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In: New West Indian Guide/ Nieuwe West-Indische Gids 63 (1989), no: 1/2, Leiden, 94-117

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THE SURINAME RAT RACE:
LABOUR AND TECHNOLOGY ON SUGAR PLANTATIONS,
1750-1900

In their article in this issue, Boomgaard & Oostindie deal with the question of whether an abundance of cheap slaves was an obstacle to efficiency in sugar production, and whether slavery and advanced sugar technology were incompatible.¹

Addressing these same questions, I shall focus on the history of innovations on Suriname sugar plantations, the development of productivity and profitability, and on the attitudes to innovation among those engaged in Suriname sugar production.

SUGAR AND COFFEE

Although Sugar was King for the better part of the past three centuries in the Caribbean, it is often forgotten that this "sweet monarchy" came under attack many a time and sometimes even suffered a defeat. This was the case for instance in Suriname between 1750 and 1820 (Van Stipriaan 1988: 2). During this period the export value of coffee surpassed that of sugar; between 1760 and 1790 it was even two to four times as high. This temporary predominance of coffee had decisive effects on the development of the sugar sector of the Suriname plantation economy. An analysis of the latter would therefore be incomplete without some preliminary remarks on the coffee sector.

Coffee was introduced to Suriname during the second decade of the eighteenth century. At first mainly a side crop on sugar plantations, it gradually became a plantation sector in its own right. Coffee proved to be so profitable that during the second half of the eighteenth century not one single new sugar plantation was laid out. In the third quarter of that

century, when an abundance of capital in the Netherlands led to large-scale investments in the Suriname plantation economy, almost three quarters of this capital flow was invested in the coffee sector.² Within just a few years at least 150 new coffee plantations were laid out. In the early 1760's the coffee plantations greatly outnumbered the 116 sugar plantations (Pistorius 1763: 26).

Many of these sugar plantations were located in the sandy interior of Suriname. By the time the soils there became exhausted, virtually all the fertile clay lands of the coastal plain had already been occupied by coffee plantations. Lacking alternatives, many sugar plantations had to be abandoned.

The capital flow to the coffee sector also gave this sector an advantageous position on the slave market.

Finally, the abundance of credit facilities, particularly in the coffee sector, resulted in the emergence of a new group of planters. Not hindered by any lack of capital, nor by great experience in planting, they tended towards conspicuous consumption, speculation and sometimes fraud.³ In combination with the soil-exhausting properties of coffee and the fact that mortgage credit was based on the ever increasing appraised value of the plantation instead of the soon decreasing average turnover, this resulted in rocketing debts and an inability to repay their loans in regular installments, or even to pay the interest. As a result, the confidence of Dutch investors was severely damaged, and in the late 1770s credit facilities came abruptly to an end. This was, however, not restricted to the coffee sector, but applied to the Suriname plantation economy as a whole, in spite of the fact that the sugar sector was far less in debt than was the coffee sector.

During the first half of the nineteenth century many coffee plantations were abandoned. This had two important effects on the sugar sector. First, at least 25 of these plantations changed to sugar production. By 1857, well over a quarter of all sugar plantations had formerly produced coffee (Hering 1858: appendix). Due to the long period of exhaustive coffee growing, sugar productivity on these plantations turned out to be far below that of 'authentic' sugar plantations (Van Stipriaan 1988: 5-6). Second, the sugar sector as a whole profited from the abandonment of many coffee plantations by taking over their slave forces. It should be added that this caused a great deal of unrest. Not only did many slaves resist leaving their birthplace, but they often simply refused to work on a sugar plantation, where labour conditions were generally much harsher than those reigning on coffee plantations.

It is clear, then, that an analysis of only one sector of a mixed plantation economy such as the Surinamese would be incomplete: the interaction between the sectors was of great significance. It was no coincidence that sugar production and productivity in Suriname were low when coffee was at its zenith (1770s) and vice versa (1830s).

This interaction also bears on the question of whether abolition of the African slave trade, and eventually slave emancipation, were consequences of declining profits and a quest for free labour. At first sight the data about the deterioration of the once dominant coffee sector and about the enormous indebtedness (also in part of the sugar sector) suggest a confirmation of the decline thesis. Yet when the slave trade was abolished in Suriname (1808), it was precisely at a moment when sugar was recovering, fresh capital (from England) was being pumped into the plantation economy, and a virtually new sector (cotton) was emerging. As a consequence of the Napoleonic wars, Suriname at that time formed part of the British Empire,⁴ and the abolition of the slave trade was simply imposed on the Surinamese planters. After Suriname was again ceded to the Dutch in 1816, it took almost another half a century before slavery itself was abolished. Further on we will discuss whether or not the late date of Emancipation may be seen as proof that slavery constituted no obstacle to technological progress and expansion.

TECHNOLOGY ON SUGAR PLANTATIONS: INFRASTRUCTURE AND THE FACTORY

From North to South, in Suriname, a swampy coastal plain of sea clay with sand ridges, gives way to a sandy savanna belt. This in turn is followed by rocky highlands, which cover the greater part of the country. The first sugar plantations were located along the river banks in the savanna belt and in the intermediate area between it and the low lying coastal plain.

In the beginning of the eighteenth century, new sugar plantations were laid out along the more fertile banks of the Lower Cottica and Suriname rivers. The infrastructural problems posed by these wet, swampy lands demanded new technical solutions, of which the construction of *polders* was the most important. Trenches were dug and dikes erected to drain these lands, and to protect them from floods. Each of these plantations contained two separate water systems: one took in water from the river and acted as a transportation network for flat-bottomed vessels which carried cane from the fields to the factory; the other drained off water from the cultivated fields to the river. Because of the opposite functions

of these two systems, it was crucial that they be in no way connected. Both systems were equipped with costly hydraulic devices, such as sluices, and several types of culverts.

Drainage was further facilitated by planting the cane on plant beds, intersected by small gutters. This lay-out was to become a major obstacle against the use of the plough in Suriname. On the other hand, the water system, in combination with the tides of the rivers in these lowlands, favoured the use of water mills which generated more grinding power than the animal traction mill. Thus the introduction of one innovation (*polders* and water systems), at the same time prevented (ploughs) and promoted (watermills) other innovations.

Initial expenses for the installation of a water mill were much higher than for an animal traction mill. Hence, their introduction took place only gradually during the eighteenth century. Some planters stuck to their animal traction mills well into the nineteenth century either because of the location of their plantation or because of lack of capital, or both. As it turned out in the long run, plantations with water mills stood a much better chance of survival than plantations using animal power.

TABLE 1: TYPE OF SUGAR MILL AND CHANCE OF SURVIVAL

period	source of energy			sugar cultivation abandoned
	animal	water	steam	
1745-1760	34	9	–	–
1775-1780	15	26	–	2
1857	–	11	18	14

Source: Sample of 43 plantations ARA: SONA; Hering 1858: app.

Of the fourteen plantations in this sample which were abandoned by 1857, 12 had been operating an animal traction mill around 1750, and ten of these had used it to the end. Some 80% of the plantations in the sample changed to a more sophisticated type of mill during the years 1745 – 1857; half of these changes occurred during the eighteenth century. Almost one fifth of the plantations concerned changed twice during this period.

More sophisticated mills provided a higher cane crushing and processing capacity. As a consequence, changes also took place in the boiling house.

The growing number of boiling pans shows that an increasing quantity of cane (liquid) could be handled at one time. This was not only due

TABLE 2: NUMBER OF BOILING PANS PER PLANTATION 1740 – 1855

period	average number of pans	standard number with type of mill		
		animal	water	steam
1740-1769	5.3	5	6	–
1780-1809	6.7	5	8	–
1825-1855	7.9	5	8	10

Source: two samples of each 15 eighteenth-century and 13 nineteenth-century plantations. ARA: SONA; plantation records.

to the higher capacity of new types of mills, such as the steam mill introduced around 1815, but also to innovating adaptations in existing mills. For instance, from the end of the eighteenth century cast iron came to replace wood (crushers, waterwheel) and red copper (boiling pans) as the basic material. Also, after about 1820 an increasing number of mills had horizontally-placed cane crushers – which had more power – instead of the traditional vertical ones.

These innovations aimed at increasing cane productivity by raising the extraction rate of juice from cane. After the abolition of the slave trade new labour-saving innovations were added. One example was the introduction of the *doubleuse* or “trash turner” which appeared rather late in Suriname.⁵ This device consisted of a curved shield behind the mill rollers, which turned the crushed cane (“trash”) automatically back for a second crushing. This saved the labour of several slaves who had formerly performed this task by hand.

Another labour-saving innovation was the use of coal instead of wood as fuel for the steam engines. In the 1820s at Meerzorg plantation for example, this costly change was deliberately introduced “to save hands from chopping wood” (Teenstra 1835 I: 223).

In fact, the steam mill itself was a life- and labour-saving device. A steam engine could be put to work at any time. In contrast, a water mill only operated when the tide was high (16 days a month), during which time it was used day and night. Cutting cane during the day did not necessarily excuse a slave from also having to operate the mill at night. Labour shifts lasting more than 24 hours were no exception on these plantations.⁶ This of course had a devastating effect on the slaves’ health. A government enquiry revealed that during the period 1838 – 1842 the excess of deaths over births on nine water mill-equipped plantations was 13.5%, whereas this figure for ten steam-equipped plantations was ‘only’ 6.4%.⁷ Although other variables may also have influenced this difference

in mortality, these figures do seem to indicate that the use of steam power was labour-saving in a very literal sense. Yet, owing to costs, it took some time before steam engines were no longer an exception: in 1833, 28% of the sugar plantations possessed such a device, while in 1862 this had increased to 66%.⁸

Yet, all of these innovations were labour-saving only to a degree. Large scale mechanization only gained momentum around 1850, a date still well before Emancipation (1863). In a few years, 16 out of 86 sugar plantations adopted steam-driven cane and trash carriers, three plantations started to operate a central factory system, two others were equipped with vacuum pans and six began to work with centrifugal devices (Hering 1858: appendix). The latter three innovations both saved labour and increased output. By 1863, a significant part of the sugar sector was thus as highly mechanized as possible.⁹

Technology in the field

The distinction between output-increasing and labour-saving innovations can also be applied to cane field technology. Improvement (or stabilization) of soil fertility by manuring was an example of the first kind. From the end of the seventeenth century it was applied in several parts of the Caribbean (Watts 1987: 399-402). In Suriname the only manuring practices were flooding the fields with river water (and mud) when they had to lie fallow for some years, spreading mud dug up from the trenches of the water systems over the fields, and, during the first part of the growth cycle, leaving the cut cane leaves to rot on the ground. The latter practice however, was usually rendered less effective by burning the fields after the harvest, thereby damaging the top soil. Cow dung or other natural fertilizers were never used in Suriname and it was not until the very end of the nineteenth century that the first reluctant experiments were carried out with artificial fertilizers such as superphosphate and lime.¹⁰

In contrast to their neglect of Caribbean methods of manuring, the Suriname planters were among the first to introduce the most important innovation outside the factory, i.e. new, more productive cane varieties that were to replace the Creole cane. Imported in Suriname in the late 1780s, the Otaheite and Moluccan varieties had come into general use around 1800.¹¹ This resulted in a considerable increase in cane productivity (table 5); at the same time, however, soil resilience decreased severely (Reyne 1922: 23; Watts 1987: 435).

As for labour-saving innovations in the field, no mechanization whatsoever took place in Suriname. In the period under discussion, all over the world

cane cutting was done by hand. Further, as we have seen, the absolute necessity of using plant-beds and drainage trenches in the swampy lands of Suriname prevented the use of the plough.¹² Therefore cane cutting and hoeing in the heavy sea clay remained among the most labour intensive and backbreaking of plantation routines.

In the transportation of the cane to the factory grounds some innovations did occur. On the oldest plantations slaves or oxcarts had done this job. Later, when water systems had come into general use, wooden vessels, punted by slaves, had come to replace them. In the nineteenth century, these again were replaced by iron boats, often pulled by animals. At the end of that century the central factory at the Marienburg plantation, then the most advanced in Suriname, was connected to its five supplying plantations by twelve kilometers of railway tracks (Hoeft 1987: 183).

Ratooning was general practice in Suriname. Compared to some other Caribbean countries, where after every harvest cane had to be replanted, this in itself was a labour saving technique (Watts 1987: 404/405). By further increasing the number of ratoons as happened in Suriname, more labour could be saved (Table 3).

During the eighteenth century production up to and including the fourth ratoon was considered to be optimal. This changed rapidly after the turn of the century. From then on, the same cane stools were used for an increasing number of harvests. Although De Resolutie is the only plantation with post-Emancipation figures, ratooning practices there suggest that this trend continued after 1863. But this change can no longer be considered innovative, for the increase of ratoon age was accompanied by a fall of cane productivity. The fifth ratoon, for example, produced only half as much sugar as the first one.¹³ Instead of being innovative, this policy can only be explained as a consequence of labour scarcity.

Finally, the concentration of labour-intensive activities, such as cutting the cane within a limited period, might have been labour-saving or rather, cost-reducing, particularly during the post-emancipation era. Indentured labour systems however, based on five-year contracts, made this not a viable option. In fact, the opposite happened. In Suriname, owing to the wet seasons, four to five months of the year are less suited to cane cutting, and during the eighteenth century no cane was cut during, on average, 4.3 months a year. During the nineteenth century, before and after Emancipation, this period was reduced to 3.6 months on average.¹⁴ This not only contradicts the theory that during slavery these activities were more spread out over the year to keep the (supposedly abundant) labour

TABLE 3: CANE ACREAGE PER RATOON 1750-1880
(as percentage of total cane acreage)

period	r a t o o n - a g e							(n)
	1	2	3	4	1-4	5	>5	
ca. 1750	24%	22%	18%	17%	81%	10%	9%	29
ca. 1790	27	23	19	15	84	6	10	20
ca. 1825	30	15	15	11	71	15	14	20
ca. 1855	25	22	13	5	65	17	18	9
'De Resolutie'								
1835	16	25	12	7	60	13	27	
1880	17	2	19	10	48	21	31	

Source: Sample ARA: SONA and SNA; plantation archives.

De Resolutie: ARA: SNA, 108 and Rademakers 1985: 99.

force busy, it also suggests that planters were forced to expand cane cutting to less favourable seasons as a consequence of labour scarcity.

PRODUCTIVITY

If slavery had been incompatible with innovation, productivity would have remained at more or less the same level until 1863, to expand only after that date. Yet as we have seen, innovations were introduced long before Emancipation. The question then is: to what extent did these changes influence productivity levels?

TABLE 4: THE AVERAGE PLANTATION 1750-1899.

year	slaves	fieldhands	cane- fields (ha.)	produc- tion (tons)	total number of plantations
ca.1750	113	59 (52%)	52	62.4	135
ca.1790	142	61 (43%)	68	73.8	101
ca.1825	130	62 (48%)	68	120.4	95
1854	208	87 (42%)	87	198.5	86
1862	230	93 (40%)	93	183.7	86
1882	-	190	116	288.1	34
1899	-	710	285	1,366.7	7

Source: see note¹⁵

Between 1750 and 1900 the total number of sugar plantations dwindled from 135 to 7, while during the same period another 50 plantations were established, only to be abandoned again. At the same time the average plantation kept on expanding. Although, for instance, the number of plantations fell between 1750 and 1862 by well over 36%, total cane acreage and total slave population in the sugar sector expanded by 4 and 26% respectively.¹⁶ Changes in the demographic composition of the slave force, it should be noted here, gradually made the total slave population less productive, due to the decrease in, and finally the end of, slave imports (see also table 8).¹⁷ Nevertheless, productivity in general rose spectacularly. Total output of the seven remaining plantations in 1899 still exceeded that of 135 plantations in 1750 by 27%.¹⁸

In order to allow for comparison, I have computed productivity per slave as well as per field hand. Productivity per field hand provides us with the most realistic view, because these labourers took care of most activities in sugar production, and their number relative to the total slave force changed in the course of time. Comparison with the post-emancipation era is also easier this way.

TABLE 5: PRODUCTIVITY OF THE AVERAGE SUGAR PLANTATION 1750-1899

year	production per slave (kg.)	fieldhand (kg.)	ha. cane (kg.)	ha. cane per fieldhand
ca.1750	552	1,058	1,200	0.9
ca.1790	520	1,210	1,085	1.1
ca.1825	926	1,941	1,770	1.2
1854	954	2,281	2,281	1.0
1862	799	1,976	1,976	1.0
1882	-	1,519	2,493	0.6
1899	-	1,924	4,803	0.4

Source: see note 15.

Until shortly before Emancipation productivity per field hand appears to have been constantly on the rise. For a long time this was probably the result of making the slaves work harder, stimulated by the whip, because until the 1820s the number of cane fields per field hand was growing too. The unrivalled growth peak of field hand productivity between 1790 and 1825 (+60%) was, however, also the result of the introduction of more productive cane varieties. The general application of new technology in the sugar factory made productivity grow until well into the 1850s. Growth

of productivity by increasing the workload per slave no longer occurred. This is illustrated by the slight decline in hectares per field hand. More protective labour regulations and a reluctance to work hard(er) when Emancipation seemed imminent, might explain the productivity decline in 1862. However that may be, the productivity level of 1854 was never reached again during the rest of the century. Contract labourers could not be forced to work as hard as slaves had done in former years, and the lack of experience of plantation labour among the growing number of Asian immigrants after 1873 depressed labour productivity even further¹⁹. The rise by 1899 was solely due to innovations in field and factory, illustrated by the further reductions in hectares per fieldhand. In sum, slaves were no obstacle to an increase in labour productivity, and in fact proved to be more productive than (semi-) free labourers.

Cane productivity showed a different development. Due to unfavourable climatological circumstances around 1790, productivity in that year was at an all-time low. With the exception of 1862, cane productivity was always on the rise during the nineteenth century. The 1862 figure was probably influenced by labour tensions and neglect of production in the face of Emancipation, but in general terms the application of new technologies pushed up productivity figures. The most influential of these were the introduction of new cane varieties around 1800, the horizontal, steam powered mill, well before Emancipation, and the general application of the vacuum pan in the 1880s.

These data indicate that the rise in cane productivity was certainly not restricted to the post-Emancipation era. A comparison of the increase between 1790 and 1854 with the rise between 1854 and 1899 shows that both were of the same level, i.e. 110%.

PROFITABILITY

A recurring question in the debate about the abolition of the slave trade and of slavery itself, is whether slave-operated plantations were still profitable on the eve of abolition. Definite answers to this question are more often than not frustrated by the scanty, irregular and chaotic material with which the historian has to deal. Unfortunately, Suriname is no exception. Long series of data are almost non-existent, and the remaining scattered data belong to only a few plantations, which makes the samples rather small. Furthermore, particularly during the 1760s and 1770s when Dutch capital was abundant, one half of the sugar plantations was heavily mortgaged, but when it turned out that these mortgages could never be

redeemed they were, in most cases, simply given up, and the investors received shares in the plantations. This complicates a comparison with those plantations that were never mortgaged. Therefore the figures in Table 6 should be viewed as indicative only.

Profitability is computed here as the quotient of average yearly profits and the average number of slaves on the plantations concerned.²⁰ After all, slaves were a constant at every plantation, they constituted the most precious 'capital goods', and they took care of production.

TABLE 6: PROFITABILITY PER SLAVE ON SUGAR PLANTATIONS
1760 – 1862

period	average profit per slave	(n)	average sugar price (per 100 kg)
1760-1769	Fl. - 9	5	Fl. 33
1770-1779	- 15	6	37
1780-1789	- 38	7	41
1790-1799	23	10	85
1800-1809	8	8	40
1810-1819	21	6	86
1820-1829	60	7	39
1830-1839	8	10	31
1840-1849	12	9	25
1850-1862	17	8	28
1880-1889	25	4	18

Source: plantation archives²¹; prices: Posthumus 1943: 125-128; GAR: Hu., 686.

(All sugar prices are Amsterdam market prices, except 1800-1815 which are London market prices).

Despite rising sugar prices, and owing to the increasing burden of mortgage debts in part of the sugar sector, the sector as a whole worked at a loss at least until the 1790s. By then, however, many debts were considered not collectable and counterproductive, and were written off. At the same time sugar prices skyrocketed as a consequence of the Napoleonic wars and the end of sugar exports from Saint Domingue/Haiti, part of which had previously been sold on the Amsterdam market. Furthermore, the slave population in Suriname had dwindled due to falling imports. Due to all these factors, per capita profits rose considerably.

During the first decade of the nineteenth century profitability declined again due to lower prices at the London market where all Suriname sugar

had to be shipped, and the enormous wartime insurance rates that had to be paid on every shipload.

The end of the war, and high prices and increased cane productivity during the following decade, resulted again in rising profits. These were somewhat reduced, however, by high plantation costs, because during the years of British occupation plantation maintenance had often been neglected. After these recovery costs were dealt with, and thanks to ever growing cane productivity, profitability rose to an all time high during the 1820s, despite the fact that sugar prices declined to a much lower (but more normal) level.

This was immediately followed by a severe drop in profitability during the next decade. This cannot be attributed solely to the fall of sugar prices. Prosperity after the Napoleonic wars had persuaded a number of planters to expand their labour force and/or introduce innovations in their factories. The great expenses involved, had a negative effect on profits.

Although after the 1830s the average price level continued to decline, profitability did not deteriorate any further; it even appeared to increase slightly. This suggests that the great modernization expenses were paying off. The further increase in the figures of the last decade before Emancipation appears to support this assumption, although slightly rising prices may also have contributed to the increase in profitability.

Clearly then, in terms of profitability, 1863 was not the most appropriate moment to abolish slavery. At first sight, the end of the 1830s would have been preferable. But then again, low profit levels during this period were not so much a sign of decline, as a consequence of a process of innovation and expansion, the outcome of which eventually was increased production, compensating for low prices.

This process was continued after Emancipation, albeit at the expense of the majority of sugar plantations, which lost the costly rat race. This however, had been a structural phenomenon since the eighteenth century. The remaining plantations turned out to be quite successful, as illustrated by the 1880s figures.

THE PEOPLE

In many eighteenth- and nineteenth-century agricultural handbooks and descriptions of Suriname society, we are made to believe that planters were arrogant, lazy, and opposed to any change:

"One follows the same old course, because it would be something extraordinary to make more effort than necessary."²²

Yet, it is doubtful if statements such as this may be generally applied to sugar planters; after all, changes did occur.

The same can be said of slaves, who were generally described as lazy, ignorant, and also resistant to change. In twentieth-century literature it is often stated that the presence of such an abundant and cheap labour force was an obstacle to the rationalization of sugar production.

Since the end of the eighteenth century, most sugar plantations were absentee-owned and managed by administrators and directors whose interests did not always coincide with those of the owners. At times such people turned out to be thieves, or alcoholics who caused the ruin of the properties under their care. One should keep in mind, however, that their cases stand out in the plantation archives, whereas the "all is well" remarks do not make a lasting impression.

While in the course of time the majority of plantations had to give up sugar production, innovating plantations stood a far better chance of survival than those traditionally operated (Table 1). It is impossible to determine whether the lack of innovations on the latter plantations was due to conservative stubbornness, or to the inability to attract sufficient investment capital.

Yet, in the sugar sector as a whole, innovations were introduced continuously, and plantation output and productivity rose during the entire nineteenth century. Therefore it seems plausible that a majority of planters, administrators and directors indeed tried to run their operations as smoothly and efficiently as possible. They were striving for the maximization of productivity within the context of their (financial) possibilities.

This can be illustrated by the Vossenburg plantation, where a formerly highly praised director was fired after eleven years because

"from time to time he drinks to excess, which makes [the administrator] fear that this could have the saddest consequences for this property, and particularly a most unfavourable effect on the slave force; to have to report this made him [the administrator] very sad, because Mr. Polichy was known as a bright agriculturist."²³

Despite his unquestioned qualities, Mr. Polichy was fired as his drinking behaviour became a threat to optimal labour conditions.

On this same plantation the installation of a steam engine was discussed several times during the 1830s and 1840s, but every time it was rejected by the owners who thought it too expensive. Yet the management of this plantation could not be termed backward or opposed to change. During the years 1820-1858 at least thirteen improvements were introduced in the sugar factory, including the installation of horizontal rollers.²⁴

A final indication that planters and managers really were interested in modern plantation agriculture can be found in the lists of subscribers to two planters' guides in 1835 and 1858 (Teenstra and Hering). Both books were written to promote a scientific approach to planting, and the second one strongly advocated the application of the latest techniques such as vacuum pans and the central factory system. Almost fifty percent of all sugar plantations were 'covered' by subscribers to the first book (either their owner, administrator or director), while almost forty per cent were covered by subscribers to the much more specialized second one. This does not mean, of course, that all subscribers wholeheartedly supported the views of the authors, but neither can they be accused of remaining indifferent to new developments.

Were slaves opposed to change? Not if it was a change of their own choice, such as running away from the plantation, nor if a change clearly promised to improve their living conditions. Other changes however, often created uncertainty, or worsened conditions and to these they were understandably opposed. Slave resistance to resettlement, when their plantation was abandoned or sold, was common during the nineteenth century. There were also frequent labour strikes against heavy work loads or the cruelty of staff members. Of the Potribo plantation in 1829, the administrator reported with surprise that the director

"had given no other motive for grievances and bad conduct to the slaves, than his continuous insistence on regular and industrious labour."²⁵

Despite his surprise, the administrator, unwillingly, had to give in and replace the director.

There is a correlation between slaves' rebellious behaviour and the turn-over of plantation staff. This is illustrated at the Vossenburg plantation by the average number of severely punished slaves per year and the average number per period of white officials, of which there were never more than two at the same time.²⁶

Were slaves also opposed to technological changes, or incapable of handling more complicated machinery? This is unlikely. No single protest by slaves against technological innovation was registered. When the owners of Vossenburg, for instance, considered the installation of a steam engine, no one mentioned the possibility that slaves would not or could not operate such a device, whereas on other occasions the slaves' possible reactions were always taken into account.²⁸

In virtually every slave list of plantations with a steam engine, one or

more black engineers can be found. No complaint about them was reported. Moreover, when at the Rustenburg plantation in 1858 a group of Chinese indentured labourers worked side by side with slaves, all artisans and engineers were blacks and all Chinese were field workers.²⁹ This again suggests that slaves and advanced technology were not at all incompatible. Certainly, the more complicated the machinery in the sugar factory became, the more planters had to call on specialized technicians to install or repair these devices. But this was no indication that slaves in particular could not do the job; neither could the planters, nor the free local population: the majority of these specialists came from the United Kingdom.

TABLE 7: PUNISHMENTS AND SUCCESSION OF OVERSEERS
VOSSENBURG 1823-1844²⁷

period	average number of punished slaves	average number of white officials
1823-1824	1.0	2.0
1825-1829	4.0	2.8
1830-1834	7.0	3.6
1835-1839	1.6	2.8
1840-1844	0.6	2.2

Source: Sur. Mus.: Coll. Brantsen, Verslagboekjes 1823-1844.

As is well known, the average slave population on a plantation was not a homogeneous mass of field labourers, but a social configuration, differentiated by age, colour (all mulattos were elite slaves and did not perform any fieldwork) and occupation. Especially during the nineteenth century some important changes occurred in this configuration (Table 8).

The number of black overseers grew probably to compensate for a lesser use of the whip, due to more protective slave regulations. The proportion of artisan slaves declined, but their absolute number remained more or less stable, indicating that expanding sugar plantations needed no more than a fixed number of artisans.

The number of domestic slaves showed a relative decline, but their absolute numbers increased as a result of the growing number of white officials who had to be taken care of. All in all, the proportion of elite slaves (A+B+C) declined steadily. This tendency points to a process of 'proletarianization' of the labour force, a not uncommon phenomenon in modernizing enterprises.

This trend seems to contradict the more than proportional decline of the group directly responsible for sugar production, the field labourers.

TABLE 8: OCCUPATIONAL COMPOSITION OF THE SLAVE FORCE
1770 - 1862

period	average popul- ation	black over- seer (A)	artisan (B)	domestic (C)	A+B+C	
1770-1779	147	1.8%	8.4%	5.1%	15.3%	
1820-1835	145	2.0	7.2	5.1	14.3	
1850-1862	205	2.3	5.5	4.4	12.2	
	field work	odd jobs (D)	non- produc tive (E)	child (F)	D+E+F	(n)
1770-1779	47.2%	4.2%	7.6%	25.5%	37.3%	24
1820-1835	45.4	6.3	8.4	25.0	39.7	20
1850-1862	40.6	6.0	8.9	31.8	46.7	13

Source: plantation records.

In reality however, their average numbers increased after the 1830s, although not as fast as the slave population as a whole (20 and 41% respectively). This unbalanced growth was caused by the rapidly rising numbers of non- or semi-productive slaves during the final decades of slavery (D+E+F). At the end of the 1820s slave imports had virtually come to an end, whereas infant mortality was still high. This resulted in a more than proportional increase in the number of slaves in the non-productive age-brackets. On the other hand, during the final years of slavery the proportion of elderly people remained constant, whereas improved child care resulted in a remarkable growth of the (potentially) productive people of the future. The latter development was partly the result of planters' policies to increase the natural reproduction of labour. This policy was definitely in line with rational labour management.

Nevertheless, the number of 'idle' mouths to be fed had risen to a high level. Substantial growth of productivity, by full-speed mechanization or rationalization of production, might have solved this problem. In reality, the latter process did not proceed fast enough, and productivity even slightly declined (Table 5).

Emancipation, of course, put an end to the planters' legal obligation to take care of the unproductive part of the slave population. The question whether slave labour was more expensive than free labour during the second

half of the nineteenth century still remains to be answered. The scanty profitability figures seem to suggest that it was (Table 6).

Was, finally, a cheap and abundant slave labour force hindering the rationalization of sugar production? It is hard to determine whether slaves were abundant and cheap before the end of the 1770s. Between 1750 and 1780 average yearly imports for Suriname as a whole amounted to almost 4,200 slaves (the plantation population around 1770 was ca. 60,000), and the average purchase price for slaves of all ages was Fl. 255.³⁰ It is difficult to say whether this import was sufficient for the sugar sector. From the end of the 1770s however, slaves were always in short supply and expensive. During the years 1780-1795 average imports amounted to no more than 1,050 slaves per year and their price had more than doubled.³¹ Enormous debts and lack of capital prevented planters from buying new slaves, and this made Suriname unattractive for slavers. Slaves became scarce 'goods' and prices skyrocketed. This was the more serious since at that time the annual natural decrease of the slave population may have averaged 4% (Lamur 1977:163). In the sugar sector the result was a severe decline of the total slave population from almost 17,000 slaves around 1770 to just over 10,000 in 1813.³² Obviously this had negative effects on sugar production. As early as 1786 sugar plantations could be observed

"where one has more cane on the fields, than one can cultivate with the labour force; a shortage of which one can see too many examples over the past few years" (Blom 1786: 55).

In these circumstances the arrival of the higher yielding Otaheite cane variety must have been considered a blessing. Other, more capital intensive innovations to compensate for the labour shortage could only be dreamt of.

After the all-time low population figure of 1813, the sugar sector showed a remarkable recovery. Total slave population in this sector rose from well over 12,000 in 1827 to almost 20,000 in 1862.³³ It is striking that so many slaves were available, because slave imports had completely ended after the 1820s and natural reproduction was still below the death rate, albeit not as seriously as during the eighteenth century. Reconstruction and remittance of old debts, high profits and some fresh credit supplied the necessary capital to make this expansion possible. Also, sugar planters had been buying slave labour from the rapidly deteriorating coffee sector since the turn of the century, and, to a much lesser degree, from the cotton sector after the 1830s.

Again the question arises whether this great influx of slave labour was

an obstacle to innovation. Apparently it was not, because it was precisely during these four decades that the majority of surviving sugar plantations changed from water, or animal, to steam power, all kinds of labour saving devices were introduced, and the first central factory was constructed. This suggests that the existence of a large number of slaves was not incompatible with technological innovation at all; at the same time, it may also imply that there was still a labour shortage.

As for this latter assumption, it turns out that slave labour indeed had not become a cheap commodity.

Again the Vossenburg plantation provides the best example. In the 1760s slaves were bought for this plantation at an average price of Fl. 280 per slave. This rose to Fl. 610 in the 1790s. During the 1820s an average fieldhand cost the owners Fl. 650, the next decade Fl. 1,000 and during the early 1840s even Fl. 1,200 – 1,400.³⁴

To avoid these heavy expenses, the planters might try to hire slaves. This, however, was easier said than done. In the beginning of 1835 it was decided at Vossenburg that a piece of land had to be turned into a polder for new cultivation. It was not until the end of 1838 that 20 slaves could be hired from three coffee plantations to do the job in two months at Fl. 1.25 a day per slave. The same happened in 1852, when the managers had to wait until the end of 1855 to find a labour gang for hire.³⁵

The example of Vossenburg indicates that the release of labour from other plantation sectors was not sufficient to meet demands in the sugar sector. This labour shortage was caused by a chronic, though diminishing, natural decrease of the slave population, by the rapid expansion of some plantations, and by a less oppressive labour regime.

The improvement of labour conditions may have been a deliberate policy in order to lessen the labour shortage. Mechanization was another means to reach this end. Neither of these policies depended on the abolition of slavery. Curiously, at the Meerzorg plantation, the introduction of a steam-driven mill in the late 1820s stimulated demographic growth, whereas Emancipation had a negative influence.

Even if the Meerzorg plantation was not representative of the Suriname sugar sector as a whole, it illustrates at least that Emancipation did not guarantee demographic improvement in the slave population. On the contrary: Emancipation, and the subsequent import of indentured labour from Asia, seem to have given planters the idea that they were now relieved of their human and managerial duty to take care of the labour population. This illustrates that a rational labour policy and free labour were not 'naturally' linked phenomena.

TABLE 9: DEMOGRAPHIC BEHAVIOUR OF THE BLACK POPULATION AT MEERZORG 1818 – 1872

period	natural decrease (yearly average)	natural increase (yearly average)
1818-1827	4.40%	
1838-1842	0.10	
1849-1851		1.94%
1857-1859		0.42
1863-1872	0.37	

Source: ARA: Coll.v.d. Bosch, 141; ARA: MvK, A-792; ARA: OB&W 1828-1876, 3036; SS: slavenregisters; ARA: Coll. Berg, 349.

CONCLUDING REMARKS

Developments in the sugar sector of the Suriname plantation economy can not be analyzed without paying attention to other sectors too, particularly coffee. The boom in coffee production during the third quarter of the eighteenth century attracted the better part of the capital, slaves and fertile lands to this sector, thereby hindering further development in the sugar sector. Moreover, the negative economic performance of the dominant coffee sector gave a bad name to the entire Suriname plantation economy, resulting in a negative Dutch investment climate during the nineteenth century.

Nevertheless, in the sugar sector innovations were always a common phenomenon. In general, plantations innovating more rapidly in the eighteenth century turned out to have a significantly better chance of survival during the next century, than those traditionally operated.

Innovations were partially of an output-increasing, partially of a labour-saving character. The former were part of a process originating long before the nineteenth century, which seems to indicate that there is no clear interdependence between innovation and labour system. Labour saving techniques, on the other hand, were only introduced from the end of the eighteenth century, implying that labour was becoming a scarce commodity. This too undermines the assumption of an incompatibility of technological progress and slave labour.

The extension of the cane cutting period into less favourable seasons and the prolongation of ratoon age during the nineteenth century again point to labour scarcity. This is further confirmed by constantly rising slave prices from the late 1770s, the virtual impossibility of hiring labour gangs in a period when labour supply from other plantation sectors was

very high, and, finally, by the more than proportional growth of the non-productive part of the slave population. Therefore, rationalization of sugar production was not hindered by a supposedly cheap and abundant labour force. Even when during the nineteenth century the influx of labour into the sugar sector was high, so were levels of mechanization.

The assumption that planters or slaves were opposed to innovation may be disregarded as a myth. As long as they could afford it, most planters applied new technology, and slaves were as willing and able as anybody else to work with it.

A result of these innovations was that the productivity of both labour and cane were almost constantly on the rise until shortly before Emancipation. Labour unrest then provoked a slight decline in productivity. Further innovations after Emancipation increased cane productivity again to unprecedented levels. Labour productivity, on the other hand, recovered only belatedly, and during that century never touched pre-Emancipation levels again.

Conclusions about the development of profitability must be drawn with the utmost care, since data are scarce and disjointed. In general, the available data suggest that from the middle of the eighteenth century until the 1790s, the sugar sector produced at a loss, due to heavy debts and relatively low productivity. In a next phase, when most debts were given up as uncollectable and counter-productive (at the cost of the Dutch investors), when prices were relatively high, and when productivity increased considerably (thanks to the introduction of Otaheite cane), the sugar sector began to prosper, reaching an all-time high profitability level during the 1820s. Falling prices and the high cost of slaves and new technology caused a severe drop in profitability during the next two decades. Yet as Emancipation came within sight, the sugar sector seemed to have recovered and, from an economic point of view, to have been prepared for a successful transition to free labour. This appears to be confirmed by the profitability level of the 1880s.

To summarize, in the Suriname sugar sector slave labour and technological progress were by no means incompatible. The introduction of more advanced technology did not have to wait for the abolition of slavery.

ABBREVIATIONS

ARA	Algemeen Rijks Archief, Den Haag
EHB	Economisch Historisch Bibliotheek, Amsterdam
GAA	Gemeente Archief Amsterdam

GAR	Gemeente Archief Rotterdam
Hu.	Collectie Hudig
KIT	Koninklijk Instituut voor de Tropen, Amsterdam
KV	Koloniaal Verslag
OB&W	Onbeheerde Boedels En Wezen, 1828-1876
MvK	Ministerie van Koloniën
PRO	Public Record Office, London
PWIB	Particuliere West Indische Bank
RvP	Raad van Politie
SNA	Suriname na 1828, Notarieel Archief
SONA	Suriname Oud Notarieel Archief
SS	Staats Archief Suriname, Paramaribo
Sur. Alm.	Surinaamsche Almanak
Sur. Mus.	Surinaams Museum, Paramaribo

NOTES

1. See the Introduction of Boomgaard & Oostindie in this volume. I should like to express my gratitude to both Peter Boomgaard and Gert Oostindie for their constructive criticism, and their moral support.
2. Sample of 313 mortgaged plantations in GAA: NA, 9003-10365.
3. Van Stipriaan 1987:16-7.
4. During the years 1799-1802 Suriname was a protectorate of Great Britain, and from 1804-1816 it was a British colony. In 1807/1808 the African slave trade was abolished in all British colonies.
5. According to Watts (1987: 420) this invention was introduced around 1755, while in Suriname it was not found before the early nineteenth century (Teenstra 1835 I: 220).
6. ARA: Van den Bosch, 142.
7. ARA: M.v.K., A792. At Meerzorg plantation the difference was even more astonishing. Total death surplus of the years 1818-1827 was 39.5%. In 1828 a steam mill was installed. In the years 1838-1842 the percentage of deaths over birth dwindled to a mere 0.3%. (ARA: Van den Bosch, 141; ARA: M.v.K., A792). Note that these figures concern slaves of all ages.
8. Teenstra 1835 I: 82; KV 1862.
9. An example of this mechanization is provided by the government-owned plantation Catharina Sophia. In the early 1860s this plantation had three steam engines, which operated a traditional boiler and pump, a multi-tubular boiler, four clarifiers, two cane carriers, two trash carriers and a trash elevator, while transportation over the factory grounds was provided by well over half a kilometer of railways. (ARA: PWIB, 146)

10. This started in 1874 at plantation De Resolutie, where it was literally stated that "up till now, manuring has not been applied in this colony". (Cited in Reyne 1922: 23). In the 1830s a few planters seem to have experimented with cow dung, but according to a planters guide, this was soon given up as worms entered the cane stool and its roots (Teenstra 1835: I: 202).

11. Reyne 1922: 22 and inventories of plantations Groot Chatillon, Perou, Libanon, Hooyland, Soribo and Roosenburg. (ARA: SONA, 292 and 295; GAR: Hu, 229).

12. In some plantation inventories ploughs were mentioned, but these were probably only used when old sugar fields were prepared for fallowing.

13. Production figures of a sample of 11 plantations revealed that, compared to the first ratoon, the second produced 92%, the third 70%, the fourth 66% and the fifth 56% of its sugar quantity. (Plantation archives 1820-1860.)

14. Samples of 20 plantations producing during 1750-1799 and 15 plantations during 1820-1860 (ARA: SONA and SNA; and plantaton archives) and Hoefte 1987: 241.

15. Table 10: Suriname sugar sector 1750-1900.

year	slaves	fieldhands	cane area (ha.)	production (kg.)
ca.1750	15,315	7,924	7,021	8,423,663
ca.1790	14,292	8,575	6,875	7,452,266
ca.1825	12,352	5,925	6,459	9,621,333
1854	17,884	7,442	7,442	17,068,533
1862	19,789	7,977	7,977	15,800,256
1882	-	6,448	3,929	9,794,133
1899	-	4,972	1,992	9,566,752

Source: 1750-1825 are extrapolations based on samples of ARA (SONA and SNA), and plantation archives, in which $n = 44$ (1745-'55), 28 (1783-'95), 18 (1820-'29). The number of plantations is based on ARA: RvP, 607 (1750); Surinaamsche Staatkundige Almanach 1796 (1790); ARA: Van den Bosch, 161 (1825). All data 1854-1899: KV of relevant years. All production figures are 3-year averages based on Nassy 1791: appendix; GAR: Hu., 164; Van der Voort 1973:237 and 260; Sur. Alm. 1824-1826; KV of relevant years. For the years 1882 and 1899 all indentured labourers are considered field hands.

16. Ibidem.

17. The increased percentage of field hands in 1825 was a result of the paradoxical situation that after the abolition of the slave trade with Africa, illegal imports and imports from the French and Danish islands, which were not forbidden, rose to a level unknown since the 1770s. In 1828 this trade came to a virtual stop as a result of the introduction of compulsory slave registration.

18. See note 24.

19. After Emancipation a 10-year apprenticeship system was introduced. After 1873, the large majority of ex-slaves left the plantations and were replaced by indentured labourers from British India and, later, from Java.
20. Profits are calculated as total income minus all costs. This includes all plantation costs, transportation costs, market costs, mortgage costs and interests.
21. Data from plantations: Aurora, Bleyendaal, Catharina Sophia, Crawassibo, Groot Marseille, Kroonenburg, Libanon, Lunenburg, Meerzorg, Perou, Potribo, Rustenburg, Sinabo, La Singularité, Siparipabo, Vossenburg, Vreedenburg, Waterwijk, Wayampibo, Wolffs Capoeira, Zoelen, Zorg en Hoop.
22. KIT: Coll. Van Breugel.
23. Sur. Mus.: Coll. Brantsen, Verslagboekje 1835.
24. Ibidem, 1820-1857.
25. GAA: PA-600, 544.
26. In the plantation hierarchy white officials held a rank below that of plantation director.
27. These punishments concern only the most severe crimes, such as running away or violent behaviour.
28. Sur. Mus.: Coll. Brantsen, Verslagboekjes 1834 and 1848.
29. ARA: PWI-Bank, 179.
30. Goslinga 1985: 615-619; Postma 1975: 237-242; plantation records.
31. Ibidem.
32. 1770: extrapolation based on a sample of 41 sugar plantations; 1813: PRO: T-75, 14 and PRO: Co-278, 15.
33. 1827: ARA: Coll. Van den Bosch, 161; KV 1862.
34. EHB: KA-87, 17; Sur. Mus.: Coll. Brantsen, Verantw. Rek.
35. Sur. Mus.: Coll. Brantsen, Verslagboekjes for relevant years.

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