usina Brasileiro: Um Caso de Successo em Terras Atalaienses," at http://professorcarlosabreu.blogspot.com/2009/05/usina-brasileiro-um-caso-de-sucesso-em.html (dated May 22, 2009). The site has some excellent photos of the old Usina Brasileiro.

[31] Vandesmet died at the usina in 1932.

[32] Alain Huetz de Lemps (1977), op. cit.: 99

[33] Details in Danillo Fragoso, Boulitreau, Senhor do Engenho Francês em Pernambuco (Recife: Museu do Açúcar, Imprensa Universitária da UFPE, 1970), 106 pp.

[34] from Richard Graham (1968), op. cit.: 151, but data in "Bahia Central Sugar Factories," Monthly Bulletin of the Bureau of the American Republics vol. 8 (1900): 412

[35] F. Simoens dos Santos, "Sugar-Producing Provinces of Brazil," in Reports of the Consuls of the United States 24 (October-December 1887): 227

[36] James W. Wells, "Appendix F. Central Sugar Factories in Brazil," in Three Thousand Miles through Brazil from Rio de Janeiro to Maranhão (Philadelphia: J.B. Lippincott Company, 1886): 344-46

[37] Graham (1968), op. cit.: 152

[38] Other difficulties are mentioned by de Lemps (1977), op. cit.: 69-70

[39] "Brazil," Appleton's Annual Cyclopedia and Register of Important Events of the Year 1888, Vol. 13 (New York: D. Appleton and Company, 1889): 105

[40] Consul-General Eugene Seeger, "The Sugar Trade in Brazil," Consular Reports on the Commerce, Manufactures, Etc vol. 58 (1901): 554-55

[41] From 1889-1904, Cail supplied 4 million French Francs in sugar machinery to Egypt and Fives – Lille had built three sugar factories at a cost of 15 million Fr. Frs (from Le Mois Scientifique et Industriel. Revue Internationale d'Information 7, No. 65 (January 25, 1905): 384-85).

[42] "Marketing Industrial Machinery in the Netherlands East Indies," Trade Information Bulletin No. 633 (Washington D.C.: Bureau of Foreign and Domestic Commerce, Department of Commerce, 1929): 12-13.

[43] Alain Huetz de Lemps (1977), op. cit.: 70

[44] J.H. Galloway, The Sugar Cane Industry: An Historical Geography from Its Origins to 1914 (Cambridge and New York: Cambridge University Press, 2005): 161

[45] Lucien Lanier, L'Amerique. Choix de Lectures de Geographie (Paris: Berlin Freres, 1900): 519. A large factory in Cacau, Pernambuco, which in 1905 crushed 280 tons of cane sugar a day, making 28 tons of sugar a day, was equipped with machinery from Cie. Fives-Lille (Percy Falcke Martin, Through Five Republics (of South America) (New York: Dobb, Mead and Company, 1906): 213).

[46] Castillo Fernando, "A Saga Industrial do Leão no Norte," Jornal do Comércio Online (Recife) at http://www2.uol.com.br/JC/_1999/80anos/80d_28.htm

[47] Benjamin Taylor, "The Brussels Sugar Convention," The North American Review 190, 646 (September 1909): 355

[48] A report by Charles Seigneuet cited in O.P. Austin, Sugar Industry of Brazil," in The World's Sugar Production and Consumption, Showing the Statistical Position of Sugar at the Close of the Nineteenth Century (Washington D.C.: Bureau of Statistics, Treasury Department, 1902): 2677

[49] Diário da Bahia (July 7, 1902)

[50] Kestell (1973), op. cit.: 71

[51] Alain Huetz de Lemps (1977), op, cit.: 70-71

[52] Kestell, op. cit.: 68-69

[53] See also Diario Official do Estado da Bahia. Edição Especial do Centenário 1823-1923 (Salvador: Estado da Bahia, 1923): 155 which notes that The 19201/22 sugar harvest from usinas amounted to 766,604 sacks of which three usinas (the Aliança, São Bento and Terra Nova) accounted for 45%.

[54] Graham (1968), op. cit.: 153-56

[55] Goes Calmon (1926), op. cit.: 119-120

[56] O.P. Austin, "Sugar Industry of Brazil," in The World's Sugar Production and Consumption Showing the Statistical Position of Sugar at the Close of the Nineteenth Century (Washington: Bureau of Statistics, Treasure Department, January 1902): 2677.

[57] M. Leroy, "Le Secheur Huillard en sucrerie de cannes, son application au sechage de la bagasse de diffusion a l'Usine Esther (Bresil)," Bulletin des Chimistes de Sucrerie et de Distillerie de France et des Colonies Vol. 24 (1906-7): 1199. But de Lemps (1977: 69) wrote that the first central sugar factory using the diffusion method was in Barcelos (Campos (opened c. 1878)).

[58] "The Sugar World," The Louisiana Planter and Sugar Manufacturer, A Weekly Newspaper XXIX, 24 (December 18, 1902): 376

[59] Graham (1968), op. cit.: 157

[60] Graham (1968), op. cit.: 158

[61] Explored in Jaime Jose Reis, "From Bangue to Usina: Social Aspects of Growth and Modernization in the Sugar Factories of Pernambuco, Brazil, 1850-1920," in Kenneth Duncan, Ian Rutledge (eds), Land and Labour in Latin America (Cambridge: Cambridge University Press, 1977): 369-96.

[62] Graham (1968), op. cit.: 159

[63] Kenneth Pomeranz and Steven Topik, "7.1. Sweet Industry: The First Factories," in World That Trade Created. Society, Culture and the World Economy 1400 to the Present (Armonk: M.E. Sharpe, 1999): 226-229

[64] This question is explored in Dale W. Tomich, Through the Prism of Slavery: Labor, Capital, and World Economy (Lanham: Rowman & Littlefield, 2004): 88-93

[65] Mentioned in Meira (2008), op. cit.

[66] Mentioned in Meira (2008) who cited Joaquim Fernandes Ribeiro, Publicação Demonstrando aos Lavradores e mais Interessados as Vantagens das Fábricas Centrais de Açúcar (Bahia: Typografia do Diário, 1874)

[67] Mentioned in Alain Huetz de Lemps, La Canne a Sucre au Bresil (Talence: Centre d'Etudes de Geographie Tropicale, 1977): 41

[68] From Charles Ribeyrolles and Victor Frond, Brazil Pittoresco. Campos dos Goitacazes Tome III (Rio de Janeiro: Typographia Nacional, 1859); 14-15

[69] In 1874, British Consul Morgan of Bahia had noted that Bahia possessed "valuable factories for refining sugar, one of them operating on the system of Derome et Caille" (sic. really Derosne et Cail), from Consul Morgan, "Bahia," Reports from her Majesty's Consuls on the Manufactures, Commerce, &… of the Consular Districts. Part IV (London: Harrison and Sons, 1875): 1396

[70] A diagram of sugar-making process is presented in Anibal R. Mattos, Açúcar e Álcool no Brasil (Sao Paulo: Companhia Editora Nacional, 1942): 77-78

[71] H.W. Furniss, "Sugar Industry in Bahia," Consular Reports – Commerce, Manufactures etc. vol. 69 (1902): 584-589

[72] The sugar machinery manufacturers of Glasgow are described in Angus McLean (ed), Local Industries of Glasgow and the West of Scotland (Glasgow: Local Committee for the Meeting of the British Association, 1901): 63-66

[73] The acting British consul in Rosario, Argentina, for example noted in 1878 that large amounts of sugar-making machinery were being imported from Europe on steamers of the Lamport and Holt line.

[74] From "British Machinery in Brazil," The Board of Trade Journal (July 1895): 70-1

[75] Consul H.W. Furniss, "Sugar Industry in Bahia," Consular Reports. Commerce, Manufactures etc. vol. LXIX, no. 263 (August 1902): 586

[76] Perry Elliott, "Production of Sugar in the United States and Foreign Countries" (Washington D.C., U.S. Department of Agriculture, Bulletin No. 473, February 12, 1917): 30

[77] Kestell (1973), op. cit.: 81

[78] de Lemps (1977), op. cit.: 72

[79] Tamas Szmrecsanyi, "Growth and Crisis of the Brazilian Sugar Industry, 1914-39," in Bill Albert and Adrian Graves (eds), The World Sugar Economy in War and Depression, 1914-40 (London and New York: Routledge, 1988): 59-61

[80] data in Szmrecsanyi, op. cit.: 58

[81] Examined in Margaret Leidelmeijer, Van Suikermolen tot Grootbedriff: Technische Verniewing in de Java- Suikerindustrie in de Negentiede Eauw (Amsterdam: Nederlands Econmisch-Historisch Archief, 1997), 388 pp.

[82] Data for the 1850's from Barickman (1998), op. cit.: 35; data for 1900 from O.P. Austin (1902), op. cit.: 2677 and for 1901-2 from "Brazil. Report for the Year 1902 on the Trade of Bahia," Diplomatic and Consular Reports No. 3061 Annual Series (1903): 8 and 13.

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